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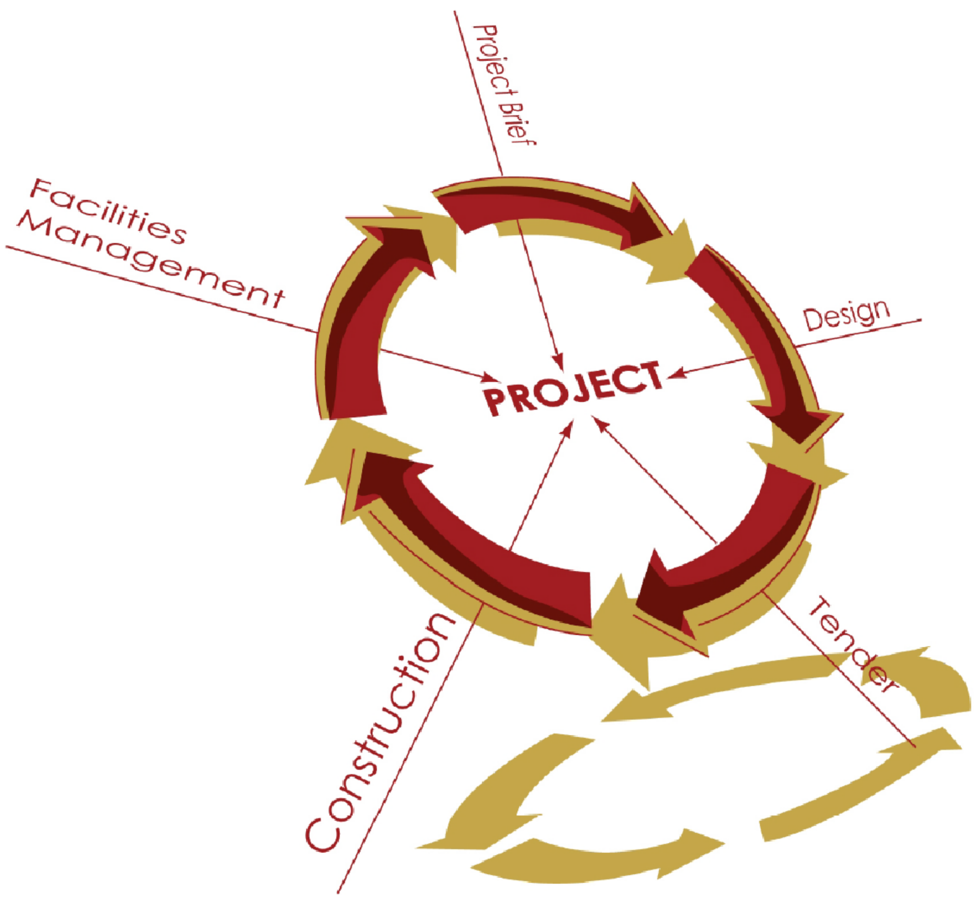
EMPOWERING THE BUILT ENVIRONMENT : NURTURING SKILLS FOR SUSTAINABLE DEVELOPMENT



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Contents

Introduction v

Editorial Advisory Board vi

Editorial viii

INTEGRATION OF FACILITIES MANAGEMENT (FM) DURING DESIGN STAGE FOR OFFICE BUILDING IN MALAYSIAN CONSTRUCTION INDUSTRY 1
Nurulhuda Hashim, Myzatul Aishah Kamarazaly and Lim Yi Xin

THE IMPACT OF IMPLEMENTING THE NEW MALAYSIAN STANDARD METHOD OF MEASUREMENT (MySMM) 2020 IN THE MALAYSIAN CONSTRUCTION INDUSTRY 16
Loo Seong King, Myzatul Aishah Kamarazaly and Tan Kher Xin

THE IMPACT OF INDIVIDUALISM/COLLECTIVISM ON DISPUTE RESOLUTION: A VIEW FROM THE MALAYSIAN CONSTRUCTION INDUSTRY'S STATUTORY ADJUDICATION REGIME 28
Farrah Azwanee Aminuddin and Paul Chynoweth

GENERATION Z: SKILLS FOR QUANTITY SURVEYING GRADUATES 49
Veronica Kah Jo Wong, Yoke Mui Lim and Nurul Sakina Mokhtar Azizi

SMART B2B ONLINE PROCUREMENT CLOUD PLATFORM IN MALAYSIAN CONSTRUCTION INDUSTRY 66
Myzatul Aishah Kamarazaly, Shirley Chin Ai Ling and Julian Au Mun Hoong

THE MODERATING EFFECT OF PRIOR EXPERIENCE ON SMART HOME TECHNOLOGY ADOPTION 81
Fock-Kui Kan, Esther Wong Siaw Wei and Winnie Wong Poh Ming

PROSPECTS AND CHALLENGES OF DIGITAL TRANSFORMATION IN THE MALAYSIAN CONSTRUCTION INDUSTRY 104
Han Seng Kong and Chiew Wei Jie

EMPLOYEE ENGAGEMENT IN BUILDING INFORMATION MODELLING (BIM) BASED PROJECTS: A SYSTEMATIC REVIEW 127
Wong Foo Yeu and Yew Yee Fang

PROPOSED METHODS IN ENHANCING THE BIM-BASED QUANTITY TAKE-OFF 146
Lam Tatt Soon, Wan Jing Ng and Book Tik Leong

IDENTIFICATION OF ECO-INNOVATION (EI) COMPONENTS WITHIN CONTRACTOR'S SCOPE OF WORK 162
Aimi Shahirah Fisol and Nazirah Zainul Abidin

CHALLENGES OF IMPLEMENTATION ENERGY RETROFIT IN EXISTING BUILDINGS IN MALACCA MALAYSIA 179
Kai Chen Goh, Nadzirah Zainordin and Sui Lai Khoo

A SUSTAINABLE DECISION MAKING MODEL FOR THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGIES IN THE MALAYSIAN CONSTRUCTION INDUSTRY – A PILOT STUDY 194
Nur Hidayah Idris, Rohana Mahbub and Norfashiha Hashim

SUSTAINABLE SMART CITY (SSC) ATTRIBUTES VIA SYSTEMATIC LITERATURE REVIEW 212
Nadzirah Zainordin, Sui Lai Khoo, Zairra Mat Jusoh, Irna Nursyafina Rosdi, Ika Diyah Candra Arifah and Kai Chen Goh

DELIVER 21ST CENTURY QUANTITY SURVEYOR BIM SKILL SET: A SNAPSHOT OF ACADEMIC READINESS IN MALAYSIAN HIGHER EDUCATION INSTITUTIONS 225
Wong Shi Yin and Wong Chee Hong

DETERMINING THE CURRENT PRACTICES IN BUILDING MAINTENANCE MANAGEMENT FOR PUBLIC UNIVERSITY BUILDINGS IN MALAYSIA 241
Prescilla Palis, Mohd. Saidin Misnan and Sylvia Gala Mong

VERBAL COMMUNICATION BETWEEN CONTRACTORS AND FOREIGN WORKERS 254
Kai Chen Goh, Nadzirah Zainordin and Sui Lai Khoo

THE POTENTIAL OF SMART WEARABLE TECHNOLOGY IN MALAYSIAN CONSTRUCTION HEALTH & SAFETY 267
Faraziera Mohd Raslim, Koo Jia Ern and Hamizah Liyana Tajul Ariffin

IDENTIFYING CONSTRUCTION SUPERVISOR COMPETENCIES FOR EFFECTIVE SITE SAFETY IN SARAWAK 282
Magdalen Petrus, Ting Siew Lung and Esther Wong Siaw Wei

RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE IN THE MALAYSIAN CONSTRUCTION INDUSTRY 293
Yoke-Lian Lew, Yang-Jie Ong and Jeffrey-Boon-Hui Yap

SUSTAINABILITY CRITERIA FOR AFFORDABLE HOUSINGS IN KLANG VALLEY MALAYSIA 303
Lai Li Xuan, Wong Phui Fung and Felicia Yong Yan Yan

Introduction

Welcome to this special issue in the Malaysian Construction Research Journal (MCRJ) for "Empowering the Built Environment: Nurturing Skills for Sustainable Development", which was compiled by RISM and UCSI University.

This Special Issues of MCRJ consists of 20 selected papers by scientific committee and expert reviewers. The main theme as "Empowering the Built Environment: Nurturing Skills for Sustainable Development" with five (5) sub-themes: Construction 4.0, Contract and Legal Matters, Sustainable Development, Retrofitting, Information Technology and QS Profession.

This is consistent with the Construction Industry Transformation Plan (CITP) agenda to gear professional practices and sustainability within the industry. In addition to the practices, the discussion is toward technology implemented and adopted, which is in line with the Construction 4.0 that the Malaysian construction industry is trying to cope with.

Hence, it is believed that these special issues may contribute to promoting the QS profession and professional practices in Malaysia to deliver professionalism as well as to sustain Malaysia's construction industry. The aspect of the main concern should be taken by the QS Profession are highlighted thru the sub-theme. Therefore, one of the initiatives to publish with the Special Issues volume to shows that QS Profession are coping with the current construction issues as well as to contribute to enhancing knowledge among not only QS Profession also to all construction players.

Editorial Advisory Board

Secretariat Special Issue

Editorial

Welcome from the Editors

Welcome to this special issue in Malaysian Construction Research Journal (MCRJ) for the Royal Institution of Surveyors Malaysia (RISM) and UCSI University. We would like to express our sincere gratitude to our contributing authors, reviewers, organizers and readers.

This Special Issues of MCRJ contains twenty (20) interesting papers covering the five (5) sub-themes: Construction 4.0, Contract and Legal Matters, Sustainable Development, Retrofitting, Information Technology and QS Profession. It is hoped that the readers would greatly benefit from the scientific content and quality of papers published in this issue:

Brief introduction of each article is given as hereunder:

Nurulhuda Hashim et al., have presented the integration of facilities management (FM) during design stage for office building in Malaysian construction industry. To achieve the purpose of this research, qualitative research method with semi-structured questionnaires were designed and sent to gather information from architects and facilities manager in the industry. The results showed that there is integration of FM during design stage with full integration of FM related issues into design in the industry. However, FM team and Architect have different perceptions on the necessity of having such integration during design stage. It is important for a building to balance between maintainability and aesthetics given that architect and facilities manager have different concerns while designing a building. The data collected improves such integration to ensure the cost effectiveness during the operational life of an office building.

Loo Seong King et al., have explored the impact of implementing the new MySMM 2020 in the Malaysian construction industry. This paper aims to study the impacts of MySMM on the future construction industry in Malaysia with discussions on the new improvements and issues in the application of SMM. Comprehensive literature reviews and a qualitative approach were applied to obtain the data through semi-structured interviews with several experienced Consultant Quantity Surveyors (QS) in the Klang Valley. The findings showed that the utilizing a standard method of measurement remain pessimistic due to various factors. Thus, the research outcome intends to increase the acknowledgment and adoption of the MySMM to the extent that standardizing method of measurement is achievable by means to advance the Malaysian construction industry towards digital transformation.

Farrah Azwanee Aminuddin and Paul Chynoweth have focused a view from the Malaysian construction industry’s statutory adjudication regime on the impact of individualism/collectivism on dispute resolution. This paper is to assess the influence of collectivism on dispute resolution through a qualitative study through the adoption of the CIPAA. The study draws data from 15 semi-structured interviews. Through thematic analysis, data were coded and categorised to address the inquiry. Patterns emerging from the data were compared against the proposition. Findings from the data shows that adjudication has more favourable compatibility with the collectivist Malaysian construction parties. The group attachment factor within the construction parties’ relationships is the primary drive for the adoption of adversarial dispute resolution methods in the collectivist society. The paper presents the influence of collectivism to establish how cultural values impact the dispute resolution process. The findings hope to foster a better understanding of national culture when implementing foreign-oriented legislation to the local societal setting.

Veronica Kah Jo Wong et al., have studied on the skills of generation Z quantity surveying graduates. A quantitative research method was used where a total of 33 responses from consultant firms registered under the Board of Quantity Surveying Malaysia were received. Statistical Package for Social Science (SPSS) is used to tabulate and analyse data collect from survey. The findings showed that employers expect QS graduates to have excellent skills in Communication, Teamwork, Time Management, Lifelong Learning and Professional Ethics and Moral. Whereas for technical skills, it is important that QS graduates are computer literate. The findings will assist graduates in better planning their future careers by identifying the acquired abilities they need to improve in order to fulfil the expectations of employers and achieve a competitive advantage in the job market, whereas employers should also understand the characteristics of generation Z towards workplace.

Myzatul Aishah Kamarazaly et al., have proposed a smart B2B online procurement cloud platform in Malaysian construction industry. Contractors and suppliers have been aimed as the study's target population with the employment of qualitative research method. The results revealed that four out of seven contractors and suppliers entering thee-procurement platform. However, the extent of applying e-procurement in Malaysian construction industry is considered medium-low and unstable as it relatively new to the industry. It was also found that every respondent has agreed that the procurement barriers of long process cycle are critical. Therefore, practical solutions for a wider e-procurement adoption and practice in Malaysian construction industry has been suggested by the respondents that the adoption of e-procurement practice, it will potentially enhance the efficiency of the golden triangle in Malaysia's construction industry, which impacts time, cost, and quality constraints. In addition, it allows companies to be more transparent on showcasing their profiles and obtain a network of ready buyers and verified sellers. With e-procurement practice embedded into construction businesses, it ensures technology takes prime position, and the e- procurement platform will reinforce revenue generation with continued business success within contractors and suppliers in future project delivery. This leads to an envisioning digitalization approach for potential contractors and suppliers to on-board by adopting an efficient and effective e-procurement practice.

Fock-Kui Kan et al., have investigated the moderating effect of prior experience on smart home technology adoption. This research adopted a quantitative approach, adapting measurement scale from seminal works in Technology Acceptance Model (TAM). The respondents comprise households from various states of Malaysia and were selected via convenient sampling. Smart Partial Least Square technique was employed to examine the moderators in a structural equation model setting. The research has found that perceived usefulness and perceived ease of use lead to attitude toward technology. Whereas, attitude toward technology is positively related to intention to use smart home technology. Besides, prior experience is found to exert moderating effect on the relationship between attitude and behavioural intention. The findings have enriched the technology acceptance literature, providing insights into the influence of prior experience in predicting households' attitudes and intention to embrace smart home technology.

Han Seng Kong and Chiew Wei Jie, have identified the prospects and challenges of digital transformation in the Malaysian construction industry. A qualitative approach is adopted by interviewing experienced industry professionals selected via judgemental sampling techniques. Thus, a total of 8 virtual semi-structured interviews were conducted. The findings show the undeniable benefits of improved productivity and efficiency, less dependency on foreign labour, better site safety and management and greater accuracy from digital transformation. However, the process toward the goal is hindered by a lack of understanding on the trends and benefits of digital transformation, the cost of digital technologies, financial capability of companies, consideration of ROI and the lack of skilled manpower to operate these technologies. To overcome the obstacles, action from the Government in terms of relevant policies, education and training to prepare the needed manpower and initiatives from developers are important. Digital transformation is a critical milestone and the way forward into the future of the post Covid-19 construction industry.

Wong Foo Yeu and Yew Yee Fang have reviewed the employee engagement in building information modelling (BIM) based projects. Sixteen journal articles of relevant studies were carefully selected via the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The said journal articles are from prolific academic databases, namely Web of Science (WoS), Scopus, and Emerald. A thematic analysis was conducted to identify the themes and sub-themes of the relevant topic. This paper proposes five main themes, which are work-life balance, training and career development, reward programme, management, and work environment, followed by twenty-five sub-themes suggested from these five themes. Several future directions and recommendations are proposed, such as conducting further research on realistic motivational factors to engage employees towards BIM adoption, narrowing down the search criteria in the context of region and professions, and conducting evidence-based research on the current development of BIM to escalate the proliferation of BIM.

Lam Tatt Soon et al., have proposed methods in enhancing the BIM-based quantity take-off. This research aims to discover the methods to overcome the constraints of BIM-based QTO with the adoption of the qualitative method via an exploratory case study in a residential project. In addition, the research is conducted to identify the factors affecting the quantities differences in manual QTO and BIM-based QTO through a taking-off process following Standard Method of Measurement Building Works Second Edition (SMM 2) and ascertains the constraints of BIM-based QTO from the taking-off process. The findings are expected to allow professional bodies to enhance the BIM-based QTO in Malaysian Construction Industry by developing practical guidelines and strategies to maintain their competencies in this essential and expanding digital era.

Aimi Shahirah Fisol and Nazirah Zainul Abidin, have reviewed the identification of eco-innovation (EI) components within contractor's scope of work. It was suggested that generally, product EI, process EI and management EI are the primary principal of EI. Within these three main components, the sub-components are sustainable product procurement, sustainable product management, implementation of environmental-friendly technology, sustainable site operation, implementation of sustainable project policy, project collaboration and networking as well as sustainable management of human resources. Understanding these EI components will aid contractors to comprehensively adopt EI practices within the scope of their works and support better quality and performance of the construction sector towards a more sustainable future which contributed to better economic and environmental value.

Kai Chen Goh et al., have examined the challenges of implementation energy retrofit in existing buildings in Malacca Malaysia. This study employed a semi-structured interview as a method, with twelve interviewees being the energy service firm hired to complete the project in Malacca. The study's findings revealed that the foundational document was the primary driver and source of most of the project's problems in Malacca. However, the building owners received the retrofit project well, and each one had a chosen system that was retrofitted as part of the energy conversion project due to the structure's primary use. This research aims to provide insight into the issues retrofit participants had during the projects in Malacca or elsewhere in Malaysia in the future.

Nur Hidayah Idris et al., have studied a sustainable decision making model for the implementation of innovative technologies in the Malaysian construction industry. Out of 100 respondents, 31 responded to the questionnaire survey. Internal consistency reliability, which is determined by alpha coefficient reliability or Cronbach Alpha, is used to assess the instrument's reliability. The results of this pilot investigation suggest that the instrument is both valid and reliable. Descriptive Statistical data in this study shows that Malaysian Construction Organisations reached a consensus on TOEES framework where Economic and Security constructs are equally important as the other three constructs. The results reveal that Organisational Constructs; Leadership vision & Managerial Relations is the most important criteria upon deciding for the implementation of innovative technologies. The proposed TOEES decision making framework and identification of decision making criteria are expected to facilitate the construction decision-makers in deciding the implementation of innovative technologies in the future.

Nadzirah Zainordin et al., have presented the Sustainable Smart City (SSC) Attributes Via Systematic Literature Review which SSC implementation have drawn significant attention as initiatives for enhancing urban development. Many studies have incorporated technical and non-technical characteristics to better control the growth of smart cities. However, despite considerable achievements, the direct and indirect effects of smart city characteristics on SSC have not been quantified comprehensively. Thus, the objective of this research is to identify the attributes of sustainable smart city via systematic literature review method. Only journal with Scopus index to consider as a references for this research with year interval of publication between 2012 to 2022. The findings of the thirty-two (32) attributes of SSC have been identified which this may further boosting the level of knowledge among built environment practitioner to have in-depth knowledge before it can be further adopting into relevant vision, mission, strategies or even policy maker.

Wong Shi Yin and Wong Chee Hong have explored a snapshot of academic readiness in Malaysian higher education institutions to deliver the 21st century quantity surveyor BIM skill set. The data collection exercise was conducted through an online interview and questionnaire survey. There were seventeen public and private interviewees selected from local HEIs. These interviewees held significant roles in delivering BIM QS curriculum. The findings shows that although the BIM uptake has been advocated by the local HEIs since early 2010s, it is noticeable that a number of the interviewed HEIs continues to face challenging issues when delivering BIM in QS programmes. The industry remains in a shortage of BIM capable graduates for the workforce.

Prescilla Palis et al., have determined the current practices in building maintenance management for public university buildings in Malaysia. Despite the prior investigation in this research field, maintenance of university building appears to be a trivial factor. As such, this present study looked into the practices of building maintenance management in five Malaysian public universities. Data gathered from 10 building maintenance experts via interview were analysed via single- and cross-case analyses. The study outcomes revealed that the university maintenance department deployed the following practices; prioritise maintenance, planned maintenance, preventive maintenance, and corrective maintenance.

Kai Chen Goh et al., have examined the verbal communication between contractors and foreign workers. This study was conducted in Batu Pahat, Johor. Contractors, developers, and foreign employees were all involved. These respondents were chosen because they are the most important parties participating in the building site communication process. Triangulation design for mixed technique is the method used. The mixed method approach was chosen because it may combine the strengths and weaknesses of quantitative and qualitative methodologies. Both a survey and an interview are carried out. Contractors, site supervisors, and project managers were given questionnaires, and foreign workers were interviewed. The results demonstrate that there is no evidence of adopting any alternatives to overcome communication problems, but respondents have recommended another option: the use of body language. In conclusion, the research findings indicate that aside from decreasing worker productivity, there are several negative consequences of a communication failure that may lead to construction failure.

Faraziera Mohd Raslim et al., have studied the potential of smart wearable technology in Malaysian construction health & safety. In this study, a total of 115 Malaysian contractor firms registered under CIDB Grade 4 to Grade 7 in territory of Kuala Lumpur, Selangor, Penang, Johor Bahru have participated. Descriptive statistical analysis was used to analyse the data collected. Type of smart wearable were grouped into smart PPE, smart wrist-worn devices, clip-on wearable devices, and exoskeleton. The top three most significant challenges found in this research are cost of implementation, shortage of skilled personnel & aging of workforce and lack of awareness & understanding on wearable. Whilst the top three most vital CSFs are top level management support and leadership, corporate financial resources and corporate culture towards innovation and workplace safety.

Magdalen Petrus et al., have identified the construction supervisor competencies for effective site safety in Sarawak. Total 225 response from professional’s team including G5 and G6 contractor obtained in this research. Self-administered questionnaire was distributed to them since they have more experience in the implemented method of safety regulations through handling large projects. Collected data was analyse using Microsoft Excel and represented in figures, which are based on the respondent frequency and Relative Important Index (RII). To be compendious, there are 17 supervisor competencies that were ranked by the RII. Based on the results, the most important construction supervisor competencies for effective site safety in Sarawak, Malaysia is to have an organizing efficient safety communication, job planning and delivering, lesson learned from accidents, adapting safety and health materials into simple language should be taken into account together with other competencies variables such as safety plan implementation, providing training by using natural language, and knowledge of distributing daily work tasks. The results show the top seven most recommended competencies that may help the front-line construction supervisor to improve their knowledge, and the ability to determine all future occupational dangers and hazards in Sarawak's ongoing building project.

Yoke-Lian Lew et al., have explored the recycling of construction and demolition waste in the Malaysian construction industry. This research has adopted quantitative research method in which a total of 800 questionnaires were distributed to construction practitioners within Klang Valley, Malaysia. The overall response rate in this research was 21.38%, a total of 171 responses collected. The respondents come from three different types of companies, which are contractor, consultant and developer. The level of awareness of the practices of recycling C&D waste was identified, which 80% of the respondents are well aware of the practices of recycling C&D waste. This research has also identified eight benefits, and 9 barriers of recycling C&D waste as faced by the Malaysian construction practitioners. The five most important benefits of recycling C&D waste identified included: (1) sustainability, (2) lesser negative environmental impacts, (3) natural resources savings, (4) reduction in public health and social issues, and (5) reduction in landfill spaces. Meanwhile, the five most agreed barriers of recycling C&D waste revealed: (1) high cost of recycling, (2) lack of government policy and regulation, (3) technological barriers, (4) lack of market recycled products, and (5) lack of incentives. This research seeks to alert the Malaysian construction practitioners on the problem of C&D waste and wished to motivate and encourage the practice of recycling C&D waste in the construction industry.

Lai Li Xuan et al., have proposed the sustainability criteria for affordable housings in Klang Valley Malaysia. The criteria contributing to sustainability in affordable housing were categorised into the environment, economic, social and technological criteria A questionnaire was designed and distributed to B40 and M40 homebuyers in the Klang Valley. The data obtained were analysed using Arithmetic Mean, Mann-Whitney U Test and Kruskal-Wallis Test to identify the differences between each demographic group on sustainability criteria. This study concluded economic sustainability is essential in sustainable, affordable housing development from the homebuyers' perspective. Results also revealed that homebuyers with different demographic backgrounds have different preferences on sustainability criteria when purchasing affordable housings. The findings could guide future affordable housing policies to meet homebuyers' requirements to address property overhang and affordability issues. The research complies to the United Nations Sustainable Development Goal 11 to ensure citizens' access to adequate and affordable housing in sustainable cities and communities.

INTEGRATION OF FACILITIES MANAGEMENT (FM) DURING DESIGN STAGE FOR OFFICE BUILDING IN MALAYSIAN CONSTRUCTION INDUSTRY

Nurulhuda Hashim, Myzatul Aishah Kamarazaly and Lim Yi Xin
School of Architecture, Building & Design (SABD), Taylor's University, Subang Jaya, Malaysia

Abstract
The increasing importance of facilities management (FM) in the construction industry has led to the realization on the early involvement of FM personnel during design stage. This early involvement of FM expertise enables the incorporation of the operation and maintenance aspect of a building in its planning and design. The purpose of this paper is to study the extent of FM considerations being integrated during design stage; identify the FM related issues in an office building; and establish potential approaches for better integration of FM related issues during design stage. To achieve the purpose of this research, qualitative research method with semi-structured questionnaires were designed and sent to gather information from architects and facilities manager in the industry. The results showed that there is integration of FM during design stage with full integration of FM related issues into design in the industry. However, FM team and Architect have different perceptions on the necessity of having such integration during design stage. It is important for a building to balance between maintainability and aesthetics given that architect and facilities manager have different concerns while designing a building. The data collected improves such integration to ensure the cost effectiveness during the operational life of an office building.

Keywords: *Integrate; facilities management; design stage; office building*

INTRODUCTION

Facility management supports and maintains the structure of an organisation to satisfy the objective of ever-changing situations. The International Facility Management Association (IFMA, 2014) defines FM as a profession to ensure functionality, comfort, safety, and efficiency of the built environment by integrating people, place, process, and technology. Hence, facility managers have a role to play in project design process to ensure a cost-effective design in both capital and maintenance costs (Ransley and Ingram, 2001). According to IFMA (2014), effective maintenance and management of building can significantly reduce up to USD$15.8 billion in annual cost. Thus, the involvement and inclusion of facility management considerations during design stage appear to be of significant importance to affect the functionality, effective and efficient facilities management practices.

Besides that, Olatunji and Sher (2014) stated that the fragmented nature of construction industry separates the construction development and management of facilities. Hence, there are huge differences between the expected performance of building and actual performance from the end user (Erdener, 2003). Syahrul and Emma (2010) stated that facilities management has been successfully developed and established in western countries but there was no specific organization to provide guidelines and control on the quality and performance of the facility management practice in Malaysia (Syahrul and Emma, 2010).

This paper focuses on integration of FM during design stage for office building in Malaysia. Office building is chosen because there is a significant demand for increased reliability and performance of facilities for office buildings to enhance employee productivity

(Hyunji et al., 2018). Some buildings fail to serve the owner and occupants for their intended purposes due to design failures and lack of communication between designer and facilities management. Hence, the critical questions here are:

- What is the extent of FM considerations being integrated during design stage of office buildings?
- What are the FM related issues being taken into consideration for incorporation into design?
- How to enhance better integration of FM related issues during design stage?

LITERATURE REVIEW

Extent of Integration

The Institute of Workplace and Facilities Management (IWFM, 2019), the largest national FM association in Europe has appointed the Building Research Establishment (BRE) to research on bringing facilities expertise into the design process in year 2000. Although integration of FM during design stage was introduced for some time, the extent of integration is yet to be studied in Malaysia. Divecha (2012) stated that the practice of bringing FM consultant at the design stage is not common, but it is growing over the years. As compared to Malaysia, it is already mandatory to have the FM consultant during design stage in North America and Europe for design, build and operate project (Jawdeh, 2013). Generally, designers and clients are not usually interested in FM service considerations during design stage because they think they are saving money. However, ineffective design has cause issues during the post-occupancy activities of a facilities (Wei Hen et al., 2021).

FM Related Issues Integrated During Design Stage

For every action, there is a reaction. In building context, for every design decision, there is a consequence either in the short or longer term throughout its lifespan. Thus, the relationship between facilities management and building design is closely related. A study carried out by Jawdeh (2013) identified FM concerns related to design are grouped and discussed as follows:-

1. Client and User Satisfaction
2. Operation and Maintenance
3. Space Layout and Flexibility
4. Energy Efficiency

Client and User Satisfaction

Clients nowadays are more sophisticated and tend to be specific with their needs and demand a higher service quality. Services customized to suit the needs of users are expected from FM. User’s satisfaction is now used to measure the efficiency and quality of FM service delivered. Hence, FM companies should understand user’s satisfaction to remain competitive. According to Jawdeh (2013), client and user satisfaction includes strategic planning of physical facilities and the perception of service personnel.

Operation and Maintenance

Operation and maintenance services include a wide range of building components and services. By integrating FM during design stage, it can achieve minimum operating and maintaining cost (Olatunji and Sher, 2009). According to AL-Hammad, Assaf and Al-Sihah, (1997; as cited in Jawdeh (2013), this integration enables FM to provide several recommendations to designers for improvements in terms of suitable structural design, adequate access for maintenance staff and their equipment, appropriate exterior finishing that matches climate conditions and sufficient detail in construction drawings.

Space Layout and Flexibility

Che'Mat and Shah (2006) stated that the role of FM is to allow for efficient flow of movement. In an office building, proper space layout and flexibility provides a comfortable, safe and efficient working environment for the employees to perform at their best. According to Booty (2009), space layout for an office needs to consider the space per person, partitioning, cabling, workplace options and circulation areas. Besides that, Gibson (2003) considers flexibility to be a major concern nowadays due to rapidly changing environment and lifestyle.

Energy Efficiency

The high use of energy leads to the importance of energy conservation regulations established globally. Hartungi and Jiang (2012) discussed the use of energy-efficient lighting to promote energy efficiency through saving both energy and cost. Design modifications such as a well-chosen building orientation for consistent daylight (Brandon, n.d.). Problems with usage of energy such as the unnecessary "over lighting" or high lux level for some spaces and these areas are fully lit up even when they are unoccupied. This can be overcome by SMART lighting system which is an energy-efficient tool to reduce 10-30% in solar heat gain which also leads to savings in cooling costs (Henderick et al., 2017).

Ways to Enhance Better Integration of FM Related Issues during Design Stage

Numerous efforts can be undertaken to enhance a better integration of FM during design stage. Jawdeh (2013) stated that arranging conferences to expose FM and design professionals together was one of the most suggested measures. Myeda (2013) stated that measures are needed to overcome current problems such as FM practice in Malaysia is not guided and generally FM is neglected in the current design. On the other hand, Noor & Pitt (2010) opined that FM modules should be incorporated into tertiary education. Kelly (2018) further elaborated that data and information presented during BIM process during the building lifecycle could be useful to be collected to build the FM system, but BIM is not widely used in Malaysia. Besides that, Jensen (2009) stated that FM could also establish historic data on general FM concerns to be considered in design stage. Other suggested options by Jensen (2009) were for FM bodies and Architects' Association to promote such integration in practice, open knowledge exchange channels between the private and public sectors and educate clients on the importance and value of engaging FM during design stage.

GAPS IN THE LITERATURE AND THE RESEARCH OBJECTIVES

While past studies have identified various FM related issues to be integrated during design stage, the related issues were not perceived from the Architects' perspectives. Facilities managers and Architects would benefit from the FM related issues identified for office building to differentiate the office building in terms of maintainability and operability. This study aims to contribute to filling this gap with the specific objectives as follows:

(1) To study the extent of FM considerations being integrated during design stage of office buildings.
(2) To identify the FM related issues being taken into consideration for incorporation into design.
(3) To identify approaches for better integration of FM related issues during design stage.

RESEARCH METHODOLOGY

A semi-structured interview method was adopted to generate non numerical data in terms of people's experiences, attitude, behaviour, and interactions (Pathak, Jena and Kalra, 2013). Qualitative method with semi-structured interview and purposive sampling method was adopted to collect data for the topic. In this study, pilot tests were conducted to conclude the construct and content of this paper. Then, the questionnaire was reviewed, refined, and structured clearly to achieve data required for the research objectives. Content analysis will be conducted on the data collected to categorize the concept. Then, data was analysed manually via coding and tabulated accordingly.

This study scope was limited to industrial practitioners of Facilities Manager or Property Managers and registered Architects who had participated in integration of facilities management and during design stage for office building during their careers. Research interviews were conducted with a total number of eight participants via either Zoom meetings or phone calls after they have responded to the open-ended questionnaires which were sent via emails. The outcome of the interviews was followed by a critical review and analysis of results.

Demographic Profile

The respondents identified have experienced integration of FM during design stage and they were from consultancy firms. All the respondents have around 20-45 extensive years of working experience for a higher degree of reliability as presented in Table 1.

Table 1. Respondents' Profile

Respondents	Designation	Position	Years of Experience
R1-Ar	Principal	Architect	45
R2-Ar	Principal	CEO	30
R3-Ar	Senior	Architect	20
R4-Ar	Principal	Architect	28
R5-FM	Director	Facilities Manager	33
R6-FM	Senior Partner	Facilities Manager	28
R7-FM	Director	Property Manager	23
R8-PM	Director	Facilities Manager	26

CONCEPTUAL FRAMEWORK

The conceptual framework is a model to show the steps taken throughout the research to be able to guide researchers to be more focused on the scope of topic. Figure 1 shows the research framework of the extent of integration of facilities management and building design.

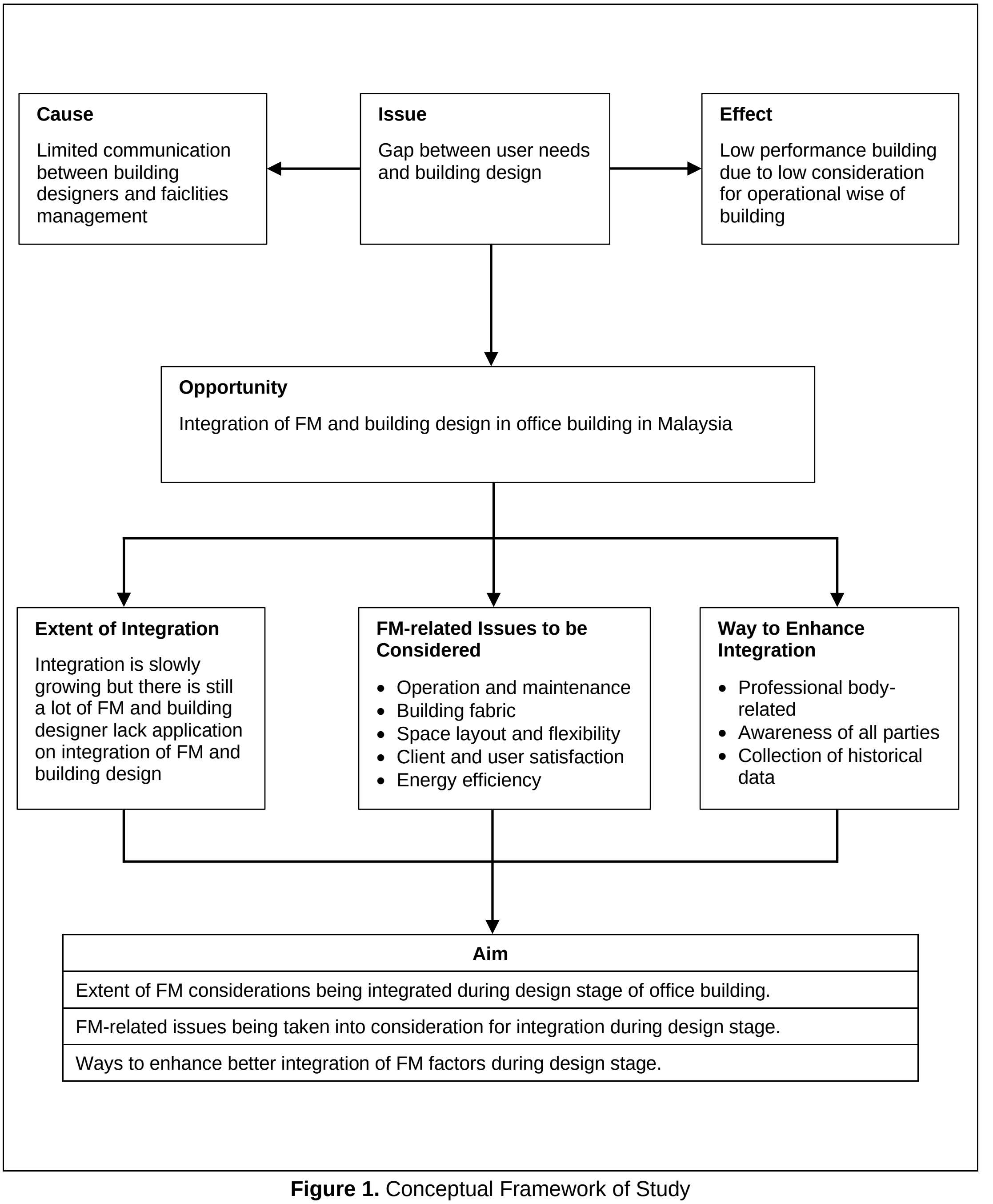

Figure 1. Conceptual Framework of Study

DISCUSSIONS AND DATA ANALYSIS

Objective 1 – Extent of Integration

Respondents who have contributed their experience to FM consideration being integrated during design stage for office building via interviews are categorized in Table 2.

Table 2. Coding for Objective 1

Category	Group	Theme
A. Objective 1 – Extent of integration of FM consideration being integrated during design stage for office building	1. Existence of Integration	a. Yes b. Very minimal c. Very little but integration is starting to rise
	2. FM involvement during design stage	a. Feasibility studies b. Conceptual design c. Design development
	3. Methods/software used for integration	a. BIM b. No software, only meetings conducted
	4. Extent of FM's input being integrated during design stage	a. FM's inputs fully integrated b. FM's input not fully integrated

Existence of Integration

Based on the Table 3, new findings show that R1, R4 and R7 have been practicing integration of FM during design stage in the industry. Most of the respondents mentioned that there is minimal integration and FM usually make an appearance during post construction only which is in-line with Ercoskun and Kanoglu (2003; as cited in Jawdeh and Wood 2010) who stated FM and design are two different processes. R8 believed that integration is starting to increase in the industry which is supported by Divecha (2012) where the practice of bringing FM consultant at the design stage is uncommon but is growing over the years.

Table 3. Summary of Respondents' Answer on Existence of FM During Design Stage

Respondents	Yes	Very Minimal	Very Minimal but Increasing
R1-Ar	√		
R2-Ar		√	
R3-Ar		√	
R4-Ar	√		
R5-FM		√	
R6-FM		√	
R7-FM	√		
R8-PM			√

FM Involvement During Design Stage

Based on the Table 4, all respondents agreed that integration of FM during design stage should take place on the conceptual design which is in-line with Jawdeh (2013) who stated that conceptual design includes various inter-relationship between parties. Besides that, integration of FM during design stage specifically for feasibility studies and detailed design are equally important. This is in-line with Noor and Pitt (2010) where involvement of facilities managers early during design phase is essential to avoid mistake on the later phase. Based on data collected, Table 5 elaborated the roles and activities taken during different phases of design stage in comparison with the statements from Jaunzens et al. (2001).

Table 4. Summary of Respondents' Answer on Existence of FM During Design Stage

Respondents	Feasibility Studies	Conceptual Design	Detailed Design
R1-Ar		√	√
R2-Ar		√	
R3-Ar	√	√	√
R4-Ar	√	√	
R5-FM	√	√	√
R6-FM		√	√
R7-FM	√	√	
R8-PM	√	√	√

Table 5. Roles of Facilities Manager During Design Stage

Design Stage	FM Activities During Design Stage Concluded from This Study	FM Activities During Design Stage According to Jaunzens et al. (2001)
Feasibility Studies	Preliminary data collection such as identify client requirements and budget constraint	Input to strategic requirements relating to operational issues
	Giving advice on setting the project brief	Giving advice on the requirements setting
Conceptual Design	Integrate element from client's design brief into design	Integrate strategic facilities requirements into design
	Advice on space layout and operational cost of the building	Contributing to assessment of design
	Balance the beauty element against functionality of building	Checking that the cost plan considers operational cost
Detailed Design	FM team will confirm on the technical specification adherence	Review the design and ensure functionality has not been compromised
	Ensure that the advised cost to manage per m^2 during conceptual design stage is sufficient	Review the design and ensure that operating cost meet financial criteria
	Comment on the design to ensure accessibility for maintenance and operation of the building in future	Checking design limitations

A few new findings for the role of FM during design stage included FM advice on space layout and balancing between the aesthetics element against functionality of building during conceptual design. On detailed design stage, FM confirms on the technical specification adherence.

Methods Used for Integration of FM during Design Stage

Table 6 shows that only two respondents (R2 and R7) use BIM software. R2 and R7 explained that BIM allowed easy management with collaboration on real time basis which aligns with Kelly (2018) who stated that BIM collaboration allows all disciplines to coordinate planning on the shared project models. However, R1, R5, R6 and R8 stated that the cost to obtain BIM license is high. R1 elaborated that usage of BIM is difficult to incorporate building services which contradicts John (2018) who opined that BIM helps all parties to be in a collaborative communication and is easy to use. Besides that, R3 and R4 stated that most FM company does not use BIM software so integration can only be done conventionally through meetings.

Table 6. Summary of Respondents' Answer on Methods Used for Integration

Respondents	No Software	BIM
R1-Ar	√	
R2-Ar		√
R3-Ar	√	
R4-Ar	√	
R5-FM	√	
R6-FM	√	
R7-FM		√
R8-PM	√	

Extent of FM's Input Being Integrated During Design Stage

Based on the Table 7, most of the FM's inputs are fully integrated during design stage. However, R2 has a different perspective whereby not all the FM's inputs were integrated successfully because the opinions given by FM often do not fulfil UBBL requirements. This argument is in-line with Jensen (2009) stating that FM contributes comments with inadequate knowledge. R6 and R8 mentioned that their inputs were partially integrated due to arguments.

Table 7. Summary of Respondents' Answer on Perception on Integration of FM During Design Stage

Respondents	FM's Input Fully Integrated	FM's Input Not Fully Integrated
R1-Ar	√	
R2-Ar		√
R3-Ar	√	
R4-Ar	√	
R5-FM	√	
R6-FM		√
R7-FM	√	
R8-PM		√

Objective 2 – FM Related Issues Being Integrated During Design Stage

Respondents who shared their knowledge on FM related issues being integrated for office building via interviews are categorized in Table 8.

Table 8. Coding for Objective 2

Category	Group	Theme
B. FM related issues being integrated during design stage for office building	1. Operation and Maintenance	a. Access to maintenance
		b. Selection of material and equipment
		c. Operation and maintenance manual content
		d. Operation and maintenance costs
	2. Space and Layout	a. Proper location of equipment and workspace for FM
		b. Optimum usage of office layout
		c. Flexibility of spaces to cater requirements for end user and equipment
	3. Energy Efficiency	a. Natural lighting and ventilation
		b. LED lighting / energy efficient lighting
		c. Others (energy efficient system integrated into building)

Table 8. Coding for Objective 2 (Continued)

Category	Group	Theme
	4. Client and User Satisfaction	a. Client's budget and requirement b. Safety of the office building c. Degree of comfort of the environment d. Carpark accessibility for maintenance without disturbing end user

Operation and Maintenance

According to analysis below (Table 9), most respondents considered cost to maintain and operate and selection of material and equipment to be integrated during design stage which is aligned with Enoma (2005) who stated that FM role during design stage is to lower maintenance cost. Some of the respondents mentioned on consideration for access to maintenance and only a few considered the content of operation and maintenance manual during design stage.

Table 9. Summary of Respondents' Answer on FM Related Issues in Terms of Operation and Maintenance Aspect

Respondents	Access to Maintenance	Selection of Material and Equipment	Operation and Maintenance Manual	Operation and Maintenance Cost
R1-Ar	√			√
R2-Ar		√		√
R3-Ar		√		
R4-Ar		√		
R5-FM	√	√		√
R6-FM	√			√
R7-FM	√	√	√	√
R8-PM	√	√	√	√

Space and Layout

Table 10. Summary of Respondents' Answer on FM Related Issues in terms of Space and Layout

Respondents	Proper Location of Equipment and Workspace for FM	Optimum Usage of Office Layout	Flexibility of Spaces for End User and Relocation of Equipment
R1-Ar		√	
R2-Ar	√	√	
R3-Ar		√	
R4-Ar			√
R5-FM	√		
R6-FM	√		
R7-FM	√		√
R8-PM		√	√

The above findings showed that proper location of equipment and workspace for FM and optimization of office layout are equally important. The result reflected that facilities managers are concerned on the space needed for equipment which is aligned with Jaunzens et al. (2001) who stated that FM is responsible to provide information on space needed for equipment and end user. Architects mainly considered on the office layout. According to Gibson (2003), flexibility in building was a major concern due to the rapidly changing environment and lifestyle but only few respondents mentioned on flexibility of spaces to cater for end user requirements. R3 referred to the flexibility of design concept such as co-working space, open plan or cellular space of the office building. R8 stated that the services such as discharged pipe are specially considered for different types of tenants.

Energy Efficiency

Based on the analysis (Table 11), most respondents considered energy efficient lighting which is aligned with Hartungi and Jiang (2012) who discussed the use of energy-efficient lighting to save energy and cost. Natural lighting and ventilation could be achieved by revising the building orientation to reduce the usage of mechanical ventilation and lighting. The previous statement is supported by Brandon (n.d.) who mentioned that orientation towards east and west provides sunlight half day only.

Table 11. Summary of Respondents' Answer on FM Related Issues in Terms of Energy Efficiency

Respondents	Natural Lighting and Ventilation	Energy Efficient Lighting	Others (Energy Efficient System)
R1-Ar	√	√	
R2-Ar		√	
R3-Ar	√	√	
R4-Ar		√	
R5-FM	√		√
R6-FM	√		√
R7-FM		√	√
R8-PM	√	√	√

Client and User Satisfaction

Based on Table 12, all respondents agreed that degree of comfort of the environment shall be integrated during design stage which is in-line with Jawdeh (2013) who mentioned that client's satisfaction is affected by physical planning during design stage. Most of the respondent mentioned that client's budget and expectations shall be considered to ensure equipment, system or layout proposed is within client satisfaction. The previous statement is supported by Bernhard, Donthu and Kennett (2000) who related customer satisfaction to sales and profit. A few respondents mentioned on safety of building and availability of carpark and accessibility for maintenance without disturbing tenants/occupants.

Table 12. Summary of Respondents' Answer on FM Related Issues to Client and User Satisfaction

Respondents	Client's Budget and Expectations	Safety of Office Building	Degree of Comfort of The Environment	Carpark and Accessibility for Maintenance
R1-Ar	√		√	
R2-Ar	√		√	
R3-Ar	√	√	√	
R4-Ar	√		√	√
R5-FM	√		√	√
R6-FM		√	√	
R7-FM	√	√	√	
R8-PM	√	√	√	√

Objective 3 – Ways to Enhance Better Integration of FM During Design Stage

Respondents who shared their perspectives on ways to enhance integration of FM during design stage via interviews are categorized in Table 13.

Table 13. Coding for Objective 3

Category	Group	Theme
C. Ways to enhance better Integration during design stage	1. Initiative from related professional bodies	a. Seminar
		b. Making integration mandatory
		c. Prepare guidelines
	2. Source of knowledge transfer	a. Real life-based opinion
		b. Meetings with architects during operational phase
		c. Historical data
	3. Educational level	a. Educate client
		b. Professional certification
		c. Exposure during tertiary education
		d. Emphasize the use of BIM software
		e. Others (Mindset and awareness)

Initiatives from Professional Bodies

Table 14 shows that most of the respondents suggested to have seminar for both parties on such integration topics which is supported by Jawdeh (2013) who stated that conferences expose professionals from different disciplines gathered for sharing of knowledge. The result shows that Architects are against the idea of preparing integration guidelines or such integration being made mandatory. It is further elaborated by R1 and R3 that the integration causes disputes on design liability. R4 stated that guidelines cause complexity for approval submission. R2 who specifically discourage such integration stated that building designed according to Uniform Building by Law (UBBL) and local town council is sufficient. R5, R7 and R8 believed that guidelines will encourage integration with tax incentives given.

Table 14. Summary of Respondents' Answer on Ways to Enhance Integration in Terms of Initiatives from Related Professional Bodies

Respondents	Seminar	Making Integration Mandatory	Prepare Guidelines
R1-Ar	√		
R2-Ar	Does not encourage integration of FM during design stage		
R3-Ar	√		
R4-Ar	√		
R5-FM	√	√	√
R6-FM	√	√	√
R7-FM	√	√	
R8-PM	√	√	√

Source of Knowledge Transfer

From the below table, real life-based opinions and meeting conducted for FM and Architect during operational phase are equally mentioned by respondents. A de-brief session among both parties can avoid similar mistake in future (Jensen, 2009). All Architects preferred real life-based opinion rather than historical data which opposed the statement by

Jawdeh (2013) which mentioned FM codified knowledge creates easy transfer of knowledge. R1, R2 and R6 mentioned that historical data appears to be another string of data to them. R3 and R4 believed that historical data cannot be used for other projects as all projects are unique.

Table 15. Summary of Respondents' Answer on Ways to Enhance Integration of FM During Design Stage in Terms of Source of Knowledge Transfer Between Professionals

Respondents	Real Life-Based Opinion	Meeting With FM During Operational Phase	Historical Data
R1-Ar	√	√	
R2-Ar	√		
R3-Ar	√		
R4-Ar	√	√	
R5-FM		√	√
R6-FM	√	√	
R7-FM		√	√
R8-PM			√

Based on the Table 16, most of the respondents mentioned to educate clients on the value of engaging FM during design stage. Myzeda (2013) stated that Malaysia had no certified exam provided for facilities manager compared to other countries. Hence, professional certification was suggested to identify the competent facilities manager. Findings also showed that architectural module shall incorporate FM elements. Furthermore, respondents suggested to emphasize the use of BIM software in the industry which aligns with Kelly (2018) who stated the function of BIM-enabled facilities management adds value to building. Other suggestions stated by R6 and R8 are with regards to raising public awareness and acceptance of Architects towards FM opinions and involvement during design stage.

Table 16. Summary of Respondents' Answer on Ways to Enhance Integration of FM During Design Stage Through Educational Level

Respondents	Educate Client	Professional Certification	Integrate Into Tertiary Education	Emphasize The Use of BIM Software	Others: Mindset and Awareness
R1-Ar	√	√	√		
R2-Ar		√		√	
R3-Ar	√			√	
R4-Ar	√				
R5-FM			√		
R6-FM	√	√	√		√
R7-FM	√			√	
R8-PM	√	√			√

SUMMARY OF KEY FINDINGS

Objective 1 – Extent of Integration

Overall, there is some level of FM integration during design stage. The study discovered that Architects agreed that integration eases the FM team in terms of maintenance work during operation and maintenance stage. Usually, FM's consideration during design stage was not fully integrated due to the project budget or differences of opinions that arise between parties. All FM professionals agreed that integration of FM during design stage should be done in future, but Architects pointed out that the current market was not ready to integrate FM during design stage given that BIM is not used widely in the industry.

Objective 2 - FM Related Issues Being Integrated During Design Stage

The findings for FM's issues are categorized into operation and maintenance, space and layout, energy efficiency and client and user satisfaction. The findings highlighted that Architects were still unaware on the importance of considering access for maintenance and the operation manual during design stage. In terms of energy efficiency system, none of the Architects considered energy efficient system such as installation of solar panel, centralized network control system for lighting and motion detector lightings which require early planning during design stage. FM personnel are concerned on the safety aspects of office building compared to Architects who were wary of its inclusion due to the cost.

Objective 3 - Ways to Enhance Better Integration of FM During Design Stage

It was worth to note that Architects opposed the idea of integration being made mandatory, but all FM related personnel agreed to develop framework and made such integration mandatory. Architect mentioned that FM related issues to be learnt along their career. On the other hand, FM argued that integration must be done because Architects trained in an office and thus are generally not well-versed in FM requirements as compared to FM personnel especially in terms of operability and maintainability of buildings.

CONCLUSION AND RECOMMENDATIONS

In conclusion, integration of FM during design stage practiced in the industry without proper guidelines. It was discovered that the literature findings on FM related issues aligned with the interviewees' responses but the FM role during design stage has slightly diversified into advising on space layout and ensuring user's satisfaction from previous study. The finding shows that the Malaysian construction industry has yet to take full advantage of BIM capabilities which could ease the process of integration of FM during design stage. FM related issues are identified and categorized into operation and maintenance, energy efficiency, client and user satisfaction and space layout in an office building. Additionally, ways to enhance integration of FM during design stage is established which are initiatives from related association, source of transfer of knowledge and educational institutions. Due to the limitation of the inputs expressed by architects and facilities manager, future studies can be conducted based on developer's point of view. Besides that, future studies can explore on special-purpose building such as hospital buildings and application of BIM-enabled facilities management for integration of FM during design stage.

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THE IMPACT OF IMPLEMENTING THE NEW MALAYSIAN STANDARD METHOD OF MEASUREMENT (MySMM) 2020 IN THE MALAYSIAN CONSTRUCTION INDUSTRY

Loo Seong King, Myzatul Aishah Kamarazaly and Tan Kher Xin
Faculty of Innovation & Technology, School of Architecture, Building & Design, Taylor's University, Selangor, Malaysia

Abstract
Standard Method of Measurement (SMM) is one of the most significant elements in the construction industry that forms the basis for measuring building works to produce an accurate and specifically described Bills of Quantities (BQ) that corresponds to the quantity and quality of the execution of the works. As a developing country undergoing rapid growth in construction outputs, standardization is crucial to provide the same measurement principles among the key players. Several countries have their SMM upgraded to accommodate the changes, especially in this phenomenon of digitalization. However, construction key players in Malaysia have been using the SMM1 and SMM2 for the past 20 years. Beyond gainsay, a transformation of Malaysian SMM is necessary. Until recently, the publication of the new Malaysian Standard Method of Measurement from Building Works (MySMM) is to satisfy the desirable attributes of the end-users. Thus, this paper aims to study the impacts of MySMM on the future construction industry in Malaysia with discussions on the new improvements and issues in the application of SMM. Comprehensive literature reviews and a qualitative approach were applied to obtain the data through semi-structured interviews with several experienced Consultant Quantity Surveyors (QS) in the Klang Valley. The findings showed that the utilizing a standard method of measurement remain pessimistic due to various factors. Thus, the research outcome intends to increase the acknowledgment and adoption of the MySMM to the extent that standardizing method of measurement is achievable by means to advance the Malaysian construction industry towards digital transformation.

Keywords: *Standardization; MySMM; Issues; Improvements; Impacts*

INTRODUCTION

In Malaysia, SMM is a document that contains defined principles of the construction measurement rules for producing a good BQ which will then form parts of the procurement or contract documents in a project. A more consistent and better estimating, pricing bidding, cost control, and records by the players at different stages and processes of construction can be achieved with an appropriate standard BQ (Abdul Rashid, Mustapa & Abd Wahid, 2006; Adnan, Mohd Nawawi, Mohd Akhir, Supardi & Chong, 2011).

It is known to all that the nature and the environment of the construction industry are separated and fragmented. Information was perceived as an enabler and an important input for coordination to mitigate the separation and fragmentation impact (Winch, 2010). SMM is substantial in producing good standard BQ in pursuance of a good quality construction cost and process (Adnan et al., 2011). Therefore, having a consistent basis is vital to adopt standardization in construction information, enhancing the required construction efficiency and effectiveness.

Besides that, living in this era where technology is advancing at an unpredictable rate, things evolve and with no exception in the construction industry. Thus, it is clear that there are many ongoing changes in information technology taking place throughout these years since the SMM2 publication. Reviews of the literature, however, have suggested that Malaysian SMMs have been flagging with issues and critiques leading to inconsistency in the produced BQ (Bandi & Abdullah, 2012; Cho et al., 2007; Perumal & Abu Bakar, 2011).

Remarkably Covid-19 pandemic outbreak that is currently affecting the nation and the whole world, the move to digitalization has become even more urgent. The global economy was drastically affected, causing all kinds of industries, including the construction sector, were required to halt operations for months. Many key players have then discovered the importance of adapting to digitalization. Some of them begin to accept while progressing their transition to the digital transformation, such as implementing Building Information Modelling (BIM).

With the advent of the Forth Industrial Revolution (IR 4.0), the digitalization of the construction industry is becoming more and more significant. Through IR 4.0, the enhancement in performance and productivity in the construction industry are possible (Alaloul, Mohd Shahir Liew, Abdullah Zawawi & Mohammed, 2018). The researchers further mentioned that the digital techniques employed like BIM led the way to digitalization while boosting the workability of the construction industry. To cater to the disruptive developments in the construction industry undergoing digitalization, it is a new idea to make MySMM BIM-ready with several brand-new bold features and changes. It is now completely remodified, revised, and developed to satisfy the desirable attributes of the end user.

Given the above-mentioned, this paper aims to study the impact of MySMM on the future construction industry in Malaysia by identifying the improvement made in the MySMM and the issues faced in its application. The data was gathered through the comprehensive literature reviews and a qualitative approach method using semi-structured interviews with several experienced consultant QSs in the Klang Valley. The research outcomes hope to spread awareness regarding the importance of adopting consistency and standardization in construction information and documentation especially when the country is heading towards digitalization and IR 4.0. To such extend, the construction industry in Malaysia can stride forward and develop towards a highly productive and valuable construction process.

LITERATURE REVIEW

SMM is a localized standard document that serves a purpose to ensure it fits with the local custom and practices in Malaysia (Nizam Akbar, Mohammad, Ahmad & Maisyam, 2015a). Royal Institution of Chartered Surveyors (RICS) New Rules of measurement expressed SMM as a standard set of measurement rules for the procurement of building works that can be understood sufficiently by all parties involved in a construction project. A comprehensive investigation on the SMM function carried out shows that the measurement rules outlined in the SMM are used to produce a good standard BQ as a procurement document and produce cost estimates or cost plans (Abdul Rashid et al., 2011; Nani, Mills & Adjei-Kumi, 2007). Hence, SMM plays a big part in the preparation of BQ.

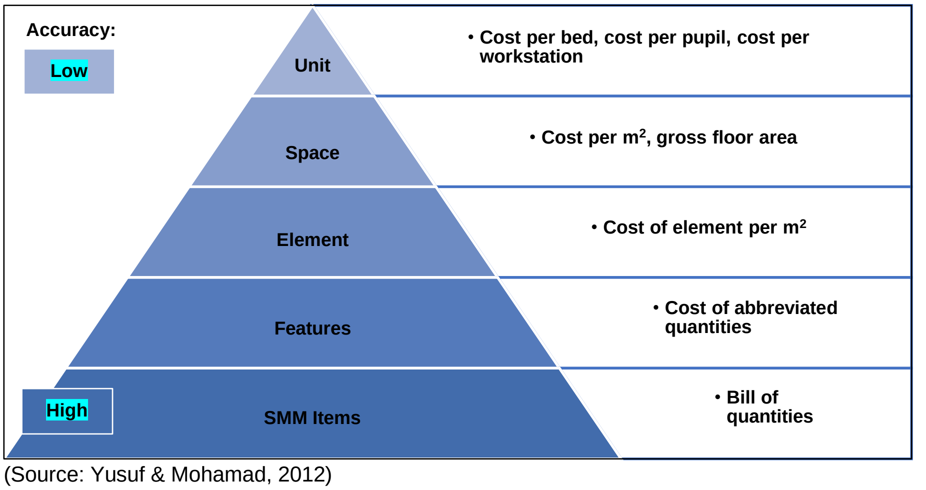
Significance of SMM in Standardization

Adopting standardized construction information and documentation within the industry ensures the construction project is good long-term, rational, and cost-effective (Bandi & Abdullah, 2012; Perumal & Abu Bakar, 2011). Thus, information was perceived as an enabler and primary input for coordination to reduce the impact on separation and fragmentation caused by different organizations in the construction industry (Winch, 2010). Smith and Conje (2002) expressed that the adoption of standardization helps to increase the conformity level in this construction industry. More consistent management and operations are accessible with more effective communication (Nizam Akbar et al., 2015a), where productivity can be increased obliquely (Perumal & Abu Bakar, 2011).

According to Adnan et al. (2011), BQ generated contains a detailed list of works to be executed and the quantities required to construct a building or other civil engineering works. Therefore, BQ serves to provide all the necessary information (Ashworth, 2004) which is very important during the pre-construct and post-contract stages.

A good BQ is highly dependent upon the utilization of SMM and Malaysia Civil Engineering Standard Method of Measurement (MyCESMM), which will then become part of the procurement or contract document of a project (Nizam Akbar, Mohammad, Maisyam & Wong, 2015b). Hence, it is fundamental that a document shall be standardized in the most professional way to deliver the accurate and adequate information provided to the key players as an assurance of matching with the need of others (Hackeet, Robinson & Statham, 2006).

Figure 1 illustrates the accuracy level with the listed available information (Ofored, 2004) as cited by Yusuf & Mohamad (2012). It demonstrates the crucial importance of SMM adoption in preparing detailed BQ to reach high accuracy in cost and contract management.



(Source: Yusuf & Mohamad, 2012)

Figure 1. Level of Accuracy with Available Information

Issue Encountered in The Application of SMM

According to Nani, Edwards, Adjei-Kumi, Badu and Amoah (2012), SMMs are not without critics. It was flagged with issues (Nizam Akbar et al., 2015a) regardless of its significance and importance as a referred document to produce a good standard BQ. Thus, standardization in the construction industry is a serious predicament to be overcome. Several issues or challenges have been identified in the utilization of SMM through the literature review conducted.

Contents and Approach

The complicated content, description, and approach of the SMM (Goh & Chu, 2002; Molloy, 2000) have caused confusion and misinterpretation to the SMM end-users (Nizam Akbar et al., 2015a). The meaning of the items and the rule of measurement are not clearly described (Abdul Aziz & Ali, 2004; Adnan et al., 2011). As a result, it is difficult for contractors to price when the description and unit of measurement are inaccurate where the actual work carried out on-site cannot be reflected (Abdul Rashid et al., 2006; Adnan et al., 2011; Molloy, 2007). Besides that, some work items are not included and covered in the SMM2, such as roads and Industrialized Building System (IBS) components (Adnan et al., 2011), give rise to unstandardized BQ preparation.

Format of SMM2

The explanation for work items displayed in paragraph style decreases the productivity and efficiency, also results in producing a poor quality BQ. Nizam Akbar, Mohammad, Ahmad and Maisyam (2014) opined that it is hard to locate the elements and sub-elements with this type of arrangement. Not to mention the invention of BIM, the paragraph format of SMM does not conform to this software technology (Tan & Yeoh, 2012). The quantity surveyors in Malaysia are still struggling to extract the quantities from the 3D models prepared by the designer to prepare BQ (Soon, Leong, Ang and Hassan, n.d.). Not only that, the standard and protocols with common language are also needed for better and effective communication (Porwal & Hewage, 2013).

Current Practice

The construction key players refer to various SMMs because no enforcement was placed on them to adopt only a single standard document (Nizam Akbar et al., 2015b). It is one of the reasons why standardization is not achievable all this time. As mentioned by Nizam Akbar et al. (2015a) another situation is that certain senior industry players persist in using SMM1, claiming that utilizing SMM2 would be a tedious task for them to change. Some consultants even have their in-house method for measurement (Molloy, 2000).

In addition, the present adopted practice does not comply with the requirements of SMM. The BQ prepared will be inadequate and lacking important information and subsequently induce the quotation to be very complex, increasing the time and cost required by the contractors for tender submission (Yusuf, Mohamad, Yusof & Misnan, 2013). Furthermore, another general exercise among many firms is the employment of other countries' SMM without defining whether it corresponds to the needs and criteria of the Malaysian construction industry (Nani et al., 2007).

The Gap Between SMM2 and Realistic Construction Environment

The limited functionality of SMM2 is incapable of serving the demand of the construction environment. The measurement and presentation of SMM in line with the standard rule set are mostly only familiar and rational to consultant but not to the contractor (Abdul Rashid et al., 2006; Adnan et al., 2011; Nani et al., 2007; Perumal & Abu Bakar, 2011). The measured items cannot fully represent the real costs as SMM is not suitable to do measurement using the composite item for the pricing purpose, variation, etc. (Abdul Rashid et al., 2006; Adnan et al., 2011; Goh & Chu, 2002). Thereupon, SMM is often being judged to be biased against the administrative cost control purpose but favouring tendering (Adnan et al., 2011; Nani et al., 2012).

Desirable Qualities of SMM

The desired characteristics of Malaysian SMM are indicated in Table 1 on the basis of its essentiality suggested by the end-users of SMM. It is divided into 4 levels of 'critical', 'high', 'moderate', and 'low' to show the priority qualities that are anticipated in a SMM.

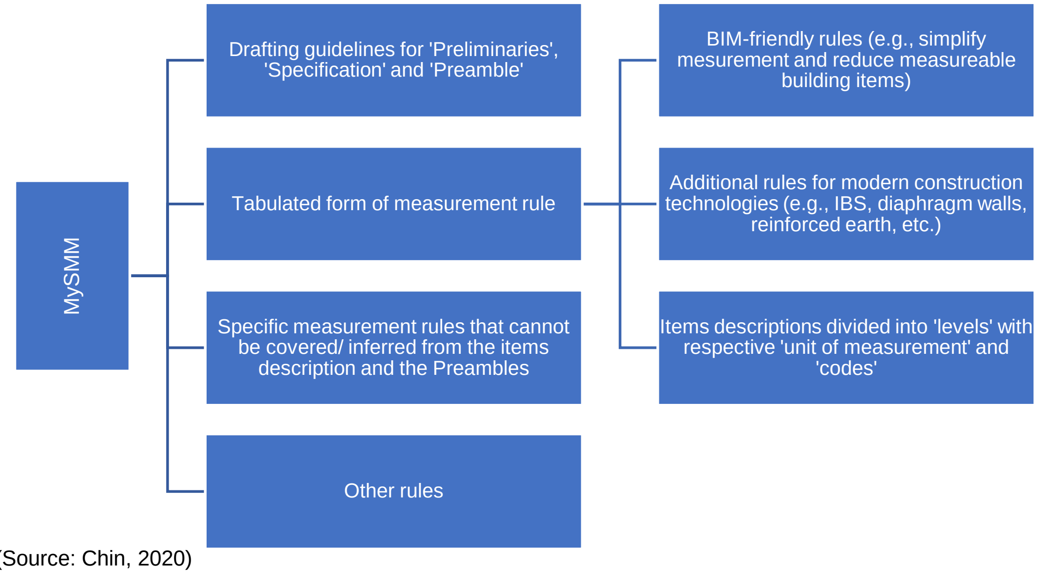
Table 1. The Desired Characteristic of SMM

Desired Characteristics of Malaysian SMM	Explanation
Priority Level: Critical	
Easy to locate	The work items and rules are easy to locate; create a clear structure that allows users to interpret SMM promptly
Simplicity	Not complicating; simple to refer to and thus accurate BQ can be produced in the shortest possible time
Precision	Straightforward and clear explanation of the rules of measurement
Priority Level: High	
Thoroughness	Thorough and logical; include all the necessary work
Regional relevant	Make relevant in the region (e.g., the amount of work is affected by the size and capacity of machinery)
Good industry practice	Accommodate with the current industry practice and based on essentials of goods; cover both pre-contract and post-contract stages (tendering and final account preparation)
National custom classification	Fit to the national custom classification system as in the common arrangement of work section which would affect the presentation of tender documents
Priority Level: Moderate	
Local jargon	Consist local industry jargon term to allow better understanding for the key players
Stakeholders' opinion and satisfaction:	
i) Contractors	Allow easy access to the approximate quantity and real cost for construction as well as the operations
ii) Clients and consultants	Make it fair in tendering and administrative cost control purpose
Priority Level: Low	
Adoptability	Flexible to all kinds of procurement systems as it the procurement adopted to influence the pricing decisions
Cost significant	Cost significant items have to be considered in the following pricing strategy for tendering, administrative cost control, and cost analysis purpose

(Source: Nizam Akbar et al., 2015b)

Improvement Made in MySMM

The construction industry has seen many radical changes over the years. In the IR 4.0, actions taken to stay relevant in this fast-expanding digital world are adding several enhancements into the MySMM to ensure synchronism with accelerating technological development. As discussed by Chin (2020), not only the ultimate objectives of MySMM are to make sure the items descriptions, specifications, preambles, and preliminaries are standardized in BQ production but also to conform with BIM technology. The presentation of the Figure 2 is a summary of an overall improvement made in the MySMM 2020.



(Source: Chin, 2020)

Figure 2. New Features Incorporated in MySMM 2020

RESEARCH METHODOLOGY

The qualitative approach has been adopted into this study to achieve the research objectives. The study is exploratory and descriptive to obtain in-depth insights and perspectives from the respondents regarding the topic discussed based on their experiences. The targeted population is the consultant QSs who have past experiences or are currently working at a QS consultancy firm in the Klang Valley.

The data collection methods are through both primary and secondary research. Firstly, the study started by reviewing available published data that has relation to the research problem statement from various sources to gather secondary data. Primary data is collected by performing semi-structured interviews with open-ended questions to the QS. This method provides flexibility to capture a more open and comprehensive discussion of the research topic. The mode of data collection was using phone calls and Zoom applications instead of face-to-face interviews because the physical meeting is inexecutable during a pandemic.

Five (5) participants were selected through the purposive sampling technique. The QS specialization can be divided into two main areas which are the consultant QS and contractor QS. However, the focus is on the consultant QSs in this study as they satisfied the requirement and criteria to be specific, they have experience in utilizing the SMM in the actual practice, and also are broadly concerned with the measurement and cost control of the construction projects. Not only that, BQ is most likely prepared by them in the format of the rules stated in SMM2. The thematic content analysis method has been used in this study to examine the qualitative data collected from the interview transcripts to identify and determine the data patterns.

FINDINGS AND DISCUSSION

Issues Encountered in The Application of SMM2

All the respondents are using SMM2 in their real practice, but a few has also adopted New Rules of Measurement 2 (NRM2) where a respondent has mentioned that she uses whichever that is relevant for the works. According to Nizam Akbar et al. (2015a), some practitioners are referring to various types of SMMs because there is no forcing by any enforcement body to obey only a single standard method. Despite that, the respondents expressed their dissatisfaction towards the SMM2. The reason being is that SMM2 is insufficient in certain aspects as format, contents, and approach to facilitate the demand of the current construction environment. Goh & Chu (2002) indicated that the SMM2's content, description, and approach are complicated which often confuse the end-users (Nizam Akbar et al., 2015a). One of the frequent-raised issue by the respondents is the paragraph format. This is in line with the Nizam Akbar et al. (2015b)'s observation that the paragraph arrangement style is difficult for the end-users to locate the work elements easily and unable to accommodate with BIM technology (Tan & Yeoh, 2011) which as a result, the information and quantity extracted from the 3D model are inadequate and not sufficient especially when the whole industries, including construction, are going through digitalization, BIM technology is starting to receive much attention. This has prevented the QS from extracting the accurate quantities from the 3D models (Soon et al., n.d.). Not only that, but IBS is also very popular over the years. However, the absence of provisions for IBS works is one of the concerns by the respondents in the application of SMM2 as the preparation of BQ for IBS items is not standardized, promoting an imbalanced exercise. In addition, SMM2 does not reflect the actual construction world as composite items are not allowed (Abdul Rashid et al., 2006; Adnan et al., 2011; Goh & Chu, 2002) and thus hinder the real costs (Nani et al., 2012) where a respondent has also utilized NRM2 as it provides more flexibility to include extra information in the work description by using composite items.

Table 2. Summary of Sub-Themes on Issues Encountered in The SMM2 Application

Theme	Sub-Theme	Respondent				
		R1	R2	R3	R4	R5
Type of SMM Utilized	SMM2	✓	✓	✓	✓	✓
	NRM2	✓				
Issues Faced in SMM2 Adoption	Contents and Approach	✓	✓	✓	✓	✓
	Format	✓	✓	✓	✓	✓
	Current Practice	✓			✓	✓

Improvement Made in The New MySMM

Based on the findings from the literature review, several improvements have been input in the MySMM. Chin (2020) has introduced a several key features incorporated in the new MySMM during an online workshop. Those are BIM-friendly rules, additional drafting guidelines, specific rules for items that cannot be covered, and the rules for modern construction technologies such as IBS. The overall work description is simplified using a tabulated form with a coding system. This implementation allows easier and effective collaboration with the BIM technology. The measurable building components also have been reduced by the use of the composite item and generic term that assembles items of a similar kind. For an example, in-site concrete in foundations where the 'foundation' term can be either pad footings, pile caps, column stump, or whichever that is considered as foundations. Rules for more modern construction methods like IBS, reinforced earth, and such are inserted into the new MySMM. Nonetheless, the participants were not aware of its recent publication and same applies to its new features incorporate since MySMM is still not widely recognized, and its application is not in the least requisite. Notwithstanding the lack of acknowledgement, most of the respondents still expressed satisfaction towards the overall MySMM because they find it more user-friendly and adaptable to the changes of latest technologies in overcoming the digital disruption, mainly in this new norm. Even though the MySMM is updated and improved, it seems like it has scarcely influenced the construction industry in the current situation. The outcomes recorded show that SMM2 is not referred frequently as a guidance by the respondents during the actual work because they have experience in producing a BQ, except for some conditions so required. In other words, they consistently abstract information of a similar kind from the previous BQ and describe the work items accordingly to suit the project. Therefore, it can be seen that the practice adopted at present does not comply with the requirements of SMM based on the Yusuf et al. (2013)'s findings. The component description is frequently found to be different from the SMM2 provision where some consultants even have their in-house method for measurement (Molloy, 2007).

Table 3. Summary of Sub-Themes on the Usage of SMM

Theme	Sub-theme	Respondent				
		R1	R2	R3	R4	R5
Usage of SMM	Rarely		✓	✓	✓	✓
	Often	✓				

Impact of MySMM in Meeting the Challenges of Standardization and Digitalization of the Malaysian Construction Industry

Current findings on the impact of the latest MySMM on the construction industry are that it has its high and low points. The respondents have reached the consensus that the new MySMM is more practical and relevant to the current construction practice including additional provisions for modern construction technologies like IBS. Hence, standardization in the information of measurable items is feasible by complying with the requirements stated in MySMM. Hackeet et al. (2006) explained that having correct and adequate information provided to the key players is important to achieve the requirements. Likewise, with the upgraded table format and BIM-ready in essence in this digital world, it helps to increase work efficiency and accuracy. In return, more time, cost and, quality-effective that can reflect the realistic construction worlds are attainable. Contrastingly, there are some obstacles to be faced in the adoption of MySMM. Undeniable, lack of recognition is the primary problem to implementing the MySMM as closely mirrored the findings that most respondents are not aware of the MySMM launching. The challenges of standardizing remain crucial if no one or only part of the community utilizes it as MySMM is still unknown to the key player. Although the respondents have acknowledged the improvement of MySMM, the tension for full adoption still exists in the construction industry. Regardless of its benefits to the construction industry, they are hesitant to change otherwise it is required or mandatory. Conforming to Seng and Salim (2015)'s findings, the major confrontation is the opposition of the industry key players to change considering that no regulation enforcing the utilization of standard measurement method. The participants claimed that it is very time and effort-consuming to learn and understand the new rules of MySMM. Similar situation brought up by Nizam Akbar et al. (2015a), certain senior industry players persist to use SMM1 as they argued that utilizing SMM2 would be a tedious task for them due to their slow learning curve at their age.

Table 4. Summary of Sub-Themes of The Impact of MySMM to Construction Industry

Theme	Sub-Theme	Respondent				
		R1	R2	R3	R4	R5
Awareness of MySMM Publication	Yes				✓	
	No	✓	✓	✓		✓
	Uncertain				✓	
Positive Impact	Practical and relevant	✓	✓	✓	✓	✓
	Efficient	✓	✓		✓	✓
	Standardized method of measurement		✓			
	Time, cost, and quality effective	✓		✓	✓	✓
	Adaptable to latest technologies					✓
Negative Impact	Lack of acknowledgement	✓	✓			
	Difficulty in standardization	✓				✓
	Requires time, cost, and effort	✓	✓		✓	✓
	Lack of understanding		✓	✓		✓
	Reluctant to change			✓	✓	✓

CONCLUSION AND RECOMMENDATION

In a nutshell, standardizing the construction information is vital where the SMM plays a dominant role in regulating the construction key players to prepare an adequate BQ under the requirements of SMM. The latest MySMM shall bring more benefits to the construction industry rather than harm as it is believed to lead to a more equilibrium and standardized environment in this era of digitalization. However, it depends merely on the determination and cooperation of the construction key players in utilizing the MySMM. Thus, further research is required to propagate MySMM and raise awareness of the significance of standardization. It is not easy to introduce the new MySMM to the whole construction industry in Malaysia. According to the research findings, the construction information is still not standardized and SMM2 adoption has not been fully utilized up until today since its publication many years ago. Therefore, relevant authorities like RISM shall provide more seminars to spread the knowledge and application of MySMM with the intent that the construction practitioners can understand and be open to adopting the recently published MySMM.

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THE IMPACT OF INDIVIDUALISM/COLLECTIVISM ON DISPUTE RESOLUTION: A VIEW FROM THE MALAYSIAN CONSTRUCTION INDUSTRY'S STATUTORY ADJUDICATION REGIME

Farrah Azwanee Aminuddin[1,2] and Paul Chynoweth[2]
[1]*Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*
[2]*School of Science, Engineering and Environment, University of Salford, Salford, United Kingdom*

Abstract
Malaysia introduced the Construction Industry Payment and Adjudication Act 2012 (CIPAA) to ensure construction payment disputes to be resolved efficiently and timely, thereby easing the cash flow problem in the construction industry. The introduction of an adversarial dispute resolution like adjudication raises cultural compatibility between dispute resolution and the individualism/collectivism dimension within a society. Malaysia is a collectivist society that manifests loyalty and a close long-term commitment. The research posits that adversarial adjudication has less favourable compatibility among the Malaysian construction parties due to its collectivist inclination that emphasises relationship maintenance. This paper is to assess the influence of collectivism on dispute resolution through a qualitative study through the adoption of the CIPAA. The study draws data from 15 semi-structured interviews. Through thematic analysis, data were coded and categorised to address the inquiry. Patterns emerging from the data were compared against the proposition. Findings from the data shows that adjudication has more favourable compatibility with the collectivist Malaysian construction parties. The group attachment factor within the construction parties' relationships is the primary drive for the adoption of adversarial dispute resolution methods in the collectivist society. The paper presents the influence of collectivism to establish how cultural values impact the dispute resolution process. The findings hope to foster a better understanding of national culture when implementing foreign-oriented legislation to the local societal setting.

Keywords: *collectivism; intergroup relationship; in-group and out-group; adjudication; dispute resolution*

INTRODUCTION

Initiatives to preserve the industry's favourable and outstanding growth are in high demand. In construction, unproductive events such as late and non-payment are problematic for the industry. Construction companies rely on cash to stay afloat, and poor payment in a building contract is a risk to economic failure. Clients and principal contractors frequently delegate some financial risk to companies farther down the supply chain. This approach allows risk for underpayment of lower-hierarchy organisations (Yung & Rafferty, 2015). The financial risk is transferred to parties who lack capital assets or credit to stay afloat.

Given the prevalence and complexity of payment disputes in construction, some Western countries have enacted adjudication as statutory legislation to address payment problems to increase the efficiency of the dispute settlement process. Such regulation was enacted and deemed necessary to protect industry stakeholders who were vulnerable to financial constraints. Such regulation intervention is called *adjudication*. Experience from other countries have shown that the intervention of adjudication legislation is to have significantly improved payment practices.

The UK became the first country in the world to establish adjudication legislation in 1996 with the passage of the Housing Grants, Construction and Regeneration Act (HGCRA). It has evolved into one essential piece of legislation the construction industry has ever had to comprehend. With limited exceptions, the adoption of adjudication is a significant step toward establishing an obligatory system that will apply to all construction contracts. In the United Kingdom, adjudication was adopted to improve payment practice and can be enforced unilaterally during a building contract to resolve a payment dispute quickly.

Similar legislation was enacted in a number of Commonwealth countries, including Queensland, New South Wales, Victoria, and Western Australia in Australia, as well as Singapore and New Zealand, not long after adjudication's "runaway success" in the UK. The influence of Western working practice has spread to many parts of the world which increases the rate at which adjudication is implemented. As a result, there is a common platform for Asian countries to consider adopting the same notion of implementing a quick and rigid judicial system for payment problems in various construction industries such as Malaysia, Hong Kong, and Thailand that considers implementing a similar legislation.

Scholars increasingly recognise the importance of how disputes are resolved. As a result, a central concern in dispute resolution is to what cultural beliefs within society lead to specific forms of dispute resolution effectively maintaining social norms in dispute settlement. The Western model for enforcing statutory adjudication at the national level is neither etic nor universally applicable to all cultures in East Asia. The adversarial adjudication process raises concerns about the Malaysian parties' cultural 'compatibility' with adjudication as a desired method of resolving disputes within their culture.

The impact of national culture characteristics on the conflict settlement process is investigated in this research. Through a qualitative investigation, this paper will investigate the impact of collectivism on the introduction of adversarial dispute resolution in Malaysia. Furthermore, cultural values have been largely overlooked in the literature of the construction field. The paper presents as part of the findings of a completed study to analyse the compatibility of dispute settlement mechanisms with the national culture dimensions of the Malaysian construction parties.

BACKGROUND OF STUDY

The Impact of National Culture on Dispute Resolution

Recent trends such as economic globalisation, increased workforce diversity, expanded international alliances, and mergers highlight the importance of evaluating disputes internationally. However, scholars cautioned against blindly adopting, disseminating, and applying Western management techniques in a local context (Hofstede, 2001). Existing research suggests that individuals from different societies understand conflict and its emergence into dispute differently and the management process and resolution tactics they use (Anakwe et al., 1999; Xie et al., 1998).

Conflicts were long thought to be a one-dimensional entity, with collaboration and competition occupying opposite ends of the spectrum. This one-dimensional technique was improved by Blake and Mouton (1962), who discovered two key underlying components.

They first defined conflict as *cooperation* – the extent to which a person tries to alleviate the other party's concern in a conflict situation – and *competition* – the extent to which a person satisfies their worries in a conflict situation. These dimensions were further characterised by Rahim (1983) as *concern for others* and *concern for self*. According to Thomas (1992), the conflict is a bi-dimensional construct representing the strategic intents of conflict parties. The primary characteristics of cooperation and competitiveness, when expressed in terms of strategic intents, constitute the desire to satisfy one's own and others' concerns in a variety of conflicting scenarios.

Across conflict and dispute resolution fields, cultural variability has been frequently used as a significant theoretical feature to explain variances in interpersonal behaviour. Many researchers have established a conceptual link between cultural heterogeneity and conflict management styles to explain management practice across cultures. The impact of dispute resolution on national culture has only lately been recognised. National culture and management theories are linked in a large body of literature. Scholars in construction have begun to focus on the disparities in conflict settlement practice between the East and the West (Agapiou, 2011; Aminuddin & Chynoweth, 2017; Danuri et al., 2015). This study is being conducted in response to a call for a thorough understanding of the impact of national culture on dispute resolution in order for the practise to be successful, appropriate, and appropriate for a given society.

National Culture Dimension: Individualism/Collectivism

According to Hofstede (1984), *culture* is *the communal programming of the mind that distinguishes one group from another*. It establishes society's core ideals and conventions. Hofstede (1984) presented the national culture aspects theory to understand cultural differences among countries. *Individualism/collectivism* has emerged as one of the most dominant social constructs among the six categories studied. The *individualism/collectivism* dimension, according to Hofstede (1984), evaluates the degree to which societies are integrated into groups and their perceived obligation and dependence on groupings. According to Hofstede (1991), individualism is a society in which individual relationships are loose, and everyone is expected to look after themselves and their immediate family solely (p.160). In contrast, collectivism is a society is in which individual relationship is tight and everyone is expected to look after the member within the same group.

Individualism also implies that achieving personal goals is more important. Within this category, a person's self-image is defined as *I*. In contrast, the collectivist group's aims for the well-being of others. Additionally, a collectivist individual's self-image is defined as *We*. Collectivism refers to a society in which people are born into strong, cohesive in-groups and are raised in them. People continue to protect them throughout their lives in exchange for unwavering allegiance.

Many researchers have compared Western people to a matched sample in Asian society to study the so-called "East-West distinctions". *Individualism/collectivism* is one of the significant constructs between Eastern and Western societies. Two main patterns emerged from the analysis, even though the cultural limits on these disparities are not well justified. First, Asians assess collectivism by social characteristics such as collaboration, interdependence, and harmony (Wong et al., 2010). In a highly collectivist culture, members of the in-group are more concerned with the consequences of their actions. It is more likely that personal interests will be sacrificed to achieve community goals (Goto & Chan, 2003). Individualistic societies have a stronger personal identity and prioritise personal aspirations and independence over a group attitude (Triandis, 2018).

Thibaut and Walker (1975 and 1978) have stimulated interest in the relative preference for conflict resolution techniques utilised in formal legal settings (e.g. Greenberg & Folger, 1983; Lind & Tyler, 1988). It is found that, the adversarial procedure is viewed as more fair than inquisitorial in settling a disagreement in highly individualistic nations such as the US and the UK. In keeping with this distinction and response to concerns about the cross-cultural similarity in preference patterns and underlying processes, Leung (1987) compared the US and Chinese cultures to examine the effect of individualism/collectivism on procedural preference. Although Chinese subjects preferred bargaining and mediation over the adjudicatory system, they tended to prefer the latter. The Chinese propensity for bargaining and mediation can be explained by their collectivistic value orientation, which emphasises interpersonal peace and social solidarity. Procedural preference is essentially a judgement of how much control a method gave disputants over the dispute settlement process and whether it could lessen antagonism between the parties.

Based on the above discussion, the primary purpose of this study is to investigate whether the Western-based adjudication has less favourability in Eastern countries, i.e., Malaysia. This study is to examine the impact of *individualism/collectivism* on dispute resolution in the Malaysian construction sector, specifically in the context of statutory adjudication. The study describes a cultural norm of procedural preference for adversarial dispute settlement to a specific target group, Malaysian construction parties. It is anticipated that there is more complexity in the form of deeply rooted values in individuals, which are reflected in their behavioural preference for procedural justice in dispute resolution, which is strongly influenced by the cultural characteristics of the group to which that individual belongs.

The Malaysian Cultural Values in Dispute Resolution

Malaysia is a multiracial, multicultural, and multireligious nation with diverse ethnic populations and cultures. Each ethnic group maintains its ethnic identity and practices its particular culture in customs, norms, values, and beliefs (Rashid & Ho, 2003). Due to its comprehensive racial and ethnic composition, Malaysia has frequently been fraught with cultural sensitivities. Malaysians appear to operate in harmony and unity, thanks to a few uniting factors, the most significant ideals that have endured the test of time. According to an assessment of work-related beliefs, to save face and maintain peace in daily life, the traditional Malaysian worldview places a premium on hierarchy, emotional restraint, and indirect communication.

Malaysia has a plural but essentially segmented society, reflected in its shareholding structure. As a result, societal segregation should be considered while studying cultural preferences for dispute resolution. Although scholars have developed broad assumptions regarding conflict mediation in Eastern countries (Augsburger, 1992; Lederach, 1996), no studies on Malaysian companies' preferred dispute resolution approach have been identified. Malaysian Chinese are more receptive to assertive mediation, whereas Malay prefer an informal style of listening, opinion gathering, and discussion (Wall & Callister, 1999). As a result, the social institution plays a significantly more active role in resolving disputes. Hooker (1976) identified that before the adaptation of English Law to accommodate the pre-existing personal laws which apply only to particular defined persons and the limits of a single territorial state in pre-independence Malaya. There have been two central personal law systems in Malaya's history: Chinese customary law and Malay *adat*. A traditional community develops the *adat* institution to mediate disagreement, which is essential than formal judicial procedures and is marked by a relationship that emphasises togetherness (Siswanto & Teslatu, 2018; Fitzpatrick, 1997). Malaysian society has a long history of preferring peaceful solutions over formal dispute resolution techniques.

Abdullah (1996) outlined five cultural values of Malaysia in modernisation today. The values were interpreted as follows by Merriam and Mohamad (2000). For a start, Malaysia is a collectivist society; identity is decided by the collective or group rather than by individual qualities. Second, Malaysians are hierarchical, and income are divided unequally; this inequality presents itself in respect for elders and is accepted as natural, as evidenced by how homage is paid to those in positions of power. Third, Malaysians value relationships; their lives are entwined in a complicated web of ties to family and social groups, in which mutual and reciprocal behaviours are well recognised and implemented. Fourth, maintaining face harmony requires maintaining a person's dignity by avoiding embarrassing or shaming them in front of others. Fifth, Malaysians are religious; pleasure can be discovered by putting one's own interests aside for the sake of others or by discovering it within through prayers and meditations.

Countries worldwide integrate new ideals as they progress toward industrialisation, particularly at work. The many waves of change, such as westernisation, globalisation, and Islamisation, have given foreign values. In the age of modernisation, Malaysian society must adjust to foreign-related challenges that may pose a threat to existing methods which may threaten the results. It may be unsettling at first, especially if those principles are not ingrained at a young age. While liberal principles such as expression freedom, success orientation, secularism, and monochromic time orientation are associated with the majority of corporate cultures, Malaysians continue to value harmonious relationships (Abdullah & Gallagher, 1995).

The Malaysian Construction Industry and Adjudication Act (CIPAA) 2012

Adjudication is a legal term that refers to a judicial decision such as a judgement or decree. A thorough adjudication procedure necessitates notification of all parties involved and the opportunity to present their facts and arguments. The fundamental goal is to establish fair decision in a dispute. Prior to the enforcement of adjudication in Malaysia, Danuri et al., (2006) reported that approximately 16,000 small contractors were on the verge of bankruptcy due to the failure of some upper-tier contractors to pay for the labour and services that were owed to them.

The Malaysian government then introduced the Construction Industry Payment and Adjudication Act (CIPAA) 2012 to adjudicate payment disputes under construction contracts for projects carried out in Malaysia to address the industry's long-standing payment problems. The statutory adjudication regime effectively negated default and conditional payment terms for construction contracts when it was implemented. The CIPAA follows other prominent international jurisdictions' introduction of adjudication as a fast-track dispute resolution method for construction contract disputes in various ways. CIPAA is a mixture of the UK model's adjudication system with the same objective as the UK, namely, to give a cash flow remedy and an alternative to arbitration or litigation for parties in dispute. Whereas disputes referred to by CIPAA are generally settled within 100 days. The goal of CIPAA is to facilitate regular and timely payment practice in the construction sector, as well as to create a framework for quick dispute settlement through adjudication and to give remedies for payment recovery.

According to a database from the AIAC, since the inception of CIPAA, the Asian International Arbitration Centre (AIAC) has administered over 1,400 adjudication cases with 2017 recording the highest number of adjudication cases with a total number of 708 cases alone. 2021 has seen another significant development in Malaysian case law relating to statutory adjudication. CIPAA as a dispute resolution mechanism by construction parties continue to grow seedily over the years (Lim, 2019). Several significant decisions decided in the Malaysian courts include the retrospective or prospective application of the act[1], accrual of defence[2], breach of natural justice[3], harmonious interpretation with other laws[4], national security[5], Injunctions in adjudication[6], under-certified claims[7], the due date of payment[8], refund of costs and expenses after trial[9], loss and expense claim from delays[10], a prerequisite for enforcement[11] and exceptional circumstances for stay[12]. Whilst the case law on statutory adjudication in Malaysia resumes growing. With the scope and complexity of adjudication related disputes, it has become necessary for the interpretation of the provisions established under the growing body of case law be consistent to maintain confidence in the regime.

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[1] *Bauer (Malaysia) Sdn Bhd v Jack-In-Pile (M) Sdn Bhd & Another Appeal* [2018] 10 CLJ 293; *UDA Holdings Bhd v Bisraya Construction Sdn Bhd & Anor and another case* [2015] 11 MLJ 499*; Vistasik Sdn Bhd v BME Tenaga Arus Sdn Bhd & Anor* [2018] 1 LNS 1278; *View Esteem Sdn Bhd v Bina Puri Holdings Bhd* [2017] 8 AMR 167; *Iskandar Regional Development Authority v SJIC Bina Sdn Bhd* [2018] 1 LNS 1194; *RH Balingian Palm Oil Mill Sdn Bhd v Niko Bioenergy Sdn Bhd* [2018] 1 LNS 1007

[2] *Mecomb Malaysia Sdn Bhd v VST M&E Sdn Bhd* [2018] 8 CLJ 380; *Emerald Capital (Ipoh) Sdn Bhd v. Pasukhas Sdn Bhd & Anor* [2018] 1 LNS 459

[3] *View Esteem Sdn Bhd v Bina Puri Holdings Bhd* [2017] 8 AMR 167*; Leap Modulation Sdn Bhd v PCP Construction Sdn Bhd & Anor* [2019] 1 MLJ 334; *Mecomb Malaysia Sdn Bhd v VST M&E Sdn Bhd* [2018] 8 CLJ 380

[4] *CT Indah Construction Sdn Bhd v BHL Gemilang Sdn Bhd* [2018] 1 LNS 380*; Sazean Engineering & Construction Sdn Bhd v Bumi Bersatu Resources Sdn Bhd* [2019] 1 MLJ 495

[5] *Government of Malaysia v Shimizu Corporation & Others* [2018] 1 LNS 202

[6] *Euroland & Development Sdn Bhd v Tack Yap Construction (M) Sdn Bhd* [2018] 1 LNS 896

[7] *MRCB Builders Sdn Bhd v Southern Builders (J) Sdn Bhd* [2018] 1 LNS 1508

[8] *SKS Pavillion Sdn Bhd v Tasoon Injection Pile Sdn Bhd* [2019] 2 CLJ 704

[9] *Gaya Analisa Sdn Bhd v Oceanergy Gases Sdn Bhd* [2018] 1 LNS 1016

[10] *Syarikat Bina Darul Aman Bhd & Anor (collectively referred to as BDB-Kery JV) v Government of Malaysia* [2017] 4 AMR 477; *Transmission Technology Sdn Bhd v PESB Engineering Sdn Bhd & Anor* [2018] 7 CLJ 516; *Cubic Electronics Sdn Bhd v Mars Telecommunications Sdn Bhd* [2019] 2 CLJ 723;

[11] *Tan Eng Han Construction Sdn Bhd v Sistem Duta Sdn Bhd* [2018] 1 LNS 428

[12] View Esteem Sdn Bhd v Bina Puri Holdings Bhd [2017] 8 AMR 167;

THE COMPATIBILITY OF INDIVIDUALISM/COLLECTIVISM WITH DISPUTE RESOLUTION MECHANISMS IN THE CONSTRUCTION INDUSTRY IN MALAYSIA: A PROPOSITION

The Influence of Out-Group/In-Group Within Collectivism in Dispute Resolution

As a collectivism-oriented country, Malaysia focuses on preserving the collectivity and the preservation of amicable relationships among its members. The orientation frequently contrasts with the Western world's more assertive individualism and egocentrism. Additionally, it has been proposed that collectivism enhanced inter-organisational cooperation (Wagner III, 1995; Smith, Carroll & Ashford 1995). Thus, there may be a propensity to focus on the group's overall importance during a debate. Consequently, an apparent effort will be made to avoid hostility that unsettles the group under the principles connected with group harmony. Furthermore, maintaining group cohesion when confronted with a conflict will adopt non-adversarial dispute resolution to preserve the spirit of collectivity.

According to social identity theory, individuals are drawn to others who share their characteristics. They develop a positive self-concept and self-esteem as a result of their similarity (Tajfel, 1982). As a result, individuals have a more favourable attitude toward and treatment of members of their in-group than they do toward members of their out-group. (Tajfel & Turner, 1986; Turner et al., 1983). Individualist and collectivist societies have an *in-group/out-group* divide to vary degrees. Individualists, for example, distinguish the autonomous self from others when comparing self-concepts regardless of individuals or organisations. Whereas collectivists make a distinction between those with whom they share a group (*in-group*) and those with whom they do not share a group (*out-group*) (Triandis, 1990). As a result, there will be a marked difference in behaviour and response toward in-group and out-group members, such that one will be considerably less cooperative toward individuals who are not in the in-group. Gomez et al. (2000) discovered that collectivists discriminate against members of other groups and favour members of their own. As a result, in collectivistic communities, *in-group/out-group* distinctions are more likely to be emphasised.

Essentially, this study asserts that collectivism in dispute resolution practice is significantly influenced by the industry's *in-group/out-group* formations. For example, the construction industry's high degree of fragmentation is due to the highly specialised and differentiated knowledge of the project participants and group allegiances and the identification of each of the organisational entities inside the project as an in-group. In a broader framework, Phua & Rowlinson (2004) hypothesised that individuals in collectivist cultures would demonstrate harmony inside the in-group. Nonetheless, society may be defined by conflict and differentiation due to framing many interpersonal connections by *in-group/out-group* relationships. This situation accurately depicts the current state of the construction industry.

Additionally, the evidence indicated that disparities in *individualism/collectivism* might act as a moderating factor affecting the success of dispute resolution. Economic progress is typically hampered by a collectivistic propensity toward in-group favouritism and out-group hostility. These perspectives highlight a critical component of the Malaysian construction industry's typical inefficiency in resolving disputes. In essence, construction firms may be operating profitably and competitively. Nonetheless, the members' collectivist tendencies tend to undermine a successful settlement due to the inter-organisational divergence that results from in-group and out-group discrimination.

Phua and Rowlinson (2004) proposed two alternative explanations for the preceding. First, because the project's members were from collectivist societies, their behaviour of other organisational members was viewed as fraught with conflict and distinction. Second, the same dynamics that make collectivist members more favourable toward their organisation will cause them to feel morally bound to collaborate with the in-group, resulting in a positive effect where members are more willing to cooperate. Thus, this study extrapolates that a greater proportion of overall adversarial conditions in the Malaysian construction industry is due to the collectivistic orientation of its workforces, who have a proclivity for treating out-group members aggressively.

The Influence of Out-Group/In-Group Within Collectivism in Dispute Resolution of The Malaysian Construction Industry

When a large proportion of project participants come from collectivist cultures, inter-organisational cooperation will be reduced, which may jeopardise the overall performance of the building project. Individualism/collectivism is defined in this study via the *in-group/out-group* distinction lens. When considering national culture as a variable to describe an organisational outcome, one must be cognizant of its multidimensional nature (Phua, 2013). Thus, this study argues that examining conflict management methods through the lens of social identity theory and the *in-group/out-group* perspective under *individualism/collectivism* will provide significant insights into organisational behaviour toward cooperation dispute settlement.

Individualism/collectivism strongly emphasises group membership and how it shapes an individual's self-concept. It can be expected that the degree to which an in-group membership is prominent is proportional to the degree to which an individual's perceived likeness to others within the same in-group increases (Brewer, 1979). As a result, the member is more apt to comply. While it is advantageous to induce collaboration between disputing parties, the benefit is lost when group members have a strong *in-group/out-group* bias. The previous discussion demonstrates that cultural orientation has contributed to a lack of cooperation within Malaysia's construction industry, impeding adversarial dispute resolution. The moderating effect of *individualism/collectivism* on an organisation's cooperative and competitive behaviour arises from in-group versus out-group attitudes. This attitude, prevalent in a collectivist society like Malaysia, may significantly impact group members' willingness to cooperate in dispute resolution.

One reason for the findings is the prevalence of relationship-oriented values in Asian cultures, which play a significant role in various social positions. Numerous Eastern cultures emphasise social harmony (Buunk et al., 2010). Individuals are socialised to prioritise the group's welfare over their own. Typically, a group's culture is determined by its members' collectivist tendencies. Rather than a collection of isolated individuals, the commune's collaborative attitude penetrates their work between the individual, the organisation, and even the nation. There is a strong emphasis on interdependence, sharing concerns, and assistance.

The Proposition

According to Hofstede (2010), with a score of 26, Malaysia is a relatively collectivist society. This collectivist perspective demonstrates a member's long-term commitment to his or her group. Loyalty is required by the majority of other social laws and regulations in a collectivist culture. Such a culture promotes healthy connections, with everyone taking responsibility for their group members. For instance, employer-employee connections are seen morally, and management is viewed as group management.

Based on the above, the study posits that: *The more adversarial the dispute resolution mechanism, the less likely it is to be compatible with a collectivistic society.*

METHODOLOGY

This data collection process aimed to capture various construction professionals' ideas, perceptions, and experiences regarding the influence of individualism/collectivism on the compatibility of a Malaysian dispute settlement practice. The study will elicit data regarding Malaysia's recent implementation of statutory adjudication and its impact on construction parties that use adjudication as a method of dispute resolution. Additionally, how collectivism's relationship maintenance affects the compatibility of an adversarial dispute resolution process with national cultural ideals will be discussed. The study takes a qualitative method to understand the phenomenon understudied to accomplish this goal. According to preliminary research conducted at the start of the project, Malaysia favours collectivist culture and a less combative approach to dispute settlement.

Numerous advantages accrue from the qualitative approach taken in this case. First, it enables examination of the complicated reality of societal influences affecting the conflict settlement process. Second, it enables the research to contextualise the adversarial nature of the Malaysian construction industry's dispute settlement procedure. The process is carried out without regard for pre-determined factors and the adjudication's suitability as a means of conflict settlement in the Malaysian construction industry. Finally, the qualitative approach enables the study to capture individual experiences using subjective data. Informal consensus on the cultural issues, notably the compatibility of adjudication in Malaysia, were addressed during the passage of the Malaysian adjudication statute. However, the literature on this subject is mainly mute. Thus, the opinion of the construction parties will be used to examine the effect of individualism/collectivism on the compatibility of an adversarial dispute resolution in the Malaysian society.

Semi-Structured Interview

The interview with construction professionals is designed to elicit perceptions and opinions about the impact of individualism/collectivism on dispute resolution procedures, notably in the practice of construction adjudication. The primary parties of adjudication were chosen to participate in the study to establish credibility and elicit unbiased perspectives under consideration.

The participants were briefed through the background of the study and were explained on the definition of key terms that are relevant to the study before starting the interview. When conducting the interview, the researcher takes notes during the interview while maintaining eye contact with the interviewee. The researcher was also ready to re-phrase the question in a more simple and understandable way to the respondents. Before transcribing for later analysis, the supplemental notes assisted the researcher in following up on the offered responses and stimulating early ideas for subsequent interviews. Before the interview, participants were briefed and informed about the audio recording and the study's goal.

As a result, participants were assured that they understood and were fine with their participation being documented for ethical reasons. Additionally, the questions were kept brief and easy to facilitate the participants' response process. All interviews lasted around one in length. The following questions were posed to respondents: 1) Opinions on the effectiveness of adjudication as a dispute resolution mechanism in the Malaysian construction industry; 2) Opinions on the acceptance of adjudication enforcement among Malaysian construction parties; 3) Cultural barriers to adjudication adoption in the Malaysian construction industry; 4) The influence of project parties' relationships on dispute resolution; 5) The impact of project parties' relationships on the initiation of adjudication.

Participants

Purposive sampling was used to target small but not necessarily representative to get more in-dept insights. The study locate potential participants who met the following criteria: 1) adjudicators with professional backgrounds in the construction industry, such as lawyers, quantity surveyors, engineers, quantity surveyors and architects, that have been appointed as adjudicator in at least three cases; 2) Construction-specific attorneys or claim consultants who have acted as claimants or respondents in at least three adjudications or court cases involving adjudication matters; and 3) academics or legal experts who have served as adjudicators in at least three cases. The participants' selection criteria are summarised in Table 1.

Table 1. Participant of The Study

Participant	Description
Adjudicator	The adjudicator must be a registered adjudicator with the AIAC panel and have a background in construction. Additionally, they must have handled at least three adjudication cases involving any type of construction project in Malaysia that is regulated by the CIPAA 2012.
Specialised Lawyers	Specialised lawyer for contractors/subcontractors/specialist consultants/material suppliers with significant experience in adjudication matters. The specialised lawyer has represented construction parties in adjudication proceedings or in court proceedings involving adjudication matters.
Academics or Expert Legal Advisors	Scholars with expertise in the field of construction dispute resolution who combine critical insight with a theoretical perspective would add increasing value to the study's subject. Experts were included because of their extensive knowledge and experience in the field of dispute resolution policymaking, which made them an ideal respondent for the study.
Construction Stakeholder	The participant may be one of the disputants in a Malaysian adjudication. The respondent must have a minimum of ten years of construction industry experience. Additionally, the respondent must be actively involved in adjudication proceedings, be knowledgeable about construction contracts, and be involved in the organisation's business administration. These requirements are necessary to ensure that their perspectives accurately reflect the subject under study.

The participants' diverse experiences ensure that their perspectives reflect fairly on the current state of adjudication as an adversarial dispute resolution method. The respondent is classified as having two types of job experiences, namely work in the construction industry and employment in the legal construction service. Fifteen (15) respondents agreed to be interviewed, and Table 2 summarises the demographic characteristics of the participants in this study. The interview question was aimed to elicit information about the impact of individualism/collectivism on dispute settlement, more specifically in the context of Malaysian construction adjudication. Participants were asked of their perspective on the role of relationship maintenance in reflecting the impact of group attachment in collectivism, particularly at times of conflict.

Table 2. Respondents' Profile for The Study

Respondent	Working Experience		Working Background	Experience in Adjudication Cases		
	Construction	Legal		Adjudicator	Party Representative	Party in Dispute
R1	14	6	Quantity surveying and legal practice	3	–	5
R2	25	10	Building/construction and civil engineering	10	3	–
R3	32	5	Architecture, town planning and civil engineering	13	2	–
R4	–	13	Legal practice	3		5
R5	35		M&E engineering	2	10	–
R6	–	25	Legal practice	8	3	–
R7	–	23	Legal practice	13	12	–
R8	14	–	Civil engineering	4	20	–
R9	15	27	Legal practice and civil engineering	3	20	–
R10	22	–	Claim management	1	–	13
R11		10	Legal practice	5	–	–
R12	28	10	Civil engineering and legal practice	8	10	–
R13	30	–	Architecture and town planning	5	–	–
R14	32	11	Building/construction and civil engineering	12	–	–
R15	16	–	Quantity surveying	–	3	–

Data Analysis

The study adopted data collection approach by Thornhill, Saunders, and Lewis (2009) for thematic analysis, pattern matching, and explanation building. First, thematic analysis was utilised to uncover recurring themes and patterns in the interviews conducted. Thematic analysis was chosen as the analysis method for qualitative data due to its methodical nature while remaining adaptable and approachable (Braun & Clarke, 2013). It permits systematic and logical analysis of qualitative data, producing a comprehensive description. This approach is deemed appropriate for interpretivism research because it enables the examination of alternative interpretations in order to comprehend the influence of individualism/collectivism on the compatibility of a newly constructed adversarial dispute resolution mechanism from the unique perspective of Malaysia's adjudication regime.

Thematic Analysis

The analysis begins with becoming acquainted with the available facts. The researcher then transcribed the sequence of interviews conducted. Finally, memos were produced to record any initial ideas, observations, queries, or observation prompted by reading the interview transcript. The goal is to document observations in real-time while still fresh in mind. Additionally, the researcher investigated the narratives that each respondent attempted to convey to uncover patterns of relevance, linkages, and interconnectedness across the data. This step involved analysing the respondents' narratives in order to familiarise and integrate the material from each case in advance of a more in-depth examination of patterns and linkages.

The following phase is data coding, which is used to classify data with similar meanings. The procedure entails labelling a data passage according to the researcher's interpretation. The coding process was carried out utilising Microsoft Word due to its ease of use and usefulness. Once the researcher has obtained the codes from the coding step, they can organise them. The label's code categories have an effect on the accessibility of evidence necessary to support the argument. Specific labels have been applied to indicate the passage of data. Still, they were not supplied too narrowly, as this limits the analysis if the labels do not have a reasonable meaning that conveys the essence of what they are attempting to represent.

The following phase involves honing the themes and their relationships. The developed themes form a cohesive set, giving the researcher a well-structured analytical framework to conduct the subsequent investigation. As the researcher developed the themes, the researcher reorganised coded data extracts to correspond to the appropriate topic or concept. As the researcher examined the data set further, the researcher used the codes and themes to organise the coded data in order to test the hypotheses and determine their relationship.

Patten Matching Analysis

Following the thematic analysis, the study performed pattern matching analysis to determine whether two patterns matched or not. Testing entails comparing an observed pattern to an expected pattern and determining whether they match, thereby confirming or disconfirming the proposition. Matching patterns entails comparing two patterns, one of which is the expected pattern and the other of which is the observed pattern. The study discussed the factors that contributed to construction parties preferring adversarial dispute resolution mechanisms such as adjudication to resolve a dispute within a collectivistic society within the Malaysian construction industry. The purpose of this procedure is to generate a contrastive explanation. Belk (2010) asserts that contrastive explanation serves two purposes. To begin, it may demonstrate that one explanation for a given situation is preferable to others. Alternatively, it demonstrates why one state of affairs occurs over others. The purpose of this study is to provide a sophisticated explanation for the effect of cultural variability on the compatibility of adversarial dispute resolution in an Asian construction industry in Malaysia.

Explanation Building

In seeking for an answer, the researcher investigated the characteristics that influenced construction parties' preference for adjudication as a means of conflict settlement and why one could choose adjudication over others. Incorporating a Western-style adjudication system into Malaysia is viewed as a cultural mismatch. It demonstrates the importance of delving into the complexities of *individualism/collectivism* in the conflict resolution process.

The ramifications of the alternative theoretical premise are critical. It will provide a rational explanation for how cultural heterogeneity affects the viability of dispute resolution processes in society. Examining the typical and predictable characteristic reveals previously unrecognised assumptions about the problem of cultural mismatch between a dispute resolution mechanism and the receiving society in terms of the evidence establishing its relevance and determinant of its occurrences. Thus, the investigation establishes that no single explanation is infallibly superior or preferable to the others, but that they all contribute to a variety of field elements.

The study's primary focus was culture, emphasising Hofstede's *individualism/collectivism* dichotomy. The study demonstrates how the state of knowledge suggests that culturally specific themes are crucial in evaluating the feasibility of a dispute resolution system within a community. Based on this perspective and the discussion above, the study hypothesises that Malaysia's adoption of a Western-style statutory adjudication process may constitute a cultural mismatch. This concept serves as the basis for the current study, which will investigate the complexity of national culture's influence on the process of conflict resolution.

RESULTS AND FINDINGS

Stakeholders are the organisations involved in a construction project. Without the contractor, consultants, subcontractors, and suppliers - these parties would be treated as a group - it would be impossible to complete the project successfully. Due to the scope and complexity of building work, these groups must divide it into manageable parts. However, such groupings frequently direct their attention and resources into their group's activities, viewpoints, and requirements, rather than toward the general objective of the project goal, which gives achievement-oriented and competitive opportunities.

Nonetheless, creating a group can provide additional difficulties due to the group's independence. As one responder observed, parties become generally hostile during the dispute resolution process in an extreme dispute: *"We have this collectivistic attitude among us. Because no one wants to take accountability for anything. Everything is decided by the board of directors that has contributed to the dispute when the dispute has worsened"* [R11, L45]. Additionally, a respondent confirms that a group network's positive functionality is critical for successful dispute resolution: *"Relationship between contracting parties is restricted to the construction industry and any contracting parties as the relationship is the key. It's essential in resolving disputes"* [R14, L20-22].

Key themes emerging from the interview data include cultural values, intergroup differences, differing group goals, and prioritisation of in-groups.

Cultural Values

Societies and their values influence the development of their legal structures, legal processes, and the law's engagement with societal change and social control. According to one respondent, if a legal structure is imposed on an unsuitable society, it can damage the system's functioning ability. Numerous replies demonstrate how Asian cultural values shape conflict resolution culture in the Malaysian construction industry. Malaysia's population is a synthesis of diverse ethnic cultures. After the Malays, the Chinese are Malaysia's second-largest ethnic group, accounting for about a quarter of the population. Today, Malaysian Chinese are heavily involved in business and commerce. Although oral communication is no longer widespread in Malaysia, one respondent emphasised how deeply embedded cultural beliefs are among Chinese Malaysian contractors and how they influence business practises: *"... the Chinese when they do business, they're word of mouth. Meaning what they say carries weight. In other words, it carries honour. That is a cultural aspect because the Chinese knew themselves from an ancient generation, trustworthy people. What they say is golden, and it may not be in writing. But, in modern and economic pressure, sometimes one cannot perform, even though their words are golden"* [R2, L31-39].

While the meaning, practise, and form of Chinese relationships are ingrained in Chinese culture, similar relationship rules persist among Chinese groups outside of China. Thus, *guanxi* and the value placed on connections impact the Malaysian Chinese culture: "*The Chinese place many relationship factors, and we call it guanxi. This cultural aspect is essential for us"* [R2, L33-35]. "*Being an Asian, I must say the relationship is a significant factor. It is precisely that. Relationship maintenance is a big part of our culture. I believe where I suppose that is part of the up-bringing culture that we brought to our working life where deference is paid to a more senior person"* [R11, L37-41].

Guanxi has a broader cultural influence not restricted to society but extends to commercial networks. According to one respondent, the purpose of CIPAA as a tool for resolving disputes is not to foster bad *guanxi* between the parties. Nonetheless, because Malaysians place a premium on relationship development, such action may create discomfort for the parties seeking an amicable resolution: *"I don't think the act is legislated to result in relationship deterioration. But because of cultural factors. It shows that you are no longer having goodwill. No matter what the decision will be. Because the decision ultimately may only favour one side. It will break the goodwill between the parties. So, if the parties have a dispute and have an open mind to resolve it, they will not embark on it in the first place"* [R11, L147-153].

The face is a sociological concept that refers to one's self-image, dignity, or prominence in a social setting. When a person's face is threatened during a confrontation, they frequently attempt to save or restore it. To save face means to protect one's reputation, trustworthiness, or dignity, which is frequently accomplished by avoiding humiliating behaviours or situations. Like other Asian countries, Malaysia has a face-saving culture: "*I think the main reason is the face value. Malaysians often don't want to be seen to be the bad guy who starts the dispute resolution process"* [R6, L68-69]. Face-saving enables parties to keep their relationships harmonious. In Malaysia, the need to maintain one's face is important that subordinates frequently hesitate to speak up in front of those perceived superior or with more power: "*I constantly remind my Project Manager, no matter how bad the situation has become, not to belittle the employer in front of the consultants. If you want to give advice, talk to them personally and discuss politely. Suppose you criticised them openly in front of everyone. They will hate it. Respect is important. We need to be sensitive and face the employer"* [R10, L203-206].

Additionally, the Malaysian parties' face-saving culture makes them hesitant to turn to legal action to assist them in resolving the disagreement. Individual and collective feelings of shame are possible in a collectivist society. Thus, an individual's activities can influence the reputation of the project group to which they belong. As a result, certain parties frequently struggle because they do not wish to draw attention to themselves by beginning adjudication against them, thereby exposing the employer to losing face. Face-saving has also stopped parties from seeking external resolution. According to one respondent, the conflict escalates when parties refuse to cooperate with the employer while also being in dispute: *"In other cultures of other jurisdictions, disputants don't mind the parties coming in to help them negotiate and settle the dispute. But in Malaysia, somehow, there is still a firm resistance in involving the third-party process unless it's a last resort"* [R6, L90-92].

Intergroup Differences

Intergroup relations encompass all aspects of a group's relationships, including both constructive and destructive intergroup conflict. Intergroup conflict can manifest itself in a variety of ways in a variety of social contexts. A poorly managed conflict between groups in an organisation can sour morale, breed hatred, and sap productivity and motivation. The interdependence society's imperative is to maintain connectedness as a sign of interdependence with other individuals. A society that is interdependent views each unit of self as a component of the encompassing social relationships and recognises that one's behaviour is determined, contingent on, and to a large extent organised by what one perceives to be the thoughts, feelings, and actions of others in the relationship. For instance, the Malaysian construction parties' experience as an organisational unit includes an awareness of their interdependence as participants in a larger project organisation unit.

The study discovered that disputes are primarily resolved through the industry player's collectivist nature and the industry's dispute resolution culture. The study discovered that the self-perception and relationship with others are not divorced from the social context but are more connected and less distinct from others. Additionally, the study's findings indicate that Malaysian construction organisations operate through interdependence with others but can transform into an independent unit during times of conflict. This is the critical root that underpins the effectiveness of dispute resolution in the highly litigious construction industry. The emphasis is on attending to the in-group’s goals rather than one's own in order to maintain social harmony among in-group members. At the group level, the in-group preference norm motivates intra- and intergroup behaviour by directing group members to consider the in-group interests primarily.

Intergroup cooperation is critical to the effective operation of a complex organisation. However, because intergroup functioning is so ingrained, it runs the risk of undermining collaboration within a building project's groups, making it more difficult to achieve and sustain. One respondent emphasised the critical nature of cooperation in intergroup relationships: *"If you have a good relationship between parties, disputes arising between the parties are minor. So, that is a significant factor. And where you find disputes coming up, there will be a direct correlation with the decrease in friendliness or conversations, which would have decreased. Where parties find themselves in a position where they become more and more adverse, or their communication has been strained, you will see the likelihood of dispute coming. So, It's essential"* [R14, L22-28]. Additionally, a responder stated that group members must abandon harmful hostility in favour of constructive cooperation: *"The fundamental to a successful relationship is win-win. If we can't achieve this, it will be painful to work together"* [R10, L61-62].

Additionally, one respondent suggested that a collaborative attitude toward intergroup relations could facilitate intergroup differences. A traditional technique is to reach a common goal through cooperation and business friendships, so fostering harmony and compromising the working environment among parties involved in a build relationship *"Relationship and communication are the keys. A lot of issues can be resolved you have these two skills. If you have a problem and ask for help, people will help you on a friendly party basis. Without a good relationship with each other, no matter how stable and strong your company is, be it financially or technicality, people will not bother if you are not close with them"* [R10, L13-18]. According to one respondent, at the time of conflict evaluation, it becomes more challenging to maintain a collaborative atmosphere when any out-group members have more significant superiority, including greater entitlement: *"Relationship becomes more difficult to maintain when it hits this process. That is why the decision to embark on adjudication to me is already at the high point of their dispute episode coming on from a very long, troubling matter due to this 'relationship' throughout the project"* [R11, L236-239].

Due to the diversity of construction firms, integrating and coordinating disparate entities within a project is challenging. Rather than attempting to resolve the dispute, each group examines it from their vantage point: *"Major players will take a more cautious approach because the image and presence of their company in the industry are essential. The outcome of any adjudicator may affect them, may affect their bottom line, may affect their company principles and all these. So, they are more cautious about approaching adjudication"* [R11, L196-200].

Differing Group Goals

Inter-group hostility can occur because of opposing aims and prejudice and discrimination directed at the out-group. According to a respondent, anger may occur when the parties view the situation in monetary terms. When both parties view the conflict as a zero-sum game in which only one party emerges victorious, hostility intensifies. *"As I said, this always has value to it. When the value is small, the contractor doesn't mind losing it. But, of course, if we have a long-term established relationship with a developer who has a lot of projects, that may differ the mindset a little bit. But that mindset has a price. There is only so much that I can bear, there's only so much risk I can take, but ultimately somebody has to settle the bill. So, when your margin is stiff when the times and the market are not doing very well, I think my tolerance level will undoubtedly be much lower from the contractor's point of view"* [R7, L98-105].

One of the initial objectives of a new construction company is to establish strong relationships with clients. The quality of the business relationship that the parties build is regarded to have a substantial impact on the company's performance: *"The fundamental thing in creating a working relationship is a win-win. If we can't reach this, do not bother to talk about the future"* [R10, L161-162]. Managing a relationship with an employer is critical for developing and maintaining a client's positive rapport to demonstrate loyalty.

Prioritisation of In-Group Goals

Perception of group distinctions results in comparison and a "we-they" orientation. Thus, the organization's rationale is founded on competition in the sense of "winning" and "losing" in the adjudication process. Comparing the procedures for resolving disputes between parties inevitably results in unfavourable outcomes for at least one party. Parties may discover discrepancies in treatment and privilege, perspectives and group values during the course of discussing the conflicts. When disputes are formally tried in adjudication, parties may discover discrepancies in treatment and privilege, perspectives and group values. One possible resolution may be for one party to defeat the other in order to accomplish its objective. Despite Malaysians' well-known characteristics at the national level, a high degree of intergroup bias and adversaries is discovered to be the industry's default culture of dispute resolution. Resentment develops when parties perceive a situation as competitive.

Intergroup hostility can develop as a result of competing goals for scarce resources. When the value of cooperation diminishes, parties are willing to forego intergroup harmony in order to pursue intragroup goals. The preceding condition exemplifies the ever-present adversary in Malaysia's construction industry. Intergroup competition between the parties, on the other hand, becomes adversarial and destructive to the parties' cooperative relationships and breeds' distrust. At the group level, suspicion and distrust are worldviews that emphasise the untrustworthiness of the out-group. Even if an adversary does not exist, suspicion can develop into distrust, leading the in-group to perceive the out-group's behaviour as vindictive. In construction, the relationship between the parties is considered a one-time transaction and is considered temporary. Parties believe that resolving the financial dispute through negotiation is inappropriate because parties already see no prospect of continuing the relationship. The collectivistic Malaysian parties' intergroup orientation is suggested to be even more competitive and aggressive.

Cash flow problems are renowned for being the biggest barrier to sustain construction businesses, therefore maintaining a healthy cash flow is critical. Respondents agreed that adjudication is necessary to recover money for work performed and guarantee that delays do not hijack the project. CIPAA would protect all parties involved in the payment process, ensuring a smooth flow of funds. When small enterprises cannot acquire new financing, they are particularly vulnerable to insolvency. According to one respondent, cash flow survival is critical for a business's survival: *"If I don't do this, my company will be just liquidated. So, they have no choice, and they have a limited long-term strategy in this industry, or the competition is too stiff for them. They embarked on this process because all other considerations do not matter anymore, whether in a relationship or not. Survival of the company is more important"* [R11, L182-189].

CONCLUSION

The research found that an adversarial dispute resolution technique i.e. adjudication is desirable for the Malaysian construction parties' collectivist society. After considering numerous alternative best explanations for the observed data, the study advances three premises:

First, the influence of intergroup adversary inside a society's collectivism value explains why adjudication is desirable from an *individualism/collectivism* perspective. Collectivism in Malaysia is stratified by race, ethnic origin, background, and hierarchy. The concept of "self" is evaluated concerning the surrounding context, and it is the "other" and "self-in-relation-to-other" that have become the central tenets of collectivism.

The second premise is that conflicts can be avoided if dependency is unnecessary. This perspective on intergroup work relationships is predicated on the premise that intergroup disagreement is unavoidable while intergroup agreement is not. If this assumption is correct, dependency is not necessary. Thus, when a conflict between groups occurs, it can be resolved by diminishing the parties' interdependence.

The third premise about intergroup disputes amongst construction parties is that agreement and continued interdependence are feasible. The presumption is that the parties have previously developed a positive and harmonious intergroup relationship long before disagreements arise. Therefore, it is necessary to seek measures to resolve a conflict between the factions. Harmony resolves the conflict by calming the dispute while preserving interdependence.

The research has made a contribution in that it provides an analytical framework for ensuring that foreign management theories and practises are translated and contextualised for use in local settings. Additionally, the study identifies that while Asian countries face value conflicts, they develop intercultural competence as a result of having to develop a more inclusive and integrated experience that guides subsequent understanding, appreciation, and action. This transformative learning paved the way for the construction players to develop a new meaning structure that allows them to function as their own social unit in their Western-influenced workplace. Furthermore, the research establishes that dispute resolution will always be a cultural process, rather than a matter of principles, techniques, and skills.

Governments are urged to develop strategies for establishing a high-performance work culture that overcomes the inherent contradictions inherent in the pursuit of modern prosperity. Additionally, the research promotes the ability to integrate the values frequently associated with a resolution-oriented dispute culture effectively with people and cultural orientation, as well as the development of abilities for demonstrating them through people's daily activities. Malaysians should translate and interpret any foreign work methods originating in an individualistic culture into organisational patterns resembling those found in a collectivist society.

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GENERATION Z : SKILLS FOR QUANTITY SURVEYING GRADUATES

Veronica Kah Jo Wong, Yoke Mui Lim and Nurul Sakina Mokhtar Azizi
Quantity Surveying Program, School of Housing, Building and Planning, Universiti Sains Malaysia, Minden, 11800, Penang

Abstract
Quantity Surveying (QS) roles are changing significantly due to the transformation of the construction sector and employer's expectations of QS graduates. Employers nowadays expect graduates to be well equipped with soft skills in addition to academic excellence. Employers are searching for QS graduates who are not only multitasking oriented, but also properly prepared to handle complicated and technical workloads in the actual work environment. While there is a basic awareness of what companies demand from graduates, the exact skills that employers seek in QS graduates remain unclear. A total of 14 skills were identified as important for increasing employability rates based on the literature. This research aims to determine which of the skills do employers seek the most from graduates in order to deliver the expectations of the job tasks. A quantitative research method was used where a total of 33 responses from consultant firms registered under the Board of Quantity Surveying Malaysia were received. Statistical Package for Social Science (SPSS) is used to tabulate and analyse data collect from survey. The findings showed that employers expect QS graduates to have excellent skills in Communication, Teamwork, Time Management, Lifelong Learning and Professional Ethics and Moral. Whereas for technical skills, it is important that QS graduates are computer literate. The findings will assist graduates in better planning their future careers by identifying the acquired abilities they need to improve in order to fulfil the expectations of employers and achieve a competitive advantage in the job market, whereas employers should also understand the characteristics of generation Z towards workplace.

Keywords: *Employer expectation; Generation Z; Soft skills; Technical knowledge; Skills; Quantity surveying graduates*

INTRODUCTION

Tun Dr. Mahathir bin Mohammad launched Vision 2020 Malaysia in 1991, with the goal of making Malaysia a developed nation (Mahmoud & Mitkees, 2017). As one of the large contribution in economy development, the construction industry has played a significant role in the vision (Khan, Liew & Ghazali, 2014). Datuk Seri Najib Razak also introduced the Construction Industry Transformation Programme (CITP) in September 2015 (Tamboo, 2015). As part of it, the roles of the construction professions, , particularly quantity surveyors are also facing a transformation in job scope to compete in the international arena as traditional roles of QSs nowadays mainly apply to small and medium-sized projects only (Tramontin & Qwabe, 2016). The QS profession has faced threats to its traditional roles and functions due to client requirements and demand in the construction industry, especially the advancements in new construction technology and the needs of a developing economy (Chandramohan, Perera & Dewagoda, 2020); (Shafie, Khuzzan & Mohyin, 2014).

Previous research studies have identified that changes in the construction environment and practises have also caused employers to no longer see graduates as adequate when equipped with current knowledge of the QS academic subjects only, but also capable to handle complicated and technical workloads in the actual work environment and diversifying themselves beyond the curriculum scope (Tan & Chan, 2016); (Yogeshwaran, Perera & Ariyachandra, 2017). According to the research findings, employers prefer a new graduate who is adequately competent in both technical and behavioural competencies (Hassan, Ismail, Zaini, Hassan, & Maisham, 2011). However, employers with different backgrounds will have different expectations of graduates. According to the finding, 3 significant soft skills with which the QS graduates should be equipped was list out: 1) having a high level of critical thinking, problem solving, and decision-making; (2) fluent communication and language skills; and (3) being capable of working independently (Shafie et al., 2014). However, there will always be additional comments as both employers and graduates agree on the development of three main categories, which are the need for general intellectual and analytical skills, specialist technical skills, and more practical "hands-on" training (e.g., problem-solving) (Davies, Csete & Poon, 1999). In this new era, the construction industry has expected new graduates to continually change the requisite knowledge and skills for professional success due to the changing environment (Bhattacharjee, Ghosh, Corbett & Fiori, 2013). Besides, Chong's (2012) noted that graduate QS needs to be aware of the changes and willing to adapt to them in order to improve their practise and equip themselves with this additional knowledge. Overall, the previous studies has found the majority of competencies are at levels lower than employer expectations.

Generation Z is the new generation of Malaysians entering the labour sector. The forthcoming workforce is expected to undergo significant transformation as a result of the Z Generation (Haziq & Amat, 2021). They are technological whizzes who prefer to study everything on their own. As they enter the workforce, employers will face obstacles due to differences in age, experience, thinking, and style with other generations in the firm. The previous findings show that representatives of Generation Z are becoming more independent and self-reliant, in contrast to the traits and trends observed in Generation Y (Jiří, 2021). According to the studies, human resource directors should see the increasing use of technology and the new generation of workers entering the workforce as a chance to reinvent entry-level labour (Bharat & Rajendra, 2018). They require continual review and feedback, do not function without the assistance of technology, and concentrate on problem solving using the most efficient and creative approaches (Nicoleta & Radu, 2021). Generation Z will soon outnumber all other age groups in terms of activity. From this vantage point, a research question arises: what does an employer look for in a QS graduate? The QS graduates are from Generation Z, which has begun to be noted due to their recent entry into the workforce. As a result, the purpose of this study is to highlight the important characteristics of a QS graduate from Generation Z, and employers must study the unique characteristics of these individuals to produce a win-win situation.

LITERATURE REVIEW

Definition of Generation Z-Quantity Surveying Graduates

A Quantity Surveying graduate can be defined as a person who is well equipped by their university and is ready to enter the construction industry as a junior quantity surveyor. In this study, the graduates are referring to Generation Z. It indicates the graduates were born in the late 1990s and early 2000s. They are the most diverse group to enter the workforce generation and require more communication compared to millennial and are familiar with the internet, or what we call "tech savvy" (Gabrielova & Buchko, 2021); (Chillakuri, 2020).

Definition of Employer

Quantity surveying firms can be defined as firms that are knowledge-intensive organisations that provide expert advice and professional knowledge in the built environment by satisfying the client through the delivery of quality service (Osunsanwo & Dada, 2018), (Fong & Choi, 2009). In Malaysia, the profession of QS is governed by a professional body - BQSM under the Act 1967 (Board of Quantity Surveyors, 2016) QS consultant firms are divided into three different scales, which include small, medium, and large. (Abidin, Adros & Hassan, 2014). The services offered by professional services firms often vary in nature to address diverse clients' needs and demands (Hassan et al., 2011). In this research, our employer can be the top management team in the consultant firm or those who have the authority to do the recruitment.

Soft Skills

Soft skills, according to John (2009), are those that can boost an individual's chances of securing a job (John, 2009). Communication, critical thinking and problem solving, teamwork, conflict resolution, workplace professionalism, adaptability and change management, planning and organising soft skills are examples of soft skills (Mohamed & Abidah, 2015), (Mahasneh & Thabet, 2015), (Shafie et al., 2014). Employers feel soft skill development is one of the most important components of graduate preparation for Industry 4.0, according to the study's findings (Low, Gao & Ng, 2019). Yao & Tuliao also emphasise that skills development is essential in building work relationships, global competency, and career-specific training. According to Shafie et al. research, most employers in quantity surveying organisations are looking for QS graduates who have soft skills and can perform QS jobs successfully. Besides, a prior study found that Generation Z had a positive perception of soft skills and utilised them at work (Haziq & Amat, 2021). As a result, seven critical soft skills have been discovered in this study, which will be explained further.

Communication Skills

The construction project is considered complex due to the large amount of cost and contractual parties involved (Succi & Wieandt, 2019). In the construction industry, communication issues frequently occur between the parties, such as the contractor-subcontractor-architect design interphase (I. A. Rahman & Gamil, 2019). As a consultant QS with the vital duty to make strategic decisions in construction projects, it is essential to have strong communication skills. Besides, it is necessary to have constant communication with all the parties from pre-construction until the end of the construction project, which will involve a tremendous amount of money (Wao & Flood, 2016).

Teamwork Skills

Teamwork skills encompass the ability to work and cooperate with people from various social and cultural backgrounds to achieve a common goal or objective in a team (Debs & Zimpfer, 2018) (Mitropoulos & Cupido, 2009). All the team members share a common goal of completing the project on time and based on the client's requirements (Dhurup, Surujlal, & Mutamba, 2016). This is not a one-man show (Adu & Opawole, 2019). There will be many disputes and problems in which teamwork is one way to settle them efficiently (Yap, Chow,

& Shavarebi, 2019). Previous findings found that Generation Z had a favourable impression of teamwork skills, among other soft skills practised in the workplace (Haziq & Amat, 2021).

Critical Thinking and Problem Solving

According to a critical skills survey by the American Management Association, the definition of problem-solving and critical thinking is the ability to use data, knowledge, and facts and think logically, creatively, and analytically to solve a problem or contribute to a new idea by thinking outside the box and applying new knowledge (Shafie et al., 2014), (Bruning, Schraw, Norby, & Ronning, 2004). A problem will be solved better if a person can think critically (Tuzlukova & Prabhukanth, n.d.). In the construction industry, there will be various types of problems from time to time (Nawi, Nasrun, Nazim, & Yusni, 2014). In a consultant firm, employers are nowadays also looking for new ways of managing contracts (Davis, Love, & Baccarini, 2004). They want to see the contribution of an employee who can think critically and creatively, share their thoughts and opinions by using good judgement and make decisions in a team (Shafie et al., 2014).

Time Management Skills

The definition of time management involves the process of determining needs, setting goals, prioritising and planning tasks to achieve the goals. It can be said as a technique to accomplish the task through effective time use (Claessens, Eerde, & Rutte, 2007). Other than cost and quality, time is the biggest concern and challenge in completing a construction project (Kerzner, 2015). In a complex construction project, there are a few keywords that express the criticality of construction industry problems in Malaysia, such as project delay, late payment, design change, time constraints, and extensive overtime. All of this will lead to a loss of revenue as the return on investment is delayed (Rahman & Berawi, 2006). Hence, the client will always prefer the shorter period of the construction project (Enshassi, Najjar, & Kumaraswamy, 2009).

Leadership Skills

Leadership skills can be defined as the strength, or art of influencing an individual to demonstrate that they help with the oversight of processes and give guide initiatives that can steer their employees toward the achievement of goals. The leader was also playing an essential role in resolving the conflict in the team (Bunashe & Broder, 2015). Hence, a quantity surveyor has to possess leadership style and power within quantity surveying in both clients' and contractors' project teams as a leader (Fellows, Liu, & Fong, 2003).

Lifelong Learning

Lifelong learning is defined as a form of or approach to education that promotes the continuation of learning throughout adult life, especially by making educational material and instruction available through libraries, colleges, or information technology in Oxford Dictionaries ("Oxford," 2020). The world is now developing at a very fast pace, and innovative technology practise is increasing. The clients' design requirements have become more irregular, and the volume of essential construction information has become more extensive and more specialised (Tan & Chan, 2016). One of the examples in Malaysia's construction industry is the Building Information Modelling (BIM) system. It has been implemented and adopted in other countries much earlier (Othman, Al-ashmori, Rahmawati, Amran, & Al-bared, 2020). The construction industry in Malaysia is now aware of this BIM software system, and some companies have started to adopt it as well (Latiffi & Tai, 2019). Employers will prefer graduates who can self-learn independently or self-initiate in the areas of skills and knowledge related to personal development. (Barrow & Keeney, 2001).

Professional Ethics and Moral Skills

RICS professionals have demonstrated their commitment to ethical behaviour by adhering to five global professional and ethical (RICS, 2017). The construction sector is different from other industries in the country due to its one-of-a-kind nature. It is owing to its complicated character, the engagement of several players, the enormous volume of financing in a single transaction, its competitive nature, and the involvement of subcontracting connections. (Ofori, 2015), (Bowen, 2007). Besides, the construction industry has also been reviewed as the most corrupt industry (Bribe Payers Index, 2008).

Technical Knowledge in Quantity Surveyor Graduates

A quantity surveyor is defined as a professional working within the construction industry concerned with building costs (BQSM, 2020). A QS is a crucial professional and acts as a cost engineer, cost planner, or cost controller in the construction industry (Olanrewaju & Anahve, 2015). He is an expert in estimating and monitoring the cost of project work (Davis, 2006). The purpose of QS is to lower the cost of a project and maximise the value of a given proposed project (Cunningham, 2014). However, in this research, the focus will be on three essential technical knowledge areas, which are procurement, construction technology, and contract administration.

Procurement

Procurement can be defined as a process that is used to deliver construction projects. In Malaysia, there are some procurement methods such as traditional procurement methods, design and build, constructing management and Public-Private Partnership (PPP), (Ramanathan & Narayanan, 2016). However, each of the different procurement methods has its advantages and disadvantages. A QS needs to understand all the characteristics of the procurement and propose an appropriate procurement method based on the client's requirements (Agha, 2013).

Construction Technology

Construction technology is essential knowledge for all construction players in Malaysia. It involves studies on methods of construction to successfully achieve the structural design with recommended specifications (T. Y. Ting & Taib, 2018). It involves a process that starts with planning, designing, and financing and continues until the structure is ready for occupancy. However, before starting the construction, there are sheets of drawings. Different types of drawings, such as architectural and structural, will consist of a lot of information and specifications. As a professional quantity surveyor, it is crucial to understand and interpret the drawing for preparing proper pricing in bill of quantities (BQ) (Admin, 2015).

Contract Administration

QS will start to involve the contract matters starting from the initial stage (Keng, Nur, Mohamed & Ching, 2018). In Malaysia, there is the administration of construction contracts facilitated through a standard form of contract. Standards form of contract which is widely implemented are including Public Work Department 203A (PWD203A), Pertubuhan Akitek Malaysia (PAM) (Zakaria & Ismail, 2013). The application of the form of contract depends on the type of project and the requirements of the client. Once the project is in the construction phase, QS needs to do continuous financial monitoring, reporting, and control during the site inspection and recommend appropriate progress payments/interim valuation (Seeley, 1984). Based on Ndihokubwayo (2008), he observed that the variation order is usually caused by the client (49%), the consultant (47%), and last (4%) by the contractor. A severe problem occurs when variation orders are issued to the contractor and owner/client, leading to cost overruns and costly disputes (Oyewobi & Jimoh, 2015). Hence, it is essential for quantity surveyor to assess variation orders as omission and addition occurring means there will be a need for the new items.

Technical Skills

It is necessary to have technical skills in order to apply QS knowledge. The previous study from Tan, Ahmad, Hassan, and Chong found the four skills are essential and needed to equip the graduates needed by employers. Hence, in this study, there are four types of skills, which are computer literacy, costing and estimation, measurement of quantity, and language proficiency, which need further study.

Computer Literacy

The architect and engineer will provide CAD drawings to the quantity surveyor in softcopy. Quantity surveyor can get the dimensions directly from the CAD drawings and then transfer them into a working sheet such as Microsoft Excel. Microsoft Word is another essential skill that will be required by employers. It has a thesaurus feature and will be one of the tools for quantity surveyor to carry out different tasks, such as processing letters and reports (Simon, 2015).

Costing and Estimation

QS as a cost planner will advise on the cost of different design elements and the total cost implications of the method of construction to keep the construction within the employer's budget. There are a total of 3 phases which will require quantity surveyors to be involved in doing the pricing, which are the preparation of estimation, the preparation of BQ, and the variation order (Cunningham, 2015). Cost estimating is to analyse the scope of the project and forecast the cost of the construction project (Amade, Okon & Akpan, 2015). The QS will collect, evaluate, and summarise data for the construction project before combining it with data from previous similar projects (Seeley, 1996).

Measurement of Quantities: Quantity Take-Off

The purpose of Quantity Take-off is to produce a BQ (Seeley, 1984). The amount of material quantity calculated will then be recorded with the unit of measure (Cunningham, 2014). A quantities take-off of material by a quantity surveyor must be accurate in order to produce a high accuracy cost estimate (Barzandeh & Zealand, n.d.). In Malaysia, the Standard Method of Measurement, second edition Malaysian (SMM2) and the Civil Engineering Standard Method of Measurement (MyCESMM) are amongst the current standardised references used in Malaysia. The documents' purpose is to provide a consistent basis for measuring construction works, which will eventually become a BQ and become part of the contract document (Akbar, Mohammad, Maisyam & Hong, 2015). A quantity surveyor can obtain the dimension directly from and then transfer it into a working sheet using Microsoft Excel software based on the guidelines of the standard method of measurement (Tan, 2003).

Language Proficiency

Malaysia is known for being a multilingual country, and we are proud as the language is never a barrier. Our national language is the Malay language. The English language is a second language in Malaysia (Azmi, 2013). In Malaysia's construction industry, we might communicate by using the Malay language or English in the workplace. However, some of the companies might be involved in an international project in which English will become the primary communication language (Ting, Marzuki, Chuah, Misieng, & Jerome, 2017). Therefore, there is a global need for using English at engineering and quantity surveying workplaces as English is a lingua franca.

RESEARCH METHODOLOGY

In the questionnaire design, all the questions will be in a close-end format with a four-point Likert scale to allow the respondents to select the best answer. The first section of the questionnaire will ask questions about the background information, which includes the size, type, and state of the firm. However, the second part of the questionnaire will focus on the employer's expectations towards graduates in terms of soft skills, technical skills, and knowledge. Eight sets of questionnaires were distributed earlier and returned in order to undergo a pilot test to examine the validity, reliability, and appropriateness of the questions.

In this research study, both primary and secondary data were collected in order to obtain a broad perspective and understanding of the competency required by a QS. The primary data was collected by distributing the closed-ended questionnaires to the respondents via email. An online questionnaire is applied for this research because it has greater flexibility in displaying questions. In this research, secondary data collection was used, and the information is stated in the literature review. The secondary data can be obtained from sources such as ResearchGate, Emerald, Springer, Emerald, Proquest, Science Direct, IEEE, IOP Science, Springer, Academic edu, Taylor & Francis.A total of 373 registered consultant Quantity Surveying Practice registered under the BQSM, which are the valid respondents in this research. The data collection was conducted over a three-month period to solicit results, from which 33 numbers responded. The number of respondents is low due to the government's having only recently implemented the MCO. There is an impact on data collection due to being unable to reach them. After receiving all the statistical data from the respondents, the data was then analysed by using the Statistical Package for the Social Science (SPSS). However, the secondary data was obtained by reviewing previous research and extracting the relevant results and findings from that past research. closed-ended questionnaires to the respondents via email.

RESULT AND DISCUSSION

Table 1. The Comparison of The Respondent and The Actual Numbers of Registered Practice in Malaysia Under BQSM

Registered Practice	Frequency	Percent	Frequency	Percent
	BQSM		Respondent	
Sole Proprietor	166	44.7	18	54.5
Body Corporate	149	40.2	8	24.2
Partnership	27	7.3	4	12.1
Multi - Disciplinary Practice	26	7.0	3	9.1
Joint Venture	3	0.8	0	0
TOTAL	**371**	**100**	**33**	**100**

The responses are divided into five categories according to the types of registered practice. 18 (54.5%) of respondents were sole proprietors, 8 (24.2%) were represented by a body corporate, 4 (12.1%) were partners, and 3 (9.1%) were multidisciplinary practitioners. However, there was no response from the joint venture. In Table 1, it shows sole appropriator and body corporate have similar percentages, which are 166 (44.7%) and 149 (40.2%). Then, followed by the partnership and multidisciplinary practice, which are 27 (7.3%) and 26 (7.0%) respectively, in a similar order. Lastly, the joint venture is the least occupied, with only 3 (0.8%). Overall, the total number of 33 respondents is similar in ratio to the actual number of consultant firms which are registered to practise under BQSM.

Most of the respondents are 63.6% (21) from the small size of company, while the medium and large sizes are 27.3% (9) and 9.1% (3), respectively. The questionnaire was distributed to all 13 states. However, out of those 13 states, only 8 states managed to get a reply, and the majority of those came from WP Kuala Lumpur (30.3%) (10). This is followed by Selangor and Sarawak, which have 27.3% (9) and 21.2% (7) respectively. At the same time, there are 6.1% (2 respondents) from Johor and Perak. There are 3.0% (1) respondents from Pulau Pinang, Kelantan, and Negeri Sembilan.

Scaling of Employer's Expectation Towards Graduates' in Soft Skills, Knowledge and Technical Skills

The respondents were asked to indicate their response on whether guidance needed for the graduates. The scale description as stated below:

Table 2. Scale Description

Description	Scale
Need guidance / training	1
Need minimal guidance / training	2
Independent / No guidance needed	3
Not relevant	4

Under this section, there are four different scales which will apply to all the variables under expectations from the employer towards soft skills, knowledge, and technical skills. The respondent will scale from 1-4 for all the variables. When a respondent scores one, it indicates that they do not have high expectations for fresh graduates in this area. However, it is still necessary to provide guidance or training to them. Followed by scale 2, which respondents agree with, there is still a need to provide minimal guidance or training to the graduates. Hence, graduates need to have at least a basic understanding of the variables above. When a respondent selects scale 3, it indicates that fresh graduates must perform well or be well-equipped in those variables, as the respondent will not provide them with guidance or training. Lastly, scale 4 indicates that the variables are not relevant to their consultant.

Table 3. Assessment of Soft Skills in QS Graduates

Soft Skills	Description	Mean	Average (mean)	Category
Communication skills	Listen attentively and give appropriate feedback	2.7	2.5	3
	Communicate with people from different culture, races, ethnic, gender and ages	2.4		
	Convey messages clearly and effectively to reach common understanding	2.3		
Teamwork skills	Work and cooperate with people from various cultural backgrounds	3.0	2.7	3
	Contribute to the team to reach common goals	2.4		
Critical thinking and problem-solving skills	Think critically, logically, creatively and analytically	1.9	1.9	2
	Provide different approaches by applying new knowledge	1.9		
	Recognise the problem and suggest solution	1.8		
Time management skills	Manage and complete task within deadline	2.7	2.7	3
Leadership skills	Motivate team members	2.4	2.1	2
	Give direction and guidance to the others	2.1		
	Resolve conflict in a team	1.8		
Lifelong learning skills	Have initiate to learn new skillset or knowledge for self-development	2.9	2.7	3
	Gain knowledge and learned behaviours from working environment	2.4		
Professional ethics and moral skills	Value and promote truth, accuracy, honesty, accountability, and ethical standards	3	2.8	3
	Decide with ethics consideration	2.7		
	Take responsible and show good attributes in working place	2.6		

Table 3 shows the soft skills of QS graduates in an average mean value range from the lowest 1.9 to the highest value of 2.8, which indicates the respondent agreed the soft skills above fall into scales 2 and 3, which means QS graduates are required to have a basic understanding of the skills above or be able to perform well or well-equipped in those skills above. Based on the data collected, the soft skills expected by QS graduates to perform well are professional ethics and moral skills, with an average mean of 2.8, lifelong learning skills (2.7), time management skills (2.7), teamwork skills (2.7), and communication skills (2.5) in the descending order of average mean. Professional ethics and moral skills (2.8) have conformed to Shafie et al. (2014) that employers rank them as one of the top three skills possessed by QS graduates. The employer believes it is because of the culture and morality instilled in society. Graduates must always be aware of the importance of professional morality and behaviour in their practice, including in sustainable construction. On the other hand, according to table above, it shows teamwork skills, time management skills, and lifelong learning skills with an average mean of 2.7.

Based on the findings from Shafie et al.'s study, the QS graduates present excellent teamwork skills. The employer believes group work assignments and projects from the university have made them used to working in teams. The results indicated that an employer expects a graduate to have initiated learning new skillsets or knowledge for self-development without giving any guidance or training. According to Ahmad, self developments is one of the top employability skills in the study (Ahmad, 2015). However, there is a discrepancy in the employer's expectations towards local university QS graduates in terms of time management skills, lifelong learning, and information management skills. The results showed they are the least expected soft skills expected from the employer (Shafie et al., 2014). It will be necessary to carry out further investigation. Malaysia is a country with multiple races, and employers will expect graduates to understand how to interact, work, and incorporate with people from various cultural backgrounds (Succi & Wieandt, 2019); (Muhamat Kawangit et al., 2012).

According to studies Oladotun & Edosa, and Yogeshwaran et al. they viewed communication skills as important and necessary in addition to the technical skills that are needed by quantity surveyors to perform their duty. However, the employer views QS graduates as performing very poorly in communication skills in Shafies's study. Instead, they have proposed to the institution how they might improve their skills. They proposed students should improve their skills in exposing their real communication skills and increase the number of presentations to encourage students to communicate with construction parties and also learn how to present and defend their task. Leadership skills and critical thinking and problem-solving skills with an average mean value of (2.1) and (1.9) are the soft skills on which employers are expected to give minimal guidance on both of the soft skills. Employers are pleased with QS graduates' ability to demonstrate strong leadership abilities (Shafie, Khuzzan et al., 2014).

The findings revealed that; leadership is not only an important aspect for quantity surveyor, but also the future, which includes the diversified role as stated and the new areas such as sustainable construction. However, leadership viewed as less important characteristic in the finding (Oladotun & Edosa, 2017). Critical thinking and problem-solving skills with an average mean value (1.9). They believe these are the necessary skills because of the nature of the QS profession, which is challenging and requires a high level of problem solving skills to tackle any problem that is related to construction projects, and indirectly, they expect QS graduates to be able to contribute to the growth of their company. However, the employer believes it is one of the lacking skills that needs to be improved by QS. In the construction industry, there will be many problems from time to time (Shafie et al., 2014). Some of the problems can be easily solved, and while some of the problems are more complicated, as we know in the construction industry, they involve many players (Mohd Nawi et al., 2014); (Smith, 2013). A problem will be solved better if a person can think critically (Tuzlukova & Usha-Prabhukanth, 2018).

Table 4. Technical Knowledge

Technical Knowledge	Description	Mean	Average (mean)	Category
Procurement	Able to advice the appropriate procurement method based on the criteria of client	1.8	1.8	2
Construction Technology	Interpreting drawings and specification	1.8	1.6	2
	Knowledge of construction technologies, process and building materials	1.6		
	Green construction knowledge	1.4		
Contract Administration	Managing variation	1.9	1.7	2
	Recommending progress payments/interim valuation	1.8		
	Progressive financial monitoring, reporting and controlling during construction	1.8		
	Administering, managing subcontracts and controlling subcontract accounts	1.4		
	Apply knowledge according to different form of contract	1.3		

Table 4 shows the technical knowledge of QS graduates in an average mean value range from the lowest 1.6 to the highest value of 1.8, which indicates that the respondents agreed the technical knowledge above falls into scale 2, which means that respondents were in agreement that QS graduates are required to have a basic understanding of the skills above. According to the table above, employers expect graduates to be able to interpret drawings and specifications and possess knowledge of construction technology and building materials with minimal guidance and training. However, employers agree that for the knowledge of green construction, they still need to provide the guidance and training. As green construction is more complicated compared to a conventional project, it requires training from the company. Construction technology is one of the most important qualities, abilities, and knowledge for quantity surveyors in their current and future or diversified roles. It is also supported by the findings in Chamikara, Perera, & Rodrigo's study as it revealed that construction technology and environmental service are significant to quantity surveyors in sustainable construction.

The result is also in line with the Tan and Chong study; it shows that among the technical skills that are most needed are measurement, followed by construction technology. As a result, there are high expectations at the industry level. According to the result above, employers are expected to provide minimal training and guidance in managing variations, recommending progress payments or interim payments, and regular financial monitoring, reporting, and control during construction. Graduates must arm themselves with fundamental knowledge and then grasp it with minimal guidance from the firm. However, it is still necessary to provide training and guidance for the graduates in administering, managing subcontracts and controlling subcontract accounts and applying knowledge according to a different form of contract as their means after round off fall in scale 1.

According to the finding, contract management is among the top 3 technical skills requested by employers (Tan & Chan, 2016). In declining order of importance, contract administration is one of the top ten most critical abilities for quantity surveyors, which is agreed upon in the finding of Dada & Jagboro. As mentioned, contract administration is one of the core competencies expected of quantity surveyors. According to table above, employers expect graduates to still need minimal guidance in order to advise on the appropriate procurement method based on the employer's criteria. Graduates need to have a basic understanding of the concept of every type of procurement and suggest the most appropriate procurement based on the client's requirements. It is also supported by Ahmad's study as respondents from the consultant quantity surveyor showed that procurement and construction technology are equally needed (Ranking No.3), (Ahmad, 2015). While it is found in the top competencies in Nkado & Meyer's study.

Table 5. Technical Skills

Technical Skills	Description	Mean	Average (mean)	Category
Computer Literacy	Microsoft Excel	2.8	2.6	3
	Microsoft Word	2.7		
	AutoCAD	2.4		
Costing and Estimation	Prepare cost plan	1.9	1.7	2
	Prepare elemental cost analysis	1.7		
	Prepare bill of quantity	1.6		
Measurement of Quantity	Quantity take off using traditional computerised measurement method	2.6	2	2
	Quantity take off based on SMM2	2.1		
	Quantity take off based on MYCESMM	1.7		
	Quantity take off by using BIM software	1.4		
Language Proficiency	Present idea verbally in English	2.6	2.4	2
	Present idea verbally in Malay	2.1		

Table 5 shows the technical skills of QS graduates in an average mean value range from the lowest 1.7 to the highest value of 2.6, which indicates the respondents agreed the technical knowledge above falls into scales 2 and 3, which means QS graduates are required to have a basic understanding of the skills above or be able to perform well or well-equipped in those skills. The respondents were in agreement that QS graduates are required to have a basic understanding of the skills above. From table above, it shows that employers are expected to Graduate are fully equipped with Microsoft Excel and Microsoft Word skills as their mean after round off will fall on scale 3. However, there is still minimum guidance and training needed for the graduates in AutoCAD as the means after round off will fall under scale 2. In the context of information and communication technology skills, the elements of computer literacy are needed by employers (Ahmad, 2015). It is due to computer literacy that we can cope with ambiguity and complexity. These are the process skills required by a quantity surveyor, which are also emphasised by the employer. There is more concern about the knowledge of QS graduates who are computer literate, especially in spreadsheets. The five most important competencies for future successful services include expertise in computer literacy.

From the results, it shows having excellent computer literacy will be a valuable skill for a quantity surveyor in Sri Lanka. These are the competencies important for quantity surveyors when handling sustainable approaches and sustainable techniques. However, in the finding Oladotun & Edosa, computer and information technology literacy was not ranked high enough by respondents as important in the pursuit of quantity surveying competency. This is despite the nature of quantity surveyors' work, which relies heavily on cost estimates and quantitative-based activities. With the help of computers and advanced designer software, surely it would make their work much faster, more accurate, and error-free. Based on the findings, graduates still need minimal guidance from the company in quantity to take off by using SMM2, and MYCESMM as both of their means, after rounding off, fall to scale 2.

Hence, it is essential to produce a high accuracy cost estimate; hence, guidance is necessary when graduates are new to handling a project. Lastly, there is training, and guidance needed for graduates in using BIM software as the mean score after rounding off falls into scale 1. In the context of basic skills, employers show the most needed skill is measurement. As mentioned by Ahmad, it is a basic and common skill of quantity surveyors that is required in the construction industry (Ahmad, 2015). It is also supported by the study by Tan and Chan, which stated that among the technical skills requested by employers, measurement skills are the highest option. Quantification and measurement have been selected as the most important/significant competences required in the performance of quantity surveying firms. Nonetheless, besides, measurement and costing are also important for quantity surveyors in handling sustainable approaches and sustainable techniques (Chamikara et al., 2018). Employers agree to provide the bare minimum of guidance or training on how to prepare a cost plan, elemental cost analysis, and BQ whose meaning after rounding falls into scale 2. This shows QS graduates are reliable for performing these tasks, as they are expected to be trained to carry out these tasks professionally (Tan & Chan, 2016).

The preparation of the BQ ranked first among quantity surveyors' roles in the construction industry. Cost estimating is one of the top ten most important competencies in their rankings. Measurement and costing are important areas in sustainable construction for quantity surveyors, and thus their competencies must be developed (Chamikara et al., 2018). QS graduate is expected to be fully equipped with the skill to present their ideas verbally in English as their mean score after rounding off falls into scale 3. It is due to some consultant firms' being involved in an international project in which English is a lingua franca. Hence, graduates need to strengthen their language skills (Adnan, 2019). Graduates require minimal guidance and training to present ideas verbally in Malay, as the mean score after rounding off falls on scale 2. Some huge changes in the country's development have changed employers' expectations towards university graduates. Communication and language skills are the top three soft skills that employers believe are most essential but are lacking in QS graduates (Shafie, Khuzzan et al., 2014).

Summary

Table 6. Need Minimal Guidance/Training for Graduates

Soft Skills	Critical thinking and problem-solving skills
	Leadership skills
Knowledge	Procurement
	Construction Technology
	Contract Administration
Technical Skills	Costing and Estimation
	Measurement of quantity
	Language Proficiency

Table 6 shows the attributes for which employers will need to give minimal guidance and training for graduates. There are two variables from soft skills and three variables from knowledge, followed by technical skills. Graduates should arm themselves with a basic understanding or concept of the variables depicted in the tables, as employers will only provide minimal guidance or training to employees.

Table 7. Independent / No guidance for Graduates

Soft skills	Communication
	Teamwork
	Time management
	Lifelong learning
	Professional Ethics and moral
Technical Skills	Computer literacy

Table 7 shows five variables from the soft skills and technical skills which graduates need to be fully equipped with those variables mentioned. The variables under soft skills include communication, teamwork, time management, lifelong learning, and professional ethics and morals. In terms of technical skills, graduates need to master computer literacy.

CONCLUSION

This study has revealed that quantity surveying employers rated the importance of employability skills highly, especially for the profession's new graduates, which are mainly for the Z-generation. They are considered to have their own unique needs in the workplace as they enter organizations. It is different from earlier generations. The study's findings clearly show that they would need to be well-prepared in order to meet the employer's requirements, which are related to soft skills such as communication skills, teamwork skills, lifelong learning skills, professional ethics, and moral and computer literacy as the most important in terms of technical skills. Employers are increasingly searching for relevant employability skills to complement the skills and expertise of graduates entering the construction industry, as the global market for graduates' shifts. Having the awareness as well as the right set of employability skills required by prospective employers can only enhance the graduates' competitiveness and increase employment opportunities in the current challenging scenario.

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SMART B2B ONLINE PROCUREMENT CLOUD PLATFORM IN MALAYSIAN CONSTRUCTION INDUSTRY

Myzatul Aishah Kamarazaly, Shirley Chin Ai Ling and Julian Au Mun Hoong
School of Architecture, Building and Design, Taylor's University, Subang Jaya, Malaysia

Abstract
During the Covid-19 pandemic, it has reflected a rapid acceleration of digital adoption in 2020 for most businesses. This has expedited the need for most businesses across every industry including the construction sector; to implement digital solutions that enable construction business continuity and productivity. However, digitalization is not fully adopted in Malaysia's construction industry especially in procurement. Therefore, the aim of research study is to drive digital transformation and establish an agile 21st century business experience in e-procurement and networking for improving Malaysian construction industry. Hence, the research objectives consist of (i) To determine the extent of e-procurement practice in Malaysian construction industry; (ii) To determine the barriers of the utilization on e-procurement adoption in Malaysian construction industry; (iii) To suggest practical solutions for a wider e-procurement adoption and practice in Malaysian construction industry. Contractors and suppliers have been aimed as the study's target population with the employment of qualitative research method. The results revealed that four out of seven contractors and suppliers entering thee-procurement platform. However, the extent of applying e-procurement in Malaysian construction industry is considered medium-low and unstable as it relatively new to the industry. It was also found that every respondent has agreed that the procurement barriers of long process cycle are critical. Therefore, practical solutions for a wider e-procurement adoption and practice in Malaysian construction industry has been suggested by the respondents that the adoption of e-procurement practice, it will potentially enhance the efficiency of the golden triangle in Malaysia's construction industry, which impacts time, cost, and quality constraints. In addition, it allows companies to be more transparent on showcasing their profiles and obtain a network of ready buyers and verified sellers. With e-procurement practice embedded into construction businesses, it ensures technology takes prime position, and the e-procurement platform will reinforce revenue generation with continued business success within contractors and suppliers in future project delivery. This leads to an envisioning digitalization approach for potential contractors and suppliers to on-board by adopting an efficient and effective e-procurement practice.

Keywords: *Digitalization; Self-Monitoring Analysis and Reporting Technology (SMART) system; Business-to-Business (B2B); 4th Industrial Revolution (IR 4.0); Golden Triangle*

INTRODUCTION

In global industry, procurement process is paramount in the supply chain and imperative for businesses to obtain competitive advantage. Procurement involves finding an external source to acquire goods and/or services and more importantly agreeing to terms of the sales and purchase. Nowadays, with modernization and digital advancement, procurement activities have the potential transition to be streamlined and procuring process can be quick to provide an advanced procurement experience to its participants over the internet. In that regard, this research topic: "SMART B2B Online Procurement Cloud Platform in Malaysia's Construction Industry" is studied to enhance its potential to be adopted in the industry. This research aims to drive digital transformation for establishing an agile 21st century business experience in e-procurement; to ameliorate business networking and opportunities to impact Malaysia's construction industry. As the concept is to connect construction procurement key players – contractors and suppliers together on an integrated digital e-procurement platform, enabling them to leverage streamlined, accelerated, transparent, and cost-effective e-procurement experience (Punn, 2020). Among the common issues that continue to plague various construction projects in Malaysia include delays in project completion (Hamzah et al., 2011) and inefficient claims management due to various reasons such as lack of proper documentation (Azman et al., 2014; Bakhary et al., 2015), which culminates in expensive cost overruns (Abdul Rahman et al., 2013).

Therefore, SMART system serves as a practical solution under this study, to complement SMART Bill of Quantities (BQ) and SMART Contract together under the integrated e-procurement platform. With SMART system, it is more transparent than regular transactions, resistant to fraud, improving time, cost performance and increased quality of data for an efficient project delivery. In addition, the benefit allows to eliminate uncertainty and make all transaction completely transparent. Contractors can foresee where goods purchased are in the supply chain, as well as the funds that have been paid for those goods with a SMART invoice issuance being auto generated by the SMART system itself.

Streamlining administration throughout the business can improve profitability and efficiency, which is why obtaining a Business to business (B2B) e-commerce adoption is a priority for construction digitalization to transform. This research in e-procurement can potentially embrace the new way of working that helps to increase construction suppliers' sales and benefit contractors to source for the right supplier; for the right job in a one-off e-procurement platform. As a result, IR 4.0 is aligned with an e-procurement platform to drive digital technology and innovation. Hence, the golden triangle of time, cost and quality of a project will be made effective with e-procurement adoption.

PROBLEM STATEMENT

During the global Covid-19 pandemic crisis, most of the world's countries went into lockdown, it created an immediate urgency to evaluate which processes could shift into digitalization. At the same time, it is negatively impacting the global construction industry with projects facing labour shortages, supply chain issues and financing pressure. The effects are rippling across the sector from the initial crisis in China to construction sites around the world (Norton Rose, 2020). As small and medium enterprise (SME) look to survive in this challenging business environment, most companies have been pushed into an accelerated state of shifting to digitalization. While the Covid-19 outbreak may have brought a damaging onslaught of economic disruptions to SME, it may have also paved the way for digital transformation as businesses change their operations to cope with office closures, restricted movement, and supply interruption. It is the best time for most companies to plan and embrace Industrial Revolution 4.0 and commence their digital transformation journey (Lee, 2020). Everything from work management and customer experience to processes further down the information chain, like physical data collection and analysis, needed re-evaluation. In a world where digitalization is becoming increasingly relevant, businesses were adopting new solutions faster than ever before. This research's problem statement on the global crisis condition have led to a strong reflection for the need to focus on digitalization and the study focus will be on "SMART B2B Online Procurement Cloud Platform in Malaysia's construction industry"; an e-procurement platform.

The modern age has achieved critical changes in the construction industry. This research problem statement arises in consideration of construction procurement. Currently, it is going through changes as stakeholders attempt to select the procurement method that best fits the business requirements, cost controls, and maintain profitability of the construction project. In contrast, organizations battle to overcome cash flow issues, tight margins, and contract management which is difficult. Imagine this can be overcome with digitalization solution that directly takeover the procurement process with a “SMART B2B Online Procurement Cloud Platform” as a practical solution that allows input of all contractors and suppliers’ information, set budgets, and input all approved materials under an integrated streamlined process. When construction procurement key players place an order, the effectiveness from SMART system technology can easily and conveniently link those materials to a budget or multiple budgets which makes it easy to keep track of what’s coming in and the amount of spending can be automatically calculated under this e-procurement system (Grace, 2019).

RESEARCH GAPS

The research gaps encountered in the literature review as there is no specific statistic source to show the extent of utilization of e-procurement within Malaysian construction industry as it is still relatively new. Moreover, there is no further expression on using buyer and seller point of view on addressing how the transaction works between contractors and suppliers with more business aspects. In addition, this study is only limited to the perspectives from both key players, as the total of 7 respondents from Klang Valley will not represent the view of the whole country. Besides, qualitative interview approach is difficult to be done face to face during this MCO.

RESEARCH OBJECTIVES

The research objectives of the study are as stated below:

1. To identify the extent of e-procurement practice in Malaysian construction industry.
2. To determine the barriers of the utilization on e-procurement adoption in Malaysian construction industry.
3. To suggest practical solutions for a wider e-procurement adoption and practice in Malaysian construction industry.

LITERATURE REVIEW

Construction Procurement

Abouzeid (2018) defines procurement in generic terms which is a purchasing process that seeks to secure equipment, materials, and services for the right price, at the right time, of the right quality, in the right quantity and from the right source. According to International Research Journal of Engineering and Technology (2020), material procurement is an essential requirement in the process to construct a building and it involves construction material selecting, ordering, invoicing, delivering and payment that must be made after the materials are delivered and checked on the construction site. Chen et al. (2020), discusses on the method of construction supply chain processes that can be improved and adopted by advanced technologies, such as, facilitation on overseeing site progress and real-time coordination of material delivery. This also improves decision making on optimal material supply quantities and delivery times at minimal costs.

Construction Procurement Management

Perdomo (2002) states that material ordering and delivery are imperative to the successful execution and completion of any construction project. The person in charge of procuring materials or the procurement department, in the case of a large company, need to ensure that the correct construction materials and machineries are procured in the right quantities. They also need to verify the release dates at which the construction material is needed according to the work programme and clearly specify those delivery dates as well as the site location of delivery to the key supplier. Other than that, other practical examples addressed (based on another author) to firmly introduce construction procurement management includes material selection, material handling and material distribution.

Key Steps in Procurement Process

Procurement process key steps are as follows, Kolenko (2014). Step 1: Identification of the need; Step 2: Submission of purchase request; Step 3: Assessment and selection of vendors; Step 4: Negotiation of terms and pricing; Step 5: Issuance of purchase order; Step 6: Receive and inspection of the goods delivers; Step 7: Conduction of three-way matching; Step 8: Approval of invoice and payment arrangement; and Step 9: Conduct of recordkeeping.

However, there is no specific statistic source to show the extent of utilization of e-procurement within Malaysian construction industry as it is still relatively new. Moreover, there is no further expression on using buyer and seller point of view on addressing how the transaction works between contractors and suppliers with more business aspects.

Construction Procurement Barriers

In today’s businesses, the view of procurement systems is as an imperative strategic contributor to an organization’s action plan and to achieve project delivery goals in construction terms. Construction procurement in organizations will commonly seek to enhance time efficiency, cost effectiveness and successful project delivery. On top of that, there is a need to standardize procurement procedures for a streamlined procurement process cycle and empowering the overall work program or action plan with the best conduct in practice, Ahmed (2019).

Barriers Encountered in Construction Procurement

E-procurement system is considered a recent development for business applications and there are limited benchmark models to reference especially for beginner users with the system's functionalities and utilize in their organizations' practice. In accordance with Griffiths et al. (2010); Gunasekaran et al. (2009); Nawi et al. (2016), these authors have found factors that contributes to barriers for e-procurement adoption such as technological innovations, infrastructure and legislation, social environment; other than resource constraints, authoritative as well as management attributes. Whilst, based on external factors within the construction industry, it will reflect on market conditions, government policies and technological advancements that are outside the ability to control (Fernandes et al., 2015). The barriers encountered in construction procurement across the construction industry, according to Kissflow (2020), consist of the followings: -

Risk Mitigation

As supply risk has always been a crucial challenge in the construction procurement process. For instance, the potential risk encountered can be in terms of cost, quality of workmanship, market conditions, frauds, and project delivery. Moreover, anti-corruption is considered a compliance risk and policy adherence is also an issue in construction.

Dark Purchasing

It is referred to purchases that are constituted to irregular procurement process that is out of the code of ethics. For instance, unethical companies will spend without control in bulk orders and causing a low supply in the market. This leads to the material price to be more expensive for its limited availability for construction projects. When items purchased cannot be explained by using capital outlay or material inventory, there will be loss of revenue and market control is a vital barrier for all scales of companies to tackle in construction projects.

Long Process Cycle

Procurement of construction materials are often done in a last-minute notice such as variation of work that has been conducted with a sense of urgency. Therefore, work schedule time and the procurement process cycle tend will be dragged for a longer timeframe than initial planned schedule. The common reasons that influence delay in time factor during the construction procurement process are delays. For instance, preparation of specification is not in detail, no supervision on procurement scheduling leading to wrong purchases, late submission of bids or proposal and the critical path is not properly evaluated and there are setbacks in contract negotiation.

Inaccurate Data

Construction procurement must be done with a precise and reliable information to incorporate proper decision making for procurement. If the purchases are accidentally based on false information such as incorrect quantities stated, this will surely lead to inventory issues to be excessive or face shortages. This is a crucial factor to look at as this procurement challenge will affect company's efficiency in performance.

Strategic Procurement

Overtime, procurement cycle proceeds in the construction industry emphasizes strategic procurement and collaborative effort, as most associations understood the benefits of obtaining a strong procurement setup to be done strategically. Nonetheless, understanding the essential ramifications of every step and sorting out an approach to execute across all practical units of business is challenging.

Supplier-Related Issues

Supplier management aspect has also brought detectable barriers in the procurement process cycle. Commencing from sourcing and identifying the right key supplier to keep track of their performances and quality check must be performed to suppliers' products have complied with the quality according to the specifications. Hence, complication will arise when there's such unwanted defaults.

Transparency

The biggest challenge among other challenges facing the buy-side community under this research is when certain group of suppliers are not willing to share full information transparently with all the members of the supply chain by providing all information into the integrated platform.

Shifting Towards Digitalization

Over the years, as construction projects gradually increased in complexity, budgeting has been tighter while requirements and expectations on quality are higher. Therefore, due to the cost limitations, the progress of technological advancement in the construction industry has typically been slow as compared to other industries. This is evidenced with the low level of improvement as it has been stagnant with traditional methods on execution of works over the past decades. Moreover, construction business' personnel tend to rely profoundly on specific skills and traditional practices which lack innovation readiness, and mainly depend on expert judgment that are experience based, which made it difficult to automate. However, digital technological evolvement is swiftly rising through modern age and as new barriers in procurement are encountered, Kissflow (2020). Recently, a study on the construction industry has uncovered neglect to keep up with productivity improvements over the last decades according to multiple authors (Blayse et al., 2004; Greenwood et al., 2002; Chan et al., 2007). With the rapid advancement in technology and digitalization approach in construction businesses; Malaysia's construction industry will be able to align with Industrial Revolution 4.0 and to attain best value and most optimum outcome from the "golden triangle" in terms of time, cost, and quality constraints for an agile project delivery.

Industrial Revolutions (IR 4.0)

Industries worldwide have abrogated with a reflective influence on its practices and productivity. In the twenty-first century, industries will need to align with IR 4.0 which involves digitalization as its' essential component in the modern age. IR 4.0 is portrayed by a combination of abilities which is obscuring the lines between the physical, digital, and biological scopes mentioned by (Saldivar, 2015; Wan, 2015). The key concepts of IR 4.0 are to significantly convert the construction industry towards digitalization that can provide quick response for problem solving, collaborative and cooperative business in a project (Adeleke, 2020). There is no official definition of IR 4.0 despite being given excessive attention to its outlook. However, it can be defined as "the integration of complex physical machinery and devices with networked sensors and software, used to predict, control and plan for better business and societal outcomes", as well as "a new level of value chain organization and management across the lifecycle of products" (Kudriashov et al., 2016; Mazzucato et al., 2008).

E-Procurement Adoption in Construction

E-procurement is seen comprehensively as an end-to-end solution, which avails the procurement processes to be integrated and streamlined (Vaidya, 2006). The distinguishing proof of the drivers and barriers to e-procurement in construction is crucial to acquire in-depth comprehension on the advantages of e-procurement that will benefit the expansion of construction procurement businesses. A restricted report had been conducted; as Eadie et al. (2007) completed a fundamental report into drivers and barriers in construction and it is based on Northern Irish contractor's outlook. The investigation applied drivers and barriers distinguished from other industries to e-procurement in construction and the significant arrangement order of drivers and barriers is executed. Martin (2008) remarked the drivers and barriers have been analysed to recognize those which are pertinent to the construction industry.

According to several authors Dusyhart et al. (2003) and Tavares (2010) the adoption of e-procurement practice has achieved over 3% reduction in public consumptions without decrease in yields. The level of potential that e-procurement has, made this conceivable for most aspects since it has proven to diminish complexity, enhancing competitive advantage with greater transparency in construction businesses. At the same time, it establishes an integrated digital age electronic environment in conjunction with the support of advanced technological devices to oversee the entire procurement process cycle and its activities within the construction key players – contractors and suppliers (Costa et al., 2013).

E-Procurement Barriers

E-procurement system is considered a recent development for business applications and there are limited benchmark models to reference especially for beginner users with the system's functionalities and utilization in their organizations' practice. Accordance to Griffiths et al. (2010); Gunasekaran et al. (2009); Nawi et al. (2016), these authors have found factors that contribute to barriers for e-procurement adoption such as: (i) Technology barrier to suppliers – commitment to a specialist software and annual membership subscription fee is sensitive towards SME company's capabilities; (ii) Usefulness and security issues – profile transparency is required to be showcased and not everyone gives full disclosure; (iii) Availability of supporting infrastructure – requires the support of sufficient broadband coverage; (iv) Inadequacies in government policies and legislation – to cater for both private and public sectors; (v) Standard procedure for governmental tendering process – mandates buying of printed tender documents; (vi) Lack of uniform standard in development – cannot communicate electronically with other system, creates diverse but fragmented e-procurement environment; and (vii) Prejudicial thinkers – resistance to change in traditional business.

E-Procurement: Supporting Features as Practical Solution

Business-to-Business (B2B) E-Commerce

Orocommerce (2020), defines Business-to-Business (B2B) e-commerce as an online transaction where both parties involved are businesses. In other words, a company selling products or services to another company is deemed as a customer to partake in a B2B transaction. Practical solution on data errors for leveraging e-commerce is hassle-free, includes its benefits: (i) Reduction in manual data errors; (ii) Reduction in system administration requirements; (iii) Diminish order handling for inside sales.

Self-Monitoring, Analysis and Reporting Technology (SMART) System

The SMART system has been programmed to integrate seamless features. It will make the entire business runs more smoothly, with fewer errors and much less stress on management of staff which can reduce administration cost. According to Harmon (2015), smart systems are required to obtain instrumentation, interconnection, and intelligence to achieve effectiveness.

SMART Bill of Quantities (BQ)

The SMART bill of quantities feature is brilliantly introduced by NiuAce (2020). As they have incorporated Optical Character Recognition (OCR) capability in its e-procurement platform. The technology lies behind OCR will allow to automatically recognize character through an optical mechanism. This helps in conversion of different types of documents, such as scanned paper documents, PDF files or images captured by a digital camera into editable and searchable data mentioned by (Mithe et al., 2013).

SMART Contract

SMART contract is a software-defined contract embedded in a software algorithm that automatically self-executes once triggered by an occurrence of a certain event. Likewise, activities of negotiation, verification and performance are eliminated from the contracting process. Therefore, significant level parallels may be drawn between smart contracts and shrink wrap agreements, which are also non-negotiated deals that come into effect when triggered by a certain event, namely use of a licensed work. The SMART contracts are incorporated into the e-procurement platform, which enables transactions applications to be listed to assist in legal constraints and does not obstruct the full mechanization and business measures to be built upon it, every legal requirement will be kept recorded.

E-Procurement Adoption: Practical Solution

The potential practical solutions provided by e-procurement adoption (Eadie et al., 2007) in the construction industry, include: (i) Reduce time on material sourcing – speedy productivity technique for sourcing online, being a lean channel for correspondence in a streamline effect; (ii) Reduce tendering price – measure procurement process' success rate reflected in cost factor; (iii) Reduce administration costs – determined by examining profits without causing rivalry, such as rental; (iv) Reduce procurement staff members – main competitive advantage through significant low expenses in an organization; (v) Reduce operating and inventory costs – in terms of ordering, carrying, shortage and replenishment; (vi) Enhance competitive advantage – unified office can manage and access all procurement activities or documentation at any point of time; (vii) Enhance communication – transparent with business details on showcasing material or service pricing; (viii) Enhance market insight and decision making – better view market pricing to take strategic procurement decisions.

RESEARCH METHODOLOGY

Data Collection Method

Qualitative method is used to achieve the research objectives of this study on: (i) Extent of e-procurement practice; (ii) Barriers to the adoption of e-procurement utilization; (iii) Practical solutions towards the adoption of e-procurement utilization and practice. All information is based on Malaysian construction industry with a semi-structured interview approach by purposive sampling. The qualitative approach is a common data collection method that has assisted to observe and interpret relevant data from experts which the samples will then be taken as small samples from expert testimonies (Othman, 2011). Interviews are conducted to explore the views, experiences, beliefs, and motivations of individual experts (Gill et al., 2008). Moreover, exploratory research is employed to formulate problems, clarify concepts, and form a hypothesis according to the research study. The interview undertaken for exploratory purpose is not required to examine a sample of a population on contractors and suppliers who are using e-procurement platform, it will be executed on looking for individuals with relevant expertise in the field regarding the research topic. Besides that, the data is obtained from e-interviews via “Zoom Meeting”, which were conducted online during this pandemic period. Hence, interview questions were prepared, and answers given by respondents was translated into a transcribe.

Target Population

The target population in this research was (3) contractors, (3) suppliers and (1) e-procurement platform company to make valid statements relevant to the research study. These opinions are limited to the contractors and suppliers in Malaysia. The location for data collection is mainly targeted within Klang Valley. The reason of selecting these targeted respondents is that they are construction procurement key players who have a certain length of experience in adopting e-procurement within the company.

Data Analysis Method

Thematic analysis is employed in this research study. According to Braun et al. (2006), it is widely used in qualitative research which can identify, analyse, organize, describe, and report themes found within a set of data. With this approach, it provides high flexibility to retrieve data in a detailed manner from relevant expertise. Moreover, it is effective to examine the perspectives and experiences from various experts to highlight comparisons. This includes unanticipated insights which is based on personal experiences. Hence, thematic analysis has enabled the collected data to systematize and increase the traceability and verification of the analysis. This analysis will benefit the research study to produce a clear and organized final report on handling the data systematically.

RESULT AND DISCUSSION

Respondent's Legend

Table 1. Respondent Legend

Respondent	Designation	Length of Experience with e-Procurement
	Contractor	
R1	Tender and Proposal Estimator	3 months
R2	Contracts Executive	9 months
R3	Quantity Surveyor	21 months
	Supplier	
R4	Sales Executive	6 months
R5	Sales and Marketing Consultant	7 months
R6	Manager	7 months
	E-procurement Platform Company	
R7	Contract consultant	36 months

Research Findings in Relation to Objective 1

Table 2. Coding Legend for Category A

Category	Theme	Sub-Theme	Code
A. Extent of applying e-procurement in Malaysian construction industry	1. Less than 3 months	a. Not frequently used b. Quite new c. Minimal	A1a, A1b, A1c
	2. Less than 1 year	a. 6 months b. Less than a year	A2a, A2b
	3. More than 1 year	a. Over a year b. 3 years	A3a, A3b

Table 3. Summary of Extent of Applying e-Procurement in Malaysian Construction Industry

Category A: Extent of Applying e-Procurement in Malaysian Construction Industry							
Code	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**
A1a		✓					
A1b					✓		
A1c	✓						
A2a				✓			
A2b						✓	
A3a			✓				
A3b							✓

The study's objective one was to identify the extent of e-procurement practice in Malaysian construction industry. As the findings show, even though it is still a relatively new platform, all the respondents from the interview are adopting e-procurement practice in the construction industry and it is considered a good response of participation. Evidently, e-procurement is being recognized by contractors and suppliers from the data analysed which they have joined the platform in recent years. From the interviews implemented, the extent of e-procurement practice has various themes which have been differentiated according to, less than 3 months, less than 1 year and more than 1 year on their participation experience with it. However, the benefits of e-procurement to assist construction procurement key players can help to overtake the traditional procurement barriers that were stated in the literature. Thus, the extent of adopting e-procurement practice is believed to increase and more potential construction procurement businesses within contractors and suppliers will shift into digitalization for aligning with the Industrial Revolution 4.0 (IR 4.0) in the future.

Research Findings in Relation to Objective 2

Table 4. Coding Legend for Category B

Category	Theme	Sub-Theme	Code
A. E-procurement barriers in Malaysian construction industry	1. E-procurement barriers encountered	a. Technology barrier to supplier	B1a
		b. Usefulness and security issues of the system	B1b
		c. Availability of supporting infrastructures	B1c
		d. Lack of standard in the development	B1d
		e. Prejudicial thinkers	B1e

Table 5. Summary of e-Procurement Barriers in Malaysian Construction Industry

Category B: E-procurement barriers in Malaysian construction industry							
Code	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**
B1a	✓		✓			✓	✓
B1b	✓	✓	✓	✓	✓		✓
B1c							✓
B1d	✓	✓	✓				✓
B1e			✓	✓			✓

The study's objective two was to determine the barriers of the utilization on e-procurement adoption in Malaysian construction industry. It is significant to appraise the barriers encountered for adopting e-procurement as further improvements can be integrated to the system to improve user's experience as a whole for future studies. The data analysed and literature findings has complimented the barriers encountered in terms of, technology barrier to suppliers, usefulness and security issues of the system, availability of supporting infrastructures, lack of standard in the development and prejudicial thinker have been expressively mentioned in this study, Griffiths et al. (2010); Gunasekaran et al. (2009); Nawi et al. (2016).

Other than that, Respondent 7 shared other alternative barriers which is pricing factor that may be sensitive to medium to small scale company, language barrier as some users are not well-versed in English language which there is no bilingual support system. Moreover, lack of manpower to migrate as it requires time and effort to conduct more training for users to adapt and learn a new system if a company has been practicing own standard operating working procedures for years; are further obstructions to change.

On additional insights from the interviews, Respondent 1 expressed paperless implementation and its adoption would greatly benefit both contractors and suppliers, there will be an integrated platform to offer their services as compared to the traditional method which has a lot of limitation on how far their reach can go. Whilst Respondent 2 believed disputes and discrepancies factors will be minimized. Respondent 3 also mentioned proper utilization will benefit construction parties with more recognition, but barriers can still be found because of security reasons in terms of business transparency. Thus, not everyone is willing to put every detail transparently as some prices reflects on bulk order discounts. From supplier's view, Respondents 4 and 5 also shared similar thoughts that human errors will still be detected when using the software, such as, data entry or information may be shared wrongly. Moreover, Respondent 4 emphasized that the current system is workable but not effective as there is a general belief that digitization can implement the same work in a shorter time frame.

Research Findings in Relation to Objective 3

Table 6. Coding Legend for Category C

Category	Theme	Sub-theme	Code
C. Practical solutions of e-procurement adoption and practice in Malaysian construction industry	1. Time aspect	a. Reduction in time to source materials	C1a
	2. Cost aspect	a. Price reduction in tendering b. Lower administration costs c. Reduction in procurement staff d. Reduced operating and inventory costs	C2a, C2b, C2c, C2d
	3. Quality aspect	a. Gain competitive advantage b. Improve communication c. Improved market intelligence and enhanced decision making	C3a, C3b, C3c

Table 7. Summary of Practical Solutions of e-Procurement Adoption and Practice

	Category C: Practical Solutions of e-Procurement Adoption and Practice						
Code	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**
C1a	✓	✓	✓	✓	✓	✓	✓
C2a			✓				
C2b			✓		✓	✓	
C2c			✓			✓	
C2d			✓				
C3a			✓	✓	✓		
C3b			✓		✓	✓	
C3c			✓			✓	

The study’s objective three was to suggest practical solutions for a wider e-procurement adoption and practice in Malaysian construction industry. It is significant to overcome the barriers encountered with effective practical solution while users will adopt e-procurement practice with confidence. The data analysed and literature were expressed in terms of, time aspect with reduction in time to source materials; cost aspect with price reduction in tendering, lower administration costs, reduction in procurement staff, reduced operating and inventory cost; quality aspect to gain competitive advantage, improve communication, market intelligence and enhanced decision making (Eadie et al., 2007). On top of that, Respondent 6 suggested an alternative practical solution to connect clients into the system to fit client’s requirement.

Additionally, Respondent 3 from the interview has shared the e-procurement workflow. Firstly, contractors will prepare and post the bill of quantities into the system, send out tender invitation to look for their preferred subcontractors or suppliers for the job. Finally, an issuance of letter of award or purchase order will be done. Thus, everything is streamlined and convenient for an efficient project delivery. In the end, e-procurement system has firmly showcased a more streamlined and standardized platform to make construction procurement businesses within contractors and suppliers to be more efficient with digitalization (Vaidya, 2006).

Respondent 7 agreed that e-procurement applied with business-to-business (B2B) concept as the platform would have all transaction and procurement under one platform. This allows ease of tracking and enhanced standardization of all procured items. The process is to allow both contractors and suppliers to use an integrated one-off platform for e-procurement all the way to contract issuance. Also, SMART system is integrated to allow files to be stored in servers and allowing multiple parties to use simultaneously. For instance, there is SMART BQ with OCR feature that allows to detect words from a PDF file, which BQ can be scanned and read by the e-procurement system feature (NiuAce, 2020).

Reflecting on IR 4.0, Respondent 1 shared a conclusive statement regarding the implementation of any form of technology in the construction industry i.e., it takes a relatively longer time than other industries. The shift from traditional methods to e-procurement involves monetary and internal restructuring to integrate it into the company's internal process. This may pose cash flow problems to smaller firms, as such transformation may not be able to be widely adopted (Adeleke, 2020).

CONCLUSION AND RECOMMENDATION

This research study has revealed from the overview of traditional procurement including barriers encountered. It has also discussed and demonstrated the need for construction businesses to shift towards digitalization utilizing an e-procurement platform for construction procurement key players – contractors and suppliers. The research study has fulfilled the research objectives to have a better understanding on e-procurement practice and it has been extensively discussed with the data collected and literature reviewed to avail validity in the research findings. This leads to an envisioning of digitalization approach for potential contractors and suppliers to be on-board by adopting an efficient and effective e-procurement practice. In the end, savings in time, cost reductions and enhanced project quality will help achieve the research aim as well as overcoming challenges for an agile 21st century business experience. The potential of e-procurement practice in Malaysian construction industry is believed to be recognized immensely adopted in the future. As the potential benefits will help connect contractors and suppliers to boost the efficiency of their procurement activities in an efficient and user-friendly way.

CONTRIBUTION OF THE RESEARCH

The findings of this research study have elevated an in-depth knowledge and understanding with the support of literature study and expert testimony gained as a researcher. Therefore, the result of this study can be drawn upon as a basis for future researchers to continue exploring on the e-procurement practice in Malaysian construction industry. More detailed case studies should be performed to avail a valid statement. It is imperative for future researchers to keep an update with the extent of e-procurement practice and continue exploring what are the barriers encountered with practical solutions for further improvements in the e-procurement system to achieve the research aim.

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THE MODERATING EFFECT OF PRIOR EXPERIENCE ON SMART HOME TECHNOLOGY ADOPTION

Fock-Kui Kan[1], Esther Wong Siaw Wei[1] and Winnie Wong Poh Ming[2]
[1]*School of Built Environment, University of Technology Sarawak, Sibu, Malaysia*
[2]*School of Business and Management, University of Technology Sarawak, Sibu, Malaysia*

Abstract
The smart home is a dwelling space that integrates with computing technology, control technology, image display technology, and communication technology via the internet of things to facilitate the management and control of automation functions. Many recent studies have specifically looked into the smart home technology adoption in Malaysia and have produced substantial empirical validation. However, prior experience has not been examined in terms of its moderating effects. This research aims to investigate the extent of moderating effect of prior experience in influencing the households' attitudes and intentions towards the adoption of smart home technology. By considering this moderator, the research aspires to reduce the inconsistencies among the previous findings. This research adopted a quantitative approach, adapting measurement scale from seminal works in Technology Acceptance Model (TAM). The respondents comprise households from various states of Malaysia and were selected via convenient sampling. Smart Partial Least Square technique was employed to examine the moderators in a structural equation model setting. The research has found that perceived usefulness and perceived ease of use lead to attitude toward technology. Whereas attitude toward technology is positively related to intention to use smart home technology. Besides, prior experience is found to exert moderating effect on the relationship between attitude and behavioural intention. The findings have enriched the technology acceptance literature, providing insights into the influence of prior experience in predicting households' attitudes and intention to embrace smart home technology.

Keywords: *Prior Experience; Smart Home Technology Adoption; Technology Acceptance Model*

INTRODUCTION

The smart home technology in Malaysia is still at its infancy stage (Wan Hidayati & Azizah, 2018). Nevertheless, it has an encouraging environment to embrace this technology. The Malaysians generally show positive behaviour in ICT consumption, i.e., multi-handset ownership, internet surfing, mobile apps, online purchases, social networking (MOSTI, 2014), and speedy growth of internet users and online activities since 2012 (MCMC, 2020).

The behaviour of using new technology has been commonly predicted via Technology Acceptance Model (TAM). Recent research has specifically looked into the adoption of smart home technology in Malaysia via the lens of TAM (Maruf Gbadebo, Abdullahi Hassan & HaimHilman, 2018; Tee Wei, Baharudin, Fatlawi & Hilmi, 2019; Wan Hidayati & Azizah, 2018). The TAM typically demonstrates that users' attitudes such as perceived ease of use and perceived usefulness could lead to technology adoption (Davis, 1989; Lai, 2017; Surendran, 2012; Susilo, Prabowo, Taman, Pustikaningsih & Samlawi, 2019).

However, smart home technology presents a completely new living environment to users and occupants alike. The acceptance and embracement of this technology are unlikely to occur instantaneously. The users require time to adjust and adapt. Hence, prior experience (i.e., learning time duration) could be a crucial factor influencing the users' beliefs and attitudes which inevitably may change over time (Venkatesh & Morris, 2000). Hence, research on smart home technology should distinguish between experienced users with non-experienced ones.

Based on the above Malaysian context, this research aims to assess the effect of prior experience on smart home technology adoption among Malaysians. The research possesses two objectives:

i. To examine the effects of TAM on smart home technology adoption among Malaysians; and

ii. To investigate the effect of prior experience as a moderator on the attitude and intention of Malaysian households towards the smart home technology adoption.

LITERATURE REVIEW

Smart Home Technology Adoption

The smart home is a dwelling space that integrates with sensor technology, computing technology, control technology, image display technology, and communication technology via the internet of things (IoT) to facilitate the management and control of automation function (Ding, Cooper, Pasquina & Fici-Pasquina, 2011; Li et al., 2018; Mocrii, Chen & Musilek, 2018). Sovacool and Furszyfer Del Rio (2020) defined smart home technology as "devices that offer some degree of digitally connected, automated, or enhanced services to building occupants". The smart home living space must be embedded with state-of-art technologies for functionalities automation (Ding et al., 2011; Markovic, Cvetkovic, Zivkovic & Popovic, 2012) to provide a sense of well-being and enjoyment of life to its occupants (Buys, Barnett, Miller, & Bailey, 2005; Demiris & Hensel, 2009).

It is now possible when personal computers have become commonplace in the home spaces (Hui, Sherratt & Sánchez, 2017), where modern ICT has been assimilated into the daily life of households (Alwaer & Clements-Croome, 2010; Wong & Li, 2009). Domb (2019) concurred that the smart home concept has gained its popularity, forming part of the modernization and cost-saving trends. The home appliances, lighting, heating, air conditioning, entertainment systems, security systems, etc. are all capable of interacting with one another while being remotely controlled via telecommunication or internet platform (Edwards & Grinter, 2001; Verma, Jain, Goel, Vikram & Verma, 2016), and operated in the ambient of IoT (Kundu, Khallil, Das, Al Mamun & Musha, 2020). The combination of these state-of-art hardware and software technologies are capable to offer better quality and intelligent living environment named smart home technology (Fabi, Spigliantini & Corgnati, 2017).

Specifically, this technology can provide efficient energy management (Gram-Hanssen & Darby, 2018), indoor environmental quality control (Schieweck et al., 2018), security and access control (GhaffarianHoseini, Dahlan, Berardi, GhaffarianHoseini & Makaremi, 2013), audio-visual entertainment management (Iqbal, Hall, Lee & Islam, 2019; Sripan, Lin, Petchlorlean & Ketcham, 2012), assisted living (Demiris & Hensel, 2009), and healthcare (De Silva, Morikawa & Petra, 2012; Smirek, Zimmermann & Beigl, 2016). All these systems possess intelligent characteristics, are constantly adaptive and adjustable to the changing needs of the households (Domb, 2019). Besides, these technologies are capable of learning and interpreting the available data, predicting the users' behaviours, and recognising irregularities that warrant users' attention (Furszyfer Del Rio, Sovacool, Bergman & Makuch 2020).

Though the benefits of smart home technology are obvious, the reasons for its adoption are varied. Previous researchers have examined the intention of smart home technology adopters. They have found that SHT adopters are generally concerned with energy and cost-saving, passionate and trust in technology, environmentally conscious, and propensity to automation and control (Hargreaves et al., 2015; Hargreaves, Wilson & Hauxwell-Baldwin, 2018; Karlin et al., 2015; Mennicken & Huang, 2012; Parag & Butbul, 2018).

Perceived Usefulness

The perceived usefulness is one of the main determinants of technology adoption (Davis, 1989). Leong, Ooi, Chong, and Lin (2013) stated that users are keen to accept a new technology if they see its usefulness. The main benefits of the smart house are improving the quality of life, reducing costs, and managing resource consumption for large households (Snow, Håkonsson & Obel, 2016). Wilson, Hargreaves, and Hauxwell-Baldwin (2017) undertook a representative national survey of potential and actual smart home technology adopters in the UK. The potential adopters primarily viewed SHTs as a means for energy management, other than providing convenience and security in living as well as enhancing entertainment and communication. The potential adopters perceive SHTs offer the benefits of energy, time, and money-saving as well as convenience in their daily life. Their responses are largely similar to the actual SHTs adopters.

Perceived Ease of Use

The perceived ease of use is defined by Davis (1989) as “having less effort or easier to carry out the tasks through the technology adoption”. This is due to even the users were attracted by the usefulness of technology, they may face difficulties in using it. If the technology is easier to use, it would increase the adoption of it as they would be free from effort while using it (Leong et al., 2013). This is corroborated by Lin (2011) that the perceived ease of use critically affects the attitude of less experienced users in using new technology. This is particularly obvious for the elderly who would consider the efforts that they have to put into the adoption of new technology (Chen & Chan, 2014; Wang & Sun, 2016). Besides, for less experienced website users, the perceived ease of use would substantially affect these users whether to revisit that website (Castañeda, Muñoz-Leiva & Luque, 2007).

Attitude Towards Technology

Attitude is the users' negative or positive feelings regarding the use of a technology (Kasilingam, 2020). Empirical studies have confirmed that attitude is a key determinant of behavioural intention towards technology (Bhattacherjee & Sanford, 2006; Lin, 2011; Moon & Kim, 2001). According to Tsourela and Nerantzaki (2020), potential users tend to believe more in their personal enjoyment experience of IoT products and applications. Their experience would lead to a positive attitude and ultimately form behavioural intention.

Besides, Dabholkar (1996) found that potential users who are unfamiliar with new technology would rely on others' attitudes towards the new technology.

Behavioral Intention Towards Technology

The behavioural intention is regarded as the conscious plan of the users to continue a specific behaviour in the future (Chao, 2019). This construct is proven to be a strong indicator of acceptance at the early stage of technology adoption where, if the behavioural intention is to increase, the likelihood of the users to adopt the technology is increased significantly (Prayoga & Abraham, 2016) Previous research has identified that behavioural intention of smart home technology adoption is affected by security, risk privacy, and trust (Yang, Lee & Zo, 2017).

Moderating Effects: Past Experiences

The past experience is defined in our research as an experience of using smart home appliances. If an occupant has used any smart home appliances and/or residing in an environment equipped with a smart home technology system, he or she is regarded as an experienced user.

Through prior exposure to similar technologies, users are more knowledgeable in dealing with new technology and that would facilitate their usage of the new technology (Sun & Zhang, 2006). However, this positive influence may be diminishing over time as the user begin to understand and assess the costs and benefits of that new technology (Kim, 2008). Bhattacherjee and Premkumar (2004) concurred that when users firstly experience the information system usage, they may alter their beliefs, attitudes, and subsequent usage behaviour, indicating experience is an important moderator.

Nevertheless, previous studies have largely neglected the moderating effect of the users' experience on their behavioural intention towards smart home technology. Instead, moderating effect of experience has been examined in other technological contexts namely, AI-powered Smart TV (Gao & Huang, 2019); mobile shopping application (Kasilingam, 2020); mobile wireless technology (Kim, 2008); (Fernandes & Oliveira, 2021) automated technologies, etc.

Specifically, Taylor and Todd (1995) discovered a stronger correlation between behavioural intention and past experience. They compared the experienced computer users with the inexperienced ones and found that the strength of behaviour intention varied between users with different levels of user's experience, affirming that experience is an important moderator.

Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) has been thoroughly studied in various research areas, namely, education (Sánchez-Prieto, Olmos-Migueláñez & García-Peñalvo, 2017), smart media (Gao & Huang, 2019), mobile application (Rafique, Almagrabi, Shamim, Anwar & Bashir, 2020), e-Commerce (Qiu & Li, 2008), healthcare (Gücin & Berk, 2015), customer interacting software (Rese, Ganster & Baier, 2020) and artificial intelligent (Sohn & Kwon, 2020), etc. The technology acceptance behaviour involves the approval, adoption, and continuous use of newly introduced devices, systems, applications with positive attitudes to the corresponding technology.

Davis (1989) proposed TAM to predict this behaviour, building on the Theory of Planned Behaviour (TPB) by Ajzen (1985) and the Theory of Reasoned Action (TRA) by Ajzen and Fishbein (1980). The former refers to the extent of usefulness of technology subjectively perceived by users. The users believe that their performance would be improved or they would obtain their expected result by adopting technology (Liébana-Cabanillas, Sánchez-Fernández, & Muñoz-Leiva, 2014). Whereas, the latter refers to ease-of-use of technology subjectively perceived by users – which a user believes that certain technologies would require less effort to master. The extent of these internal beliefs would affect the users' attitudes toward technology usage. These are favourable or unfavourable feelings obtained from the users' direct experience with technology usage (Premkumar, Ramamurthy & Liu, 2008).

With the advent of the (IoT) technologies, the extent to which households embrace smart home technology in their daily life has long been the interest of researchers abroad (Klobas, McGill & Wang, 2019; Schill, Godefroit-Winkel, Diallo & Barbarossa, 2019; Shin, Park & Lee, 2018; Wilson et al., 2017) as well as Malaysian researchers (Maruf Gbadebo et al., 2018; Tee Wei et al., 2019; Wan Hidayati & Azizah, 2018). Several models extended from TAM, depicting determinant factors of technology adoption have dominated the research in this field (Baudier, Ammi & Deboeuf-Rouchon, 2020; Luor, Lu, Yu & Lu, 2015; Nikou, 2019). Hence, TAM has been applied in this research to predict behavioural intention to use new technology.

Research Model and Hypothesis Development

Researchers employed Technology Acceptance Model (Figure 1) in assessing how the prior experience would moderate the relationship between users' attitude and their intention to use smart home technology. This has brought the following discussions and hypotheses.

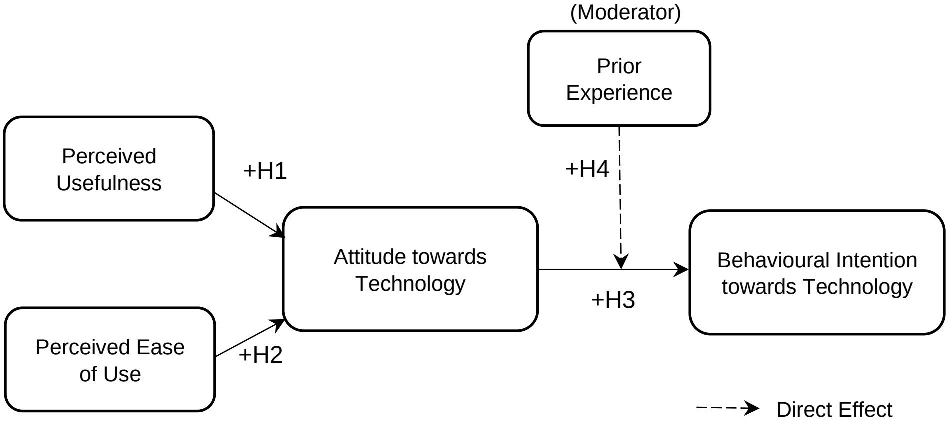

Figure 1. Proposed Research Model

Lee (2006) defined perceived usefulness as "the extent to which individuals perceive that using the new technology will enhance their task performance". When technology is beneficial and satisfies the users' needs, they assume a positive attitude towards using it

(Chao, 2019; Lu, Papagiannidis & Alamanos, 2019; Singh, Sinha & Liébana-Cabanillas, 2020).

Studies in various technological functionality have proven that perceived usefulness is an important factor to induce the adoption of a specific technology, i.e., digital voice assistants (Fernandes & Oliveira, 2021), mobile wallets (Singh et al., 2020), chatbots (Rese et al., 2020), mobile library application (Rafique et al., 2020), self-check-in kiosk (Taufik & Hanafiah, 2019), mobile health services (Zhao, Ni, & Zhou, 2018), etc. Since smart home technology can offer security, comfort, and convenience, its usefulness is justifiable. Individuals who find smart home technology useful would therefore adopt the technology. Not only that, but they must also perceive that the benefits of such technology outweigh the effort of using it.

Many scholars have found that users have preconceptions on how easy or difficult it will be to use new technology. They have agreed that the ease of use greatly influences users' attitudes toward new technological devices (Taufik & Hanafiah, 2019); mobile banking applications (Muñoz-Leiva, Climent-Climent, & Liébana-Cabanillas, 2017), information systems (Zhao et al., 2018), smartphone chatbot (Kasilingam, 2020), etc. and thus shall be seriously examined.

In this research, perceived ease of use represents the households' belief that the smart home technology system can be used with minimal learning effort, while perceived usefulness corresponds to the extent to which the households' belief that embracing with the smart home technology system is beneficial to them. As smart home technology closely associates with bringing benefits and convenience into everyday life, both perceptions seem to bring a positive effect on the users' attitude towards smart home technology systems (McLean & Osei-Frimpong, 2019). Following the preceding discussion, we propose the hypotheses below:

H1: Perceived usefulness positively influences attitude toward smart home technology.
H2: Perceived ease-of-use positively influences attitude toward smart home technology.

The Theory of Reasoned Action (TRA) posits that an individual's behaviour is influenced by their intention to perform the behaviour and that this intention is a function of their attitude towards the behaviour (Madden, Ellen, & Ajzen, 1992). This is attitude-behaviour association is concurred by Glasman and Albarracín (2006) that attitudes correlated more strongly with future behaviours when users show positive attitudes after directly experienced with the attitude object. This correlation is significant in various studies of technologies such as information technology (Bhattacherjee & Sanford, 2006), online banking (Muñoz-Leiva et al., 2017), mobile apps (Baek, 2013), IoT (Tsourela & Nerantzaki, 2020), chatbot (Kasilingam, 2020), etc.

According to Vahdat, Alizadeh, Quach and Hamelin (2020), user's intention to perform an activity in a mobile application is largely dominated by their attitude towards the applications. This, in turn, would affect their intention to purchase (Baek, 2013). Specifically, a positive attitude towards an application stimulates more frequent and longer usage of an application. This leads to overemotional attachment to the application and greater purchasing intent (Hsu & Lin, 2016; Kim, Wang & Malthouse, 2015). In the smart home technology context, positive attitude towards the technology might intensify the adoption intention to this technology. We, therefore, hypothesized below:

H3: Attitude towards technology positively influences intention to use smart home technology.

Researchers found that frequent users with a particular technology know how to use it better, are more confident and less anxious (Fernandes & Pedroso, 2017), more committed (Lee & Chang, 2013), forming stronger perceptions of its usefulness (Dwivedi, Rana, Jeyaraj, Clement & Williams, 2019); thereby would shape their attitudes (Lee & Chang, 2013) and behaviour intentions (Ajzen & Fishbein, 1980).

In the research of e-learning services, Lin (2011) discovered that attitude has a stronger influence on the continuance learning intention in more experience users than less experience users. According to Yang (2012), experienced customers enjoy more online shopping, having a more favourable attitude towards it than inexperienced ones.

Previous researchers corroborated that prior satisfaction experience influences positively the users' attitude, which in turn affects their continuance intention (Hsu & Lin, 2016; Thong, Hong & Tam, 2006). Nevertheless, Roy Dholakia and Zhao (2010) suggested that highly experienced users are more difficult to be satisfied than less experienced ones. This is affirmed by Ilias, Adamantia, Michail, and Chrissikopoulos (2014) that experience exerts moderating effects on the relationships between satisfaction and continuance intention. As such, we propose the hypotheses below:

H4: Past experience moderates the relationship in between attitude toward technology and intention to use smart home technology.

METHODOLOGY

A convenient sampling method was employed in the data collection. Self-administrated survey questionnaires were distributed online via email and social media. The population of interest in this research is households that reside in different states of Malaysia. The researchers used a large sample size to minimize sampling errors (Hair, Sarstedt, Matthews & Ringle, 2016), enabling generalizations from the sample to the overall population (Cavana, Delahaye, & Sekaran, 2001). G*Power (v3.1.9.2) software was employed to calculate the minimum sample size with a significant level of 0.05, 4 predictors and the power of 0.95 for this research is 119. 309 out of 350 returned questionnaires were properly completed with valid information, representing a response rate of 88.3 %. It is considered free from response error as it has far exceeded the minimum rate of 70% suggested by (Nulty, 2008). Section A consists of nine questions that profiled the respondent demographics. Section B to E described the predictors that affect intention to use smart technology. The last section is about the actual use of technology. The instrument was incorporated with five-point Likert scale.

The statistics software packages namely Smart Partial Least Squares 3.0 (SmartPLS) and Statistical Package for the Social Sciences (SPSS) were employed to assess the relationships in this conceptual model. The PLS technique is known as a sustainable method to estimate cause and effect relationships in complex models with a large number of constructs

(Gudergan, Ringle, Wende & Will, 2008). PLS-SEM can be attributed as a second-generation technique to evaluate both measurement and structural models concurrently (Hair, Hult, Ringle & Sarstedt, 2017). Additionally, it is a non-parametric technique with lesser retractions on distribution and sample size requirements (Hair et al., 2017). Next, it covered the respondents' demographic profiles and data.

FINDINGS

Respondents Profile

Table 1. Demographic Profile Respondents

Respondent (N=309)			
Demographic Variables	**Category**	**Frequency**	**Percentage (%)**
Gender	Male	159	51.5
	Female	150	48.5
Age	Less than 18 years	1	0.3
	18 - 24 years	26	8.4
	25-54 years	249	80.6
	55-64 years	23	7.4
	64 years and over	10	3.2
Ethnicity	Malay	63	20.4
	Chinese	211	68.3
	Indian	2	0.6
	Iban	13	4.2
	Kadazan Dusun	1	0.3
	Others	19	6.1
Total Household Income	Less than RM3,170	59	19.1
	RM3,170 – RM4,849	51	16.5
	RM4,850 – RM7,099	49	15.9
	RM7,100 – RM10,959	68	22.0
	RM10,960 – RM15,039	37	12.0
	RM15,040 and more	45	14.6
Education Level	Certificate	17	5.5
	Diploma	22	7.1
	Bachelor	170	55.0
	Master	72	23.3
	Doctoral	22	7.1
	Others	6	1.9
Marital Status	Single	116	37.5
	Married with Children	152	49.2
	Married without Children	41	13.3
Type of Residence	Terrace house	138	44.7
	Semi-detached house	77	24.9
	Detached house	37	12.0
	Apartment	25	8.1
	Condominium	20	6.5
	Others	12	3.9
State of Reside	Selangor	38	12.3
	Sabah	5	1.6
	Johor	8	2.6
	Perak	2	0.6
	Kelantan	3	1.0
	Pahang	2	0.6
	Sarawak	225	72.8
	W.P. Kuala Lumpur	14	4.5
	Pulau Pinang	11	3.6
	Terengganu	1	0.3

Table 1 shows a complete demographic profile of 309 respondents. There are 159 males (51.5%) and 150 females (48.5%). 116 respondents were single whereas 152 were married with children. 5.5 percent (n=17) respondents possess certificate qualification. The Bachelor degree holders recorded the highest number of respondents (55.0%) followed by Master Degree holders (23.3%). Their academic qualification has shown that they were generally knowledgeable. In terms of age, majority respondents were 25 to 54 years old (n=249, 80.6%), 8.4 percent (n=26) of them were 18 to 24 years old and 7.4 percent (n=23) were 55 to 64 years old. For ethnic compositions, Chinese accounted for the largest group, contributing 211 samples (68.3%), and Malays were 20.4 percent (n=63). Approximately 6.1 percent respondents were grouped as others (n=19) who made up of African, Melanau, Bidayuh, Jordanian, and Singhalese-Chinese. As for household income, majority of respondents possess RM7,100 to RM10,959 monthly household income, while 19.1 percent (n=59) were having less than RM3,170, and followed by 16.5 percent (n=51) who earned RM3,170 to RM4,849. Next, in total, the majority of respondents were from Sarawak (72.8%, n=225), 12.3 percent (n=38) of respondents resided in Selangor, and 4.5 percent (n=14) were staying in Kuala Lumpur. Lastly, 138 respondents possessed terraced houses. The second-largest respondents owned semi-detached houses (n=77, 24.9%) followed by detached houses (n=37, 12.0%).

Manipulation Checks

To execute Common Method Variance (CMV), Harman's (1976) single factor test was used to examine common method bias. CMV is a systematic error variance found among the variables measured (Richardson, Simmering & Sturman, 2009). The factor analysis shown that the largest variances explained for the first factor was 44.77 percent of the total variance. Besides, there is no correlation between the constructs exceeding the cut-off value, 0.90 (Bagozzi, Yi & Phillips, 1991). Thus, the common method bias was negligible.

Assessment of Measurement Model

In the first stage, the validity of construct was determined via Confirmatory Factor Analysis (CFA). The analysis would include convergent validity and discriminant validity. The convergent validity was assessed by Composite Reliability (CR) and Average Variance Extracted (AVE). To attain discriminant validity, the square root of AVE must exceed the correlation level. The results affirmed that this measurement model was satisfactory. Table 2 illustrates the findings of loading and cross-loading among the variables through SmartPLS statistical analysis techniques. The cross-loading for all items measured was loaded highly on its own construct instead of any other constructs. This indicated that the model constructs were adequately convergence. As presented in Table 3, all constructs results of CR fulfilled the suggested value of 0.3 by J. F. Hair, Black, Babin, Anderson, and Tatham (2006) as well as 0.7 as suggested by Gefen et al. (2000). Hence, the model constructs were adequately convergence. With regards to AVE, all indicators fulfilled the minimum level of AVE, 0.5 in the current research (Henseler, Ringle & Sinkovics, 2009).

Table 2. Results of Loading and Cross Loading

	Perception of Usefulness	Perception of Ease-of-Use	Attitude Toward Technology	Experience	Attitude Experience	Intention to Use
PU1	**0.915**	0.633	0.648	-0.246	0.220	0.578
PU2	**0.926**	0.629	0.632	-0.232	0.265	0.569
PU3	**0.905**	0.584	0.636	-0.167	0.217	0.546
PU4	**0.901**	0.574	0.605	-0.182	0.202	0.515
PU5	**0.863**	0.609	0.605	-0.286	0.180	0.534
PU6	**0.910**	0.653	0.643	-0.272	0.278	0.584
PU7	**0.904**	0.648	0.624	-0.255	0.225	0.595
PEOU1	0.480	**0.766**	0.504	-0.263	-0.011	0.481
PEOU2	0.666	**0.894**	0.604	-0.236	0.121	0.598
PEOU3	0.614	**0.909**	0.626	-0.250	0.168	0.602
PEOU4	0.585	**0.885**	0.589	-0.327	0.123	0.573
PEOU5	0.547	**0.886**	0.597	-0.282	0.045	0.575
PEOU6	0.636	**0.909**	0.665	-0.264	0.130	0.623
PEOU7	0.414	**0.728**	0.467	-0.215	0.096	0.455
PEOU8	0.704	**0.869**	0.683	-0.287	0.115	0.658
ATT1	0.650	0.642	**0.913**	-0.206	0.127	0.734
ATT2	0.665	0.663	**0.945**	-0.252	0.182	0.759
ATT3	0.661	0.633	**0.929**	-0.243	0.183	0.759
ATT4	0.687	0.670	**0.941**	-0.272	0.221	0.776
ATT5	0.626	0.635	**0.934**	-0.332	0.205	0.778
ATT6	0.578	0.633	**0.908**	-0.337	0.138	0.781
EXP_01	-0.194	-0.223	-0.199	**0.745**	0.017	-0.229
EXP_02	-0.234	-0.285	-0.280	**0.905**	-0.034	-0.358
INT1	0.591	0.643	0.773	-0.333	0.094	**0.922**
INT2	0.588	0.606	0.744	-0.367	0.121	**0.935**
INT3	0.589	0.616	0.769	-0.358	0.141	**0.953**
INT4	0.603	0.641	0.751	-0.295	0.103	**0.924**
INT5	0.558	0.633	0.765	-0.375	0.100	**0.937**
INT6	0.562	0.627	0.787	-0.330	0.114	**0.935**
INT7	0.575	0.628	0.806	-0.334	0.099	**0.946**

Note: Bold values are loadings for items that are above the recommended value 0.500.

Table 3. Results of Measurement Model

Construct	Items	Loadings	CR[a]	AVE[b]
Perceived Usefulness	PU_01	0.915	0.969	0.816
	PU_02	0.926		
	PU_03	0.905		
	PU_04	0.901		
	PU_05	0.863		
	PU_06	0.910		
	PU_07	0.904		
Perceived Ease-of-use	PEOU_01	0.766	0.957	0.736
	PEOU_02	0.894		
	PEOU_03	0.909		
	PEOU_04	0.885		
	PEOU_05	0.886		
	PEOU_06	0.909		
	PEOU_07	0.728		
	PEOU_08	0.869		
Attitude toward Technology	ATT_01	0.913	0.974	0.862
	ATT_02	0.945		
	ATT_03	0.929		
	ATT_04	0.941		
	ATT_05	0.934		
	ATT_06	0.908		

Table 3. Results of Measurement Model (Continued)

Construct	Items	Loadings	CR[a]	AVE[b]
Past Experience	EXP_01 EXP_02	0.745 0.905	0.813	0.687
Intention to Use Smart Technology	INT_1 INT_2 INT_3 INT_4 INT_5 INT_6 INT_7	0.922 0.935 0.953 0.924 0.937 0.935 0.946	0.980	0.876

Note:
[a] Composite Reliability **(CR)** = (square of the summation of the factor loadings)/{(square of the summation of the factor loadings) + (square of the summation of the error variances)}
[b] Average Variance Extracted **(AVE)** = (summation of the square of the factor loadings)/{(summation of the square of the factor loadings) + (summation of the error variances)}
* Motiv_5 and Org_Com4 were deleted due to low loading.

Discriminant validity is employed to assess the extent to which items vary among the constructs and the correlations between the measures of potentially overlapping constructs. Table 4 shows that the correlations for each of the constructs were less than the average variance extracted (in bold) by the indicators. Therefore, these underlined constructs attained adequate discriminant validity. Another new suggested method to test discriminant validity is HTMT Ratio, where the HTMT value should not exceed HTMT 0.85 value of 0.85 (Kline, 2011) or HTMT 0.90 value of 0.90 (Gold, Malhotra & Segars, 2001). Table 5 recorded that all values passed the HTMT criterion, ascertaining that the discriminant validity exists. Additionally, Table 6 recorded the result of the measurement model. It affirmed that all the constructs of this research are valid measures based on the parameter estimates and the statistical significance (Chow & Chan, 2008).

Table 4. Discriminant Validity of Constructs (Fornell-Larcker Criterion)

	Attitude Toward Technology	Experience	Intention to Use	Perception of Ease-of-Use	Perception of Usefulness
Attitude toward technology	0.928				
Experience	-0.295	0.829			
Intention to use	0.823	-0.365	0.936		
Perception of ease-of-use	0.696	-0.310	0.670	0.858	
Perception of usefulness	0.695	-0.259	0.620	0.685	0.904

Note: Diagonals represent the square root of the average variance extracted (AVE) while the other entries represent the correlations.

Table 5. HTMT Criterion for Discriminant Validity of Constructs

	Attitude Toward Technology	Attitude* Experience	Experience	Intention to Use	Perception of Ease-of-Use	Perception of Usefulness
Attitude toward technology						
Experience	**0.390**	**0.041**				
Intention to use	0.847	0.119	0.475			
Perception of ease-of-use	**0.722**	**0.121**	**0.418**	**0.693**		
Perception of usefulness	0.719	0.256	0.349	0.640	0.710	

Note: HTMT < 0.85 (Kline, 2011), HTMT < 0.90 (Gold et al., 2001)

Assessment of Structural Model

To examine path analysis and hypotheses, researchers used bootstrapping technique to generate t-value for each hypothesis and the potential impact of covariates. To test the path coefficient (β) and hypotheses, the researchers used the bootstrapping approach with 500 samples, with 0 cases per sample. PLS also created R2 value (Halawi & McCarthy, 2008). The R2 value for intention to use smart technology was 0.696. In other words, the interactions were able to explain 69.6 percent of the variance of intention to use smart technology.

Figure 1 and Table 6 present the findings of hypotheses testing. The results of the hypotheses affirmed that both perceived usefulness (β=0.411, p<0.01) and perceived ease-of-use (β=0.414, p<0.01) positively influence the attitude towards technology. Similarly, the relationship in between attitude towards technology (β=0.791, p<0.01) and intention to use smart technology is significant. For moderating effect, past experience positively leads to intention to use smart technology. To summarize, H1, H2, H3, and H4 are supported. The VIF values were in the range of 0.004 to 1.809, and is less than 10, which means that multicollinearity does not exist among the constructs (Bock, Zmud, Kim & Lee, 2005).

In this research, Goodness of fit (GoF) was 0.744 (R2= 0.696, Average AVE = 0.795) for intention to use smart technology. This figure exceeded the largest cut-off value of 0.36, indicating that the proposed model possesses an accurate prediction capability. Besides, the predictive relevance, Q2 value is obtained via blindfolding procedure. The Q2 is used to evaluate the predictive validity of the endogenous constructs in a complex model (Chin, 2010). The Q2 values of attitude towards technology and intention to use are 0.489 and 0.604 respectively, and are positive, affirming that the model is highly predictive.

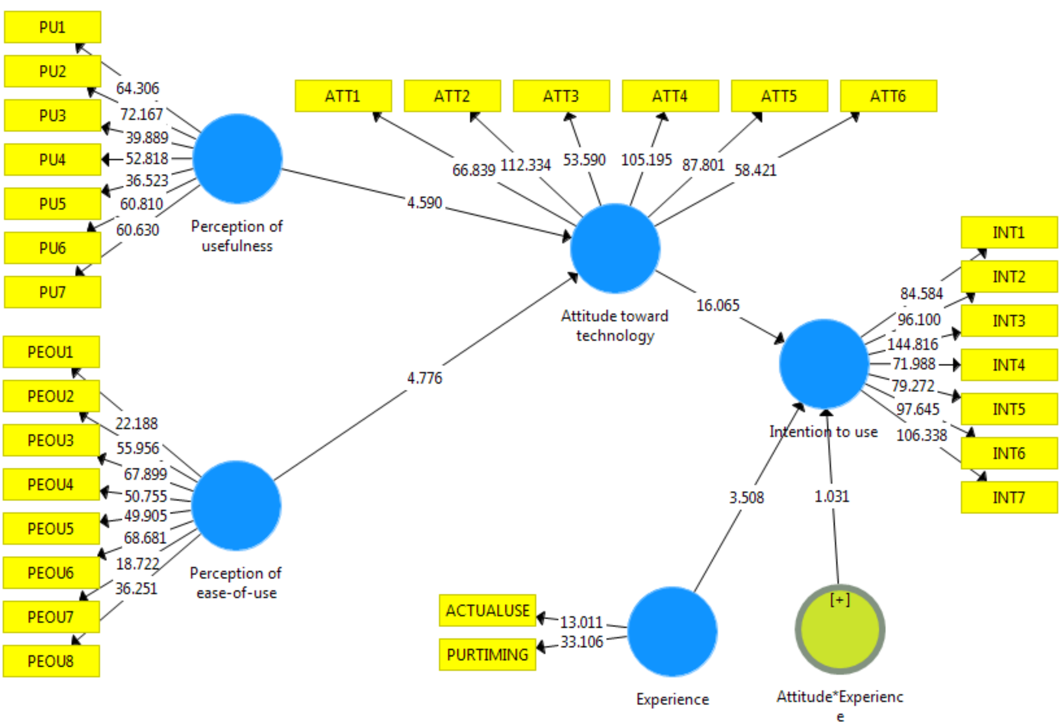

Figure 2. Research Model with Beta Value

Table 6. Path Coefficients and Hypothesis Testing

Hypothesis	Relationship	Standard Beta	P-value	t-value	Decision	VIF	f^2
H1	Perceived usefulness → attitude toward technology	0.411	0.000	4.590	Supported	1.884	0.210
H2	Perceived ease-of-use → attitude toward technology	0.414	0.000	4.776	Supported	1.884	0.214
H3	Attitude toward technology → Intention to use smart technology	0.791	0.000	16.065	Supported	1.138	1.807
H4	Positive experience moderate attitude toward technology → Intention to use smart technology	0.132	0.000	3.508	Supported	1.039	0.004

Note: t-value >2.58 (P<0.01**), t-value >1.96 (p<0.05*)

DISCUSSION

Perceived Usefulness → Attitude Toward Technology

The findings indicate that both perceived usefulness and perceived ease of use positively affect the attitude towards technology. This has supported many previous research in smart home technology (Liu & Chou, 2020; Park, Kim, Kim & Kwon, 2018; Shin et al., 2018). Households who perceived strong usefulness and ease of use in smart home technology would create an attitude positively receptive to this technology.

Neumann (2018) affirmed that perceived usefulness is the best predictor of the intention to use smart home devices. This is corroborated by Luor et al. (2015) who found that perceived usefulness positively affects the households' attitudes toward smart home functions such as home entertainment, home security, and home automation. According to Mital, Chang, Choudhary, Papa and Pani (2018), individuals are willing to use new smart devices if the devices can simplify their day-to-day tasks.

In other words, perceived usefulness would ultimately lead to the households' intention to adopt smart house appliances or applications (Hubert et al., 2019; Schill et al., 2019). Besides, Tee Wei et al. (2019) examined perceived usefulness in terms of information accuracy and information completeness. They found that it positively impacts the users' intention to adopt the smart home technology. A similar outcome has been found when these researchers examined perceived ease of use in terms of the clear user interface, consistency, and attractiveness. Essentially, the households consider usefulness more than any other factors. They will simply disregard smart home technology if they think that it is not useful at all.

Attitude Toward Technology → Intention to Use Smart Technology

The results also showed that overall attitude formed through users' perception of usefulness and ease of use plays a substantial role in affecting their behavioural intention to adopt smart home technology. Many prior studies on smart home technology have examined the concept of users' attitude – favourable or unfavourable feelings about a particular behaviour, as an important determinant influencing their intention to use (Liu & Chou, 2020; Nikou, 2018; Park et al., 2018; Shin et al., 2018). Though inconsistency in attitude and behaviour has been found in previous research (Jo & Shin, 2017), our findings is affirmative with most of the previous findings under different theoretical frameworks; that attitude is a key antecedent of the intention to engage in a particular behaviour (Yang & Yoo, 2004; Yang et al., 2017). Thus, the more positive users' attitudes to the adoption of smart home technology, the greater their intention to use them and vice versa (Klobas et al., 2019).

Positive Experience Moderate Attitude Toward Technology → Intention to Use Smart Technology

In addition, empirical evidence showed that prior experience exerts moderating effect on the intention to use smart home technology. This phenomenon is seen in users' attitudes, who are heavily affected by their awareness of technology (Mashal & Shuhaiber, 2018). Vaneechoutte (2000) found that users' awareness is formed from their prior experience and moderates the relationship between attitude and intention. Baudier et al. (2020) suggested that digital natives are more receptive to smart home products as they have been engaging and experiencing new technologies. Nikou (2019) agreed that how easy it is for the users to test a smart home device would affect their perception of ease of use – a crucial factor to technology adoption. And this is especially significant for the experience users, but not for the non-experienced ones.

In the investigation of smart home development in the UK, the researchers found that experts and consumers perceived and emphasized differently on smart home technology. Though both user groups having common concerns on smart devices, the expert focuses mostly on the technical performance of the smart devices. Whereas, the consumers are concerned with the installation, maintenance, and cost aspects of the devices (Balta-Ozkan, Davidson, Bicket & Whitmarsh, 2013a, 2013b).

Implication of Findings

Smart home technology is a user-centered service market. Nevertheless, current research lacks an understanding of users' attitudes towards smart home technological services generated by their prior experience. This research has established a valid theoretical model by integrating the Technology Acceptance Model (TAM) with the prior experience as a moderator. Empirical results suggested that the prior experience exerts positive moderating effects on attitude toward behavioural intention, and hence this expands the generalizability of Davis' TAM to the smart home technology. Besides, to increase users' acceptance of smart home technology, service providers can offer trial periods to prospective users. By emphasizing more on how these smart home technology products can create a direct utility or benefits to the households as well as the friendliness of the technology, their trial experience would likely create a positive attitude on adopting the technology. The smart home products could also be specifically targeted to digital natives – a population with technological experience who is more prepared to engage smart home technology.

CONCLUSION

The evolving interest in the smart home concept is due to its promises to revolutionize the manner of households handling their everyday life. The adoption of smart home technology is the key to create a smart living concept; where it depends on the households' perception and attitudes, of which ultimately affect their behaviour intentions.

Thus, this research aimed to investigate the Malaysian households' intention to use smart home technology, offering some of the empirical evidence on the application of TAM in predicting households' behaviour. The associations of perceived usefulness, perceived ease of use with attitude, and intention to use smart home technology were examined. Besides, it sought to answer to one of the important questions in the field of smart home technologies; is how the users' prior experience moderates the relationship between attitude and their intention to better predict their intention to adopt smart home technology.

309 responses were analysed using Smart Partial Least Squares structural equation modelling. The path coefficients between the constructs spanned from 0.13 to 0.79 supported the research model. Both the perceived usefulness and ease of use positively associate with attitude whereby positive attitudes lead to intention to adopt the technology. Most importantly, prior experience is found to exert moderating effect on the relationship between attitude and behavioural intention.

Limitation and Future Research

This research has its limitations as the smart home market in Malaysia is still at an early stage. It is difficult to obtain adequate and comprehensive microdata of the users. The data was collected primarily using a convenience sampling technique. All respondents have been part of the direct or indirect social network of researchers, which suggests a minimal influence on the results. Most importantly, the sample of this research is exclusively Malaysian; and hence, the results are not generalizable to global users. Despite these limitations, this research is meaningful as the first attempt to analyse the users' experience in moderating the relationship between attitude and behavioural intention in the context of smart home technology. In addition, we suggest that the prior experience factor can be further investigated to prove its relevancy; particularly to consider its effect on age and educational background on smart home technology adoption.

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PROSPECTS AND CHALLENGES OF DIGITAL TRANSFORMATION IN THE MALAYSIAN CONSTRUCTION INDUSTRY

Han Seng Kong[1] and Chiew Wei Jie[2]
[1]Centre for BIM Research, Faculty of Built Environment (Principal Lecturer), Tunku Abdul Rahman University College, Kuala Lumpur, Malaysia
[2]Department of Quantity Surveying, Faculty of Built Environment (Final Year Student), Tunku Abdul Rahman University College, Kuala Lumpur, Malaysia

Abstract
Digital transformation had become an increasing pertinent topic in recent years. Governments and industries from various sectors are caught in the wave of digital transformation. However, the construction industry had been reported to be one of the least digitalised among other industries. The Malaysian Government had taken cognisance of its importance and introduced the Construction Industry Transformation Programme (2016-2020) and the Construction 4.0 Strategic Plan (2021-2025) to accelerate the growth of digital transformation in the construction industry. The objectives of this research are to study and understand the current situation of digital transformation in the Malaysian Construction Industry along with the impacts and obstructions faced during the transformation. To complete the digital transformation, digital technology is one of the most crucial elements. There are several types of digital technologies such as building information modelling, augmented and virtual reality, 3D printing, blockchain technology, unmanned aerial vehicles (drones), global positioning systems and Internet of Things. These technologies bring advantages such as higher productivity, cost-saving, increase collaboration and minimise the dependency on foreign workers. In contrast, to proceed with digital transformation in the construction industry, lack of skilled or competent staff using digital technology and the perceived low return on investment from digital transformation are the main concerns of the the construction industry players. A qualitative approach is adopted by interviewing experienced industry professionals selected via judgemental sampling techniques. Thus, a total of 8 virtual semi-structured interviews were conducted. The findings show the undeniable benefits of improved productivity and efficiency, less dependency on foreign labour, better site safety and management and greater accuracy from digital transformation. However the process toward the goal is hindered by a lack of understanding on the trends and benefits of digital transformation, the cost of digital technologies, financial capability of companies, consideration of ROI and the lack of skilled manpower to operate these technologies. To overcome the obstacles, action from the Government in terms of relevant policies, education and training to prepare the needed manpower and initiatives from developers are important. Digital transformation is a critical milestone and the way forward into the future of the post Covid-19 construction industry.

Keywords: *Digital Transformation; Digital Technologies; Construction 4.0 Strategic Plan*

INTRODUCTION

Digital transformation consists of two concepts, which are digitisation and digitalisation. Digitisation is the process of transformation from analogue to digital form while digitalisation is adopting or using digital technologies to change a business model and provide new revenue and value (MDEC, 2018). Therefore, the definition of digital transformation is an action of adopting digital technology to transform the services or businesses from analogue to digital form.

However, the construction industry is the least digitalised among other industries as reported by McKinsey Global Institute Industry Digitisation Index in 2015 (Agarwal, Chandrasekaran, & Sridhar, 2016).

Source: (Agarwal, Chandrasekaran, & Sridhar, 2016)

Figure 1. McKinsey Global Institute Industry Digitisation Index in 2015

As reported by myBIM CIDB, the adoption level of Building Information Modelling (BIM) in Malaysia is 49 per centum in 2019 which is lower compared to her neighbour – Singapore which already has 71 per centum in 2015. In a study on the readiness level of BIM adoption in Malaysia, it was reported that more than one third of the 570 organisations sampled lack financial incentive allocation for using BIM, failed to invest in BIM training and failed to invest in BIM hardware and software (Roslan, et al., 2019). Globally, the adoption level in western countries is higher such as United States which has 71 per centum in the BIM adoption level (Amiruddin, 2019). For some European countries such as Austria, Denmark, Finland, and Sweden, the adoption of BIM is mandatory (Paul, 2018).

Digitalisation is essential as it optimised performance in the construction industry. The adoption of digital technologies will help to enhance the construction processes from the pre-contract to the post-contract which involved planning, design, construction, site management, building maintenance and operation. Due to the improvement in the construction process by digitisation, the benefits are improved collaboration for higher efficiency, higher productivity at lower cost, better occupational safety and health of site workers and enhanced clarity (Wheelis, 2020).

While digital transformation remained important, the status of digital transformation in the Malaysian Construction Industry remained questionnable. Thus, this research aims to understand:

1. The current situation of digital transformation
2. The impact of digital technology and digital transformation and
3. The challenges or obstructions of digital transformation faced by the Malaysian Construction Industry.

LITERATURE REVIEW

Overview of Current Situation of Digital Transformation in The Malaysian Construction Industry

The year 2021 marks the end of CITP 2016 – 2020 and the start of Construction 4.0 Strategic Plan 2021 – 2025 (CR 4.0) announced by the Malaysian Ministry of Works in collaboration with CIDB on 19 January 2021.

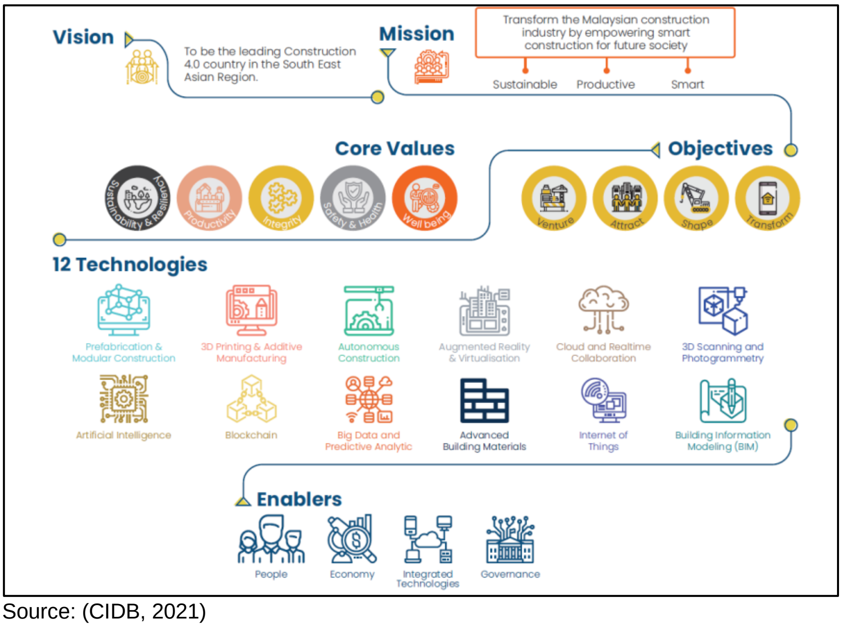
The report card presented at the CITP Ministerial Committee meeting showed positive results from the four strategic thrusts in the CITP 2016 – 2020 (Construction, 2021). CIDB claimed that all the thrusts passed with flying colours achieving higher than 90 per centum on average. The four strategic thrusts were:-

i. The quality, safety and professionalism
ii. The environmental sustainability
iii. Productivity
iv. Internationalisation and competitiveness

To have a better visualisation of the improvement through implementing CITP 2016 – 2020, the productivity level of general construction labour rose from RM 27,000.00 in the year 2014 to RM 45,000.00 in the year 2020 (Construction, 2021). Besides, the usage of IBS increase from 14 per centum and 24 per centum in the year 2014 to 41 per centum and 87 per centum in the year 2020 in the private and public sectors respectively (Construction, 2021).

Construction 4.0 Strategic Plan (CR 4.0) is a five years implementation programme from the year 2021 to 2025. This strategic plan is to align with the Shared Prosperity Vision (SPV) 2030 and the National 4.0 Industry Policy. There are four thrusts in this plan consisting of:-

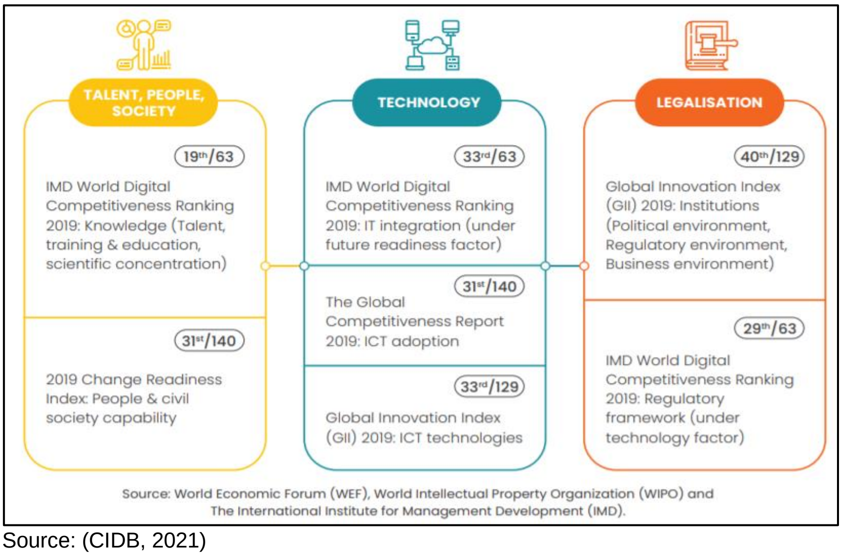
i. Capacity development
ii. Excellence in research, innovation, commercialisation and entrepreneurship
iii. Smart integrated technologies, innovation and infrastructure
iv. Enhanced business environment



Source: (CIDB, 2021)

Figure 2. Mindmap of CR 4.0 2021 – 2025

Needless to say, digital transformation had become one of the essential elements in this strategic plan. Therefore, there is an aim in the CR 4.0 Strategic Plan to bring the latest digital technologies as mentioned in Figure 2 to improve the productivity and quality of the works (Construction, 2020). CR 4.0 Strategic Plan also aims to improve the ranking of Malaysia in the aspect of talent, people and society, technology and legalisation according to World Economic Forum (WEF), World Intellectual Property Organisation (WIPO) and The International Institute for Management Development (PMD) and to show the readiness, capabilities and current level in these aspects (CIDB, 2021).



Source: (CIDB, 2021)

Figure 3. Malaysia World Ranking in The Aspects of Talent, People, Society, Technology and Legalisation

Types of Digital Technology in The Construction Industry

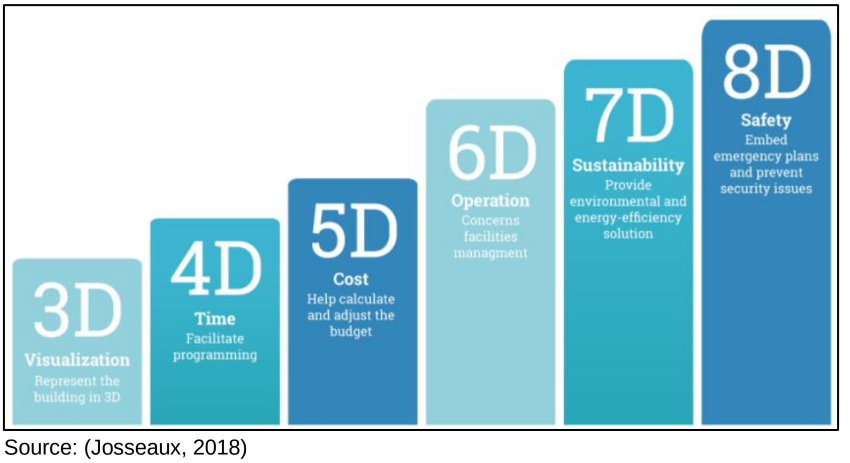
Internet of Things

There are several devices or sensors with internet connections used in the construction industry. These devices can be either placed or worn by the site workers around the construction area. IoT devices for construction can collect the data regarding activities, performance and conditions on the construction site and transmit the information and data to a data centre for analysis to help in supporting sufficient and important information for all the decisions made by the management (O'Malley, 2020). IoT is developing rapidly in recent years due to the widespread and commonality of the internet everywhere including construction site.

Now, a wide range variety of sensors can be easily upgraded to internet-connected devices by placing a chipset to connect with the internet. Wristbands, temperature sensors and vibration monitors can be connected to a database centre. This means that more information from each place of concern in the construction site can now be monitored 'live'. This would bring a huge improvement for security, productivity, safety, and cost reduction (Tucker, 2019).

Building Information Modelling (BIM)

BIM is a highly collaborative system that allows developers, consultants, contractors and other related players to initiate a project starting from the stage of planning, design, and construction of a building or structure within a 3-Dimension model throughout the construction process.



Source: (Josseaux, 2018)

Figure 4. Dimensions of BIM From 3D – 8D

The range of BIM Dimensions is from 3D to 8D BIM (Singh, 2019). The purpose of these levels is to measure the effectiveness and information that can be shared and managed throughout the entire construction process.

BIM has been introduced in Malaysia since 2007 by the Malaysian Public Work Department (PWD). In the year 2018, BIM became a mandatory software to be used in public works when the budget of the project is more than RM 100 million. These projects implemented BIM at different phases such as concept design, preliminary design, detailed design, procurement, construction and as-built stage (Othman, Yahya Al-Ashmori, YaniRahmawati, Amran, & Al-Bared, 2021). To date, none of the projects had implemented BIM from the beginning of concept design all the way to the as-built stage. This indicates the level of implementation of BIM in Malaysia is not as advanced as in foreign countries.

Unmanned Aerial Vehicle

Unmanned Aerial Vehicles (UAVs) are also known as Drones. UAVs are being used for different functions in the construction industry. As a tool that improves visualisation especially at positions or views that are difficult or inaccessible to humans, UAVs can meet the needs in a construction project by capturing real-time images from the site (The Asean Post, 2019).

A site inspection can always be done without concern for the time, angle, condition and location in the site or building while the construction is being undertaken due to the physical limitation to humans compared to UAV. Several systems allow for multiple automated assignments that provide important data for construction, such as stockpiles volumetric analysis, topographical surveys, cut and fill parameters and as a built-design comparison (The Asean Post, 2019).

In Malaysia, the Tun Razak Exchange (TRX) and Mass Rapid Transit (MRT) extension extensively used UAVs for project site condition management and topographic analysis (The Asean Post, 2019).

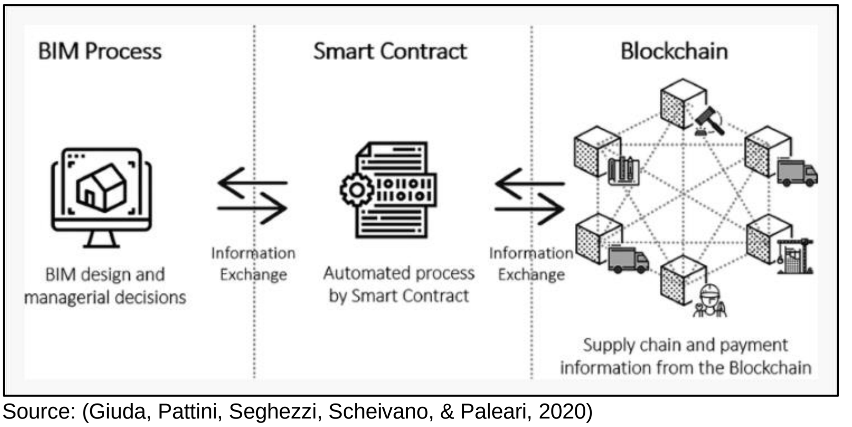
Source: (Money Compass, 2018)

Figure 5. Drone Photo of TRX Construction in June 2018

Blockchain Technology

Blockchain is a distributed ledger of information without a central authority in managing such information within the network. The ledger information is similar to transactions and contracts, which are collected and kept in chronologically order within a network of computers within the chain (Penzes, 2018). The network in the blockchain technology is essential where it indicates the party or personnel who has access right to the collected information. Although it is decentralised, the information will not be a leak from the technology itself and it is governed by all the participants in the network. Therefore, any published information in the blockchain is not reversible or deleted.

One of the innovative digital technology from the extension of blockchain technology used in the construction industry is named Smart Contract (Penzes, 2018). Generally, it is a form of digital contract, which is able to exercise the terms and conditions as stipulated in the contract itself automatically when the conditions are fulfiled. Smart contracts developed from the concept of blockchain technology can improvise, automate the cumbersome and bulky processes that have to be executed by humans. Thus, integrity and fairness be achieved.



Source: (Giuda, Pattini, Seghezzi, Scheivano, & Paleari, 2020)

Figure 6. Interactions Between BIM and Smart Contract Used in The Construction Industry

The smart contract can always provide function extension to project payments and progress management. On top of the characteristics of smart contracts, the relevant data including transaction information will be logged on the blockchain which made the process transparent and traceable for both collaborative parties. However, mitigation in the smart contract is provided if there is any mistake that occurs within the contract. The reverse action can be only executed if all involved parties agreed to the action where it should align and be without dispute with the clauses stated in the smart contract (Penzes, 2018).

Benefits of Adopting Digital Technology

There are a bunch of benefits in using digital technologies. However, this study will emphasise the benefits as below:-

i. Increase productivity collaboration among all parties in the construction project
ii. Improvement of safety and health on site
iii. Enhanced clarity and integrity throughout the entire construction process

Increase Productivity On-Site

I. Internet of Things:

- It minimises the workload for site personnel by eliminating human error occurrences and also providing more room for the management to have opportunities to improve product delivery to the customer as well as customer satisfaction (Mazhandu, 2020).

- Besides, the sensors with IoT are able to identify the quantity for the supply of materials and prompt the site manager if the number of materials has reached the threshold (Mazhandu, 2020). Through this approach, it can lessen the mistakes and always ensure the progress on-site will not be affected by the shortage of materials that further delay the works.

II. Building Information Modelling:

- BIM technology narrows the range of information between the parties in the construction project as they are all working on the same model. It bring them to the same page of understanding in the design and requirement. Therefore lesser discrepancy will be raised during the construction process.

- Furthermore, the 4th dimension in the BIM is on time management on site. It facilitates the construction site planning activities and reduces the stacking and complexity of construction projects, support for visualising site status information and site management (Singh, 2019).

Improvement of Safety and Health on Site

I. Internet of Things:

- Wearable IoT devices such as wrist bands can improve safety on building sites. It allows the safety officer to closely monitor the location and condition of workers and can alert the workers of potential surrounding safety risks before the incident happened.

II. Building Information Modelling:

- BIM in the dimension of 8D provided the feature of preventing accidents through design. It enables the professionals to indicate and detect the risks in the early design stage (Singh, 2019). Hence relevant prevention methods can be prepared in advance.

III. Unmanned Aerial Vehicle:

- UAVs can be used to substitute humans in inspecting sites especially at position or location with a potential hazard such as heights without safety barriers.

- Besides, the UAVs can be used as a detector that inspects the overall construction site to detect any potential or existing risk and generate an alert notification to all site personnel as a preventive step before the accident occurs.

Enhanced Clarity and Integrity throughout the entire Construction Process

I. Blockchain Technology

- Blockchain technology ensures the security of the documentation and efficiency of payment made by the employer. The smart contract will execute the payment once the criteria had met with the clauses stipulated in the contract (Amaludin & Taharin, 2018). The history of transactions will be immediately recorded on the blockchain or digital ledger across the network nodes.

- Furthermore, in collaboration with BIM and the smart contract, the real-time work progress on site can be easily updated to the BIM cloud and allowed for inspection by employer and consultant instantly (Amaludin & Taharin, 2018). The data of work progress will link with the criteria in the smart contract provided the progress claim is always supported by the uploaded work progress.

Blockchain technology ensures the security of the documentation and efficiency of payment made by the employer. The smart contract will execute the payment once the criteria had met with the clauses stipulated in the contract (Amaludin & Taharin, 2018). The history of transactions will be immediately recorded on the blockchain or digital ledger across the network nodes.

Challenges Faced by The Construction Industry in Digital Transformation

There are two main challenges in the way of digital transformation as stated below:-

i) Lack of skilled or competent staff using digital technology
ii) Low Return on Investment (ROI) from digital transformation

Lack of Skilled or Competent Staff in using Digital Technology

Digital technology is one of the essential instruments for digital transformation. Unlike simple basic software such as Microsoft Word, digital technolgy requires specific courses, training and certification to provide the necessary manpower to fully harness the technology. According to the Labour Force Survey conducted by the Department of Statistics Malaysia (DOSM), the ratio of employment from low-skilled, semi-skilled and high skilled are 12.4%, 60.1% and 27.5% respectively in 2019 (Talent Corp, 2020). Specialists in information technology are highly sought after in the construction industry. Skilled and competent staff are one of the key challenges that must be resolved for the industry to adopt digital technology.

Low Return on Investment (ROI) from Digital Transformation

Returns and profits are one of the main focuses of all the business sectors. Digitalising the entire process and adopting digital technologies may cost a significant outflow of cash into the respective areas. Besides, there are fewer samples or precedents that can be referred to in the Malaysian Construction Industry. This can discourage the industry players from embarking on digital transformation to avoid losses or unexpected risks. The cost of digital transformation includes purchasing digital technologies, hiring specialists, software subscriptions and other related upgrades in existing machines to achieve collaboration between the new technologies which may be costly especially in the initial stages.

RESEARCH METHODOLOGY

For this research, qualitative approach is adopted as the research technique to collect data to achieve the aim and objectives. To control the quality of the data collected for this study, experienced professionals and construction industry players who are capable to contribute or input solid ideas toward this research were selected via judgemental sampling techniques. The criteria of being chosen as the participants of the interview session are those experienced practitioners who are familiar and understand the current situation of digital technology in the Malaysian Construction Industry. Online interview sessions are carried out due to the Covid-19 movement restrictions with the targeted sampling from the selected population.

The research population is targeted from the respective professional boards such as BQSM for quantity surveyors, LAM for architects and BEM for engineers. REHDA and CIDB are also targetted as they are the important players or regulators in the construction industry namely developers and contractors. Furthermore, the players in the construction industry registered in myBIM are considered as the potential interviewees in this research because they have knowledge or had participated in the myBIM programme.

From a total of 33 interviewees identified and approached, there are in total of 8 interviewees who participated in the interview sessions which consists of Developers, Consultants (Architects, Engineers and Quantity Surveyors) and Contractors. All the interviewees are experienced in the construction industry and digital transformation in their current or former companies.

In this research, content and narrative analysis are used to analyse the data collected from the interviewees. The data analysis is carried out by comparing the answers toward a question asked in the interview session to determine whether the objectives of the research has been obtained.

Question Design

The questions design for the interview session consists of 4 sections with questions outline and conceptual definition respectively, namely:

- Section A – Respondent background and demographic.
- Section B – Current situation of digital transformation in the Malaysian Construction Industry.
- Section C – The impact of digital transformation toward the party/parties in the construction industry and the construction industry itself.
- Section D – Obstacles in the process of digital transformation in the Malaysian Construction Industry.

Section B to D uses open-ended questions with a focus discussion area.

RESULTS AND DISCUSSION

Interviewee Background

Table 1. Analysis of Interviewees' Background

Interviewee	Background	
Interviewee A	Type of Company Experience in Construction Industry Experience in Digital Transformation	: Developer : 12 Years : 7 Years
Interviewee B	Type of Company Experience in Construction Industry Experience in Digital Transformation	: Developer : 18 Years : 7 Years
Interviewee C	Type of Company Experience in Construction Industry Experience in Digital Transformation	: Architect : 9 Years : 9 Years
Interviewee D	Type of Company Experience in Construction Industry Experience in Digital Transformation	: Architect : 27 Years : 27 Years
Interviewee E	Type of Company Experience in Construction Industry Experience in Digital Transformation	: Contractor : 10 Years : 8 Years
Interviewee F	Type of Company Experience in Construction Industry Experience in Digital Transformation	: Contractor : 5 Years : 5 Years
Interviewee G	Type of Company Experience in Construction Industry Experience in Digital Transformation	: BIM Management Consultancy : 13 Years : 6 Years
Interviewee H	Type of Company Experience in Construction Industry Experience in Digital Transformation	: BIM Specialist (Engineering) : 5 Years : 7 Years

Findings in Relation to Objective One: Understanding the Current Situation of Digital Transformation in the Malaysian Construction Industry

Question 1:
What is your understanding of digital transformation in the construction industry?

Finding:

From the results of the interview, it is obvious that the understanding of digital transformation is not too far apart from each of the interviewees. Digital transformation mainly consists of the adoption of digital technologies including either software or hardware to enhance of the process of business and make use of the data collected from the technologies. Most of the interviewees see the bright side and have positive perspectives toward digital transformation.

Question 2:
What is the status of digital transformation in your current or former company?

Finding:

All of the interviewees claimed their companies are more than 50% on the way to digital transformation. 2 interviewees gave the highest percentage of digital transformation, one at 90% and the other fully transformed (100%). Most of the interviewees' companies had started on digital transformation early, one of them 5 years ago when the concept of digital transformation had just begun in the Malaysian Construction Industry. All the companies interviewed are not newcomers in digital transformation. They had been using digital tools in their businesses and at the same time, they are on the way to explore more advanced technologies for their companies.

Question 3:
What is/are the digital technology/technologies (software and/or tool) used in your current or former company?

Finding:

BIM technology is the most used digital technology across the different disciplines. The technology used by the different disciplines can be easily categorised according to the nature of business. For example, BIM technology such as Revit, BIM 360 and 3D modelling are the "must" software for Consultants and Contractors where it allowed them to have better visualisation of the possible actual design during pre-contract and post-contract stage compared to the 2D drawings. Besides, Developers and Contractors are more favourable to administration and management-based software such as financial software – IFCA, project management software – Primavera and other software which allowed them to generate useful data for better decision making in project and cost management.

Question 4:
How much would you rate the maturity of using digital technology (as mentioned above) in your company?

Finding:

The digital technologies adopted in their companies allows their employee to achieve the maturity in knowledge to operate the software. Most of the interviewees are confident to claim their maturity in using the software are high and only 1 interviewee mentioned it is at 50% maturity in software usage. 3 interviewees said they are confident of their maturity in BIM technology, of which one of the interviewees indicated it as BIM Level 3 with more than LOD 300. This indicator is established by the American Institute of Architects (AIA) to identify the content and reliability of used BIM technology at different stages of construction.

Question 5:
What are the digital technology (software and/or tool) you have used before other than the digital technology answered in Question 3?

Finding:

5 interviewees have the knowledge in using the technologies as stated before which are the current technologies adopted in their companies. However, there are another 3 interviewees who had experienced more digital technologies than their current company had. This includes experience in digital visualisation tools such as AR and VR which are not commonly used in the Malaysian Construction Industry at present.

Question 6:
How much would you rate the current situation of digital transformation in the Malaysian Construction Industry?

Finding:

There is only 1 interviewee who thinks that the Malaysian Construction Industry has a high level of implementation in digital transformation whereas other interviewees have a lower view of the current situation of digital transformation implementation. There is room for improvement in the aspect of digital transformation in the Malaysian Construction Industry. Besides, there are 4 interviewees who are of the opinion that the Covid-19 Pandemic did accelerate the process of digital transformation in the industry. 2 of the respondents mentioned the pandemic has not made substantial changes to their companies because their company had adopted digital technologies much earlier before the pandemic occurred.

Question 7:
What are the suggestions to improve the current situation of digital transformation in the Malaysian Construction Industry?

Finding:

5 interviewees are in agreement that the Government could speed up the process of digital transformation. The policy toward the usage of BIM should be made mandatory with more incentives for SME companies. Otherwise only the big construction companies had the financial capability in implementing digital transformation. Besides, the update of knowledge and sharing between the players in the industry are important to achieve overall growth in the industry. However from the interviews, it is understood that the experience and knowledge in digital transformation are treasured by the respective companies who may treat it as a trade secret to ensure their leading positions in the industry.

Question 8:
Who is/are the party/parties that has the most responsibility for the current situation of digital transformation in the Malaysian Construction Industry?

Finding:

All the interviewees agreed that the Industry Leaders (Government and private Developers) have the most responsibility for the progress of digital transformation in the Malaysian Construction Industry. This is because they have the most resources compared to other players in the industry and the Government is the only party that has the power to enact the law and rules to ensure the usage of digital technologies. Besides, as the paymasters for the project, they have the ability to initiate digital transformation and adopt the digital technologies in their projects. It is the reality of demand and supply in the usage of digital tools. The demand from the Clients will encourage more participation in digital tools from the Consultants and Contractors because they will be paid for their initiatives if they are onboard in digital transformation. However, 2 interviewees said that all the players in the construction industry shall bear equal responsibility toward the progress of situation of digital transformation in the Malaysian Construction Industry.

Findings in Relation to Objective Two: Understanding the Impact of Digital Technology and Digital Transformation

Question 1:
How will digital transformation impact (positively/negatively) the Malaysian Construction Industry?

Finding:

All the interviewees agreed that digital transformation will bring a positive impact to the construction industry in the aspects of productivity, efficiency, less dependency on foreign labour, site safety, management and accuracy. The benefits will be enlarged in scale parallel to the scale of the project. Besides, the digital transformation provide the essential benefits to keep track of the past documents and data so that the users can refer or make use of the data to become a set of meaningful information for their decision making as well as for building maintenance works.

Question 2:
Who is/are the party/parties impacted (positively/negatively) the most by the digital transformation?

Finding:

4 interviewees think the digital transformation will impact all the parties because construction projects involving all parties and the software can be only optimised if every party in the project is using the same digital technology. However, 2 interviewees think that digital transformation brought more impact toward the Project Owners due to the productivity and efficiency obtained by using digital technologies will directly reflect on the cost and time-saving. Furthermore, 2 interviewees think that digital transformation had brought the most negative impact toward the SME construction companies because they have lesser financial capability to catch up with the trend of digital transformation which had caused them to be left behind.

Findings in Relation to Objective Three: Understanding the Challenges or Obstructions of Digital Transformation

Question 1:
What is/are the challenges or obstructions during the implementation of digital transformation?

Finding:

All of the interviewees said that the understanding and mindset of the company's decision-makers are the main obstacles to the implementation of digital transformation. The reluctance to change and the minimal understanding of the trends and benefits of digital transformation will hinder the company or industry to move forward towards digital transformation. Besides, cost and financial capability are the other major issues to be considered when coming to the implementation of digital transformation. Most of the subscriptions of digital software are expensive and not all companies have the financial capability to purchase and maintain the software. The consideration of ROI, lack of skilled labour and issues such as information loss when exchanging data between software and discontinuity of software usage between parties in a project are the other factors that hinders the implementation of digital transformation.

Question 2:
What is/are the solution(s) for the challenges or obstructions as stated above?

Finding:

The Government plays an important role towards the success of the implementation of digital transformation. The Government could enforce or make the usage of digital technology mandatory for all projects regardless of private or public with incentives for the SME companies who needed it. Besides, education and training are important to ensure all the employees are competent to use digital technologies. Sharing of knowledge can be one of the solutions to overcome the low implementation rate of digital transformation. It is discouraging if a company is required to spend time and cost on trial and error on the new software to see whether it is a worthwhile investment. 2 interviewees think that there is nothing to solve as digital transformation is a "must" trend in the future, all companies will eventually go onboard or be eliminated from the industry.

Most of the interviewees took a negative view toward the current situation of the Malaysian Construction Industry in digital transformation yet the Covid-19 pandemic did accelerate the progress of transformation. All interviewees are in agreement that the digital transformation will bring a positive impact to all the players in the industry. Project Owners will benefit the most from the digital transformation where the cost and time will be reduced in their construction projects.

The understanding and mindset of players in the construction industry are the main obstacles in the way of digital transformation. Besides, the cost to purchase the digital technologies are expensive requiring high financial capability to afford such expenses. However, the obstructions can be solved by the involvement of the Government in implementing policy phase by phase to make digital technologies compulsory for all the projects regardless of private or public with incentives. This together with education and training to prepare the needed manpower will encourage more players to participate in the digital transformation.

The above findings are summarised in Table 2 below:

Table 2. Summary of Findings

Objective	Question	Finding
Objective 1: Understanding the Current Situation of Digital Transformation in the Malaysian Construction Industry	**Q1:** What is your understanding of digital transformation in the construction industry?	Using digital technologies to enhance process of business and utilise collected data.
	Q2: What is the status of digital transformation in your current or former company?	All are not newcomers in digital transformation. They had been using digital tools in their businesses, some more advanced than others.
	Q3: What is/are the digital technology/technologies (software and/or tool) used in your current or former company?	BIM (Building Information Modelling) is the most used digital technology. Others include IFCA and Primavera.
	Q4: How much would you rate the maturity of using digital technology (as mentioned above) in your company?	High maturity in using digital technology.
	Q5: What are the digital technology (software and/or tool) you have used before other than the digital technology answered in Question 3?	3 out of the 8 interviewees have also have experience in digital visualisation tools such as AR and VR.
	Q6: How much would you rate the current situation of digital transformation in the Malaysian Construction Industry	There is room for improvement. However the Covid-19 Pandemic did accelerate the process of digital transformation.
	Q7: What are the suggestions to improve the current situation of digital transformation in the Malaysian Construction Industry?	• Incentives and policies from the Government. • Sharing of knowledge and experience in digital transformation among the industry players.
	Q8: Who is/are the party/parties that has the most responsibility for the current situation of digital transformation in the Malaysian Construction Industry?	• Industry leaders (Government and private developers) : Paymasters and can make the call for digitalisation in their projects.
Objective 2: Understanding the Impact of Digital Technology and Digital Transformation	**Q1:** How will digital transformation impact (positively/negatively) the Malaysian Construction Industry?	• Postive: improve productivity and efficiency, less dependency on foreign labour, better site safety and management and greater accuracy.
	Q2: Who is/are the party/parties impacted (positively/negatively) the most by the digital transformation?	• Digital transformation will benefit the whole industry. • Project Owners will benefit the most from cost and time savings. • SME construction companies may suffer because they have lesser financial capability and be left behind.
Objective 3: Understanding the Challenges or Obstructions of Digital Transformation	**Q1:** What is/are the challenges or obstructions during the implementation of digital transformation?	• Mindset (reluctance to change) and minimal understanding of the trends and benefits of digital transformation from the company's decision-makers. • Cost of digital technologies and financial capability of companies. • Consideration of ROI. • Lack of skilled labour. • Information loss in exchange of data between software and discontinuity of software usage between parties.
	Q2: What is/are the solution(s) for the challenges or obstructions as stated above?	• Role of Government in terms of relevant policies. • Education and training to equip manpower. • Sharing of knowledge to reduce time and cost for trial and error.

CONCLUSION AND RECOMMENDATION

Discussion on The Current Situation of Digital Transformation in The Malaysian Construction Industry

Most of the interviewees have a negative perspective toward the current situation of Digital Transformation in the Malaysian Construction Industry. The progress of digital transformation is relatively slow compared with other countries such as Singapore. However, they are in agreement that the Covid-19 Pandemic did accelerate the progress of digital transformation implementation.

Cloud technology and BIM technology are the most used digital technologies in the current Malaysian Construction Industry. Cloud technology is crucial during the pandemic time, cloud sharing platform is the only solution towards the restriction of not being allowed to work in the office. Besides working files such as Microsoft Office and AutoCad files sharing between the employees, BIM360 allowed the BIM files to be shared between the consultants to ensure the progress is on track.

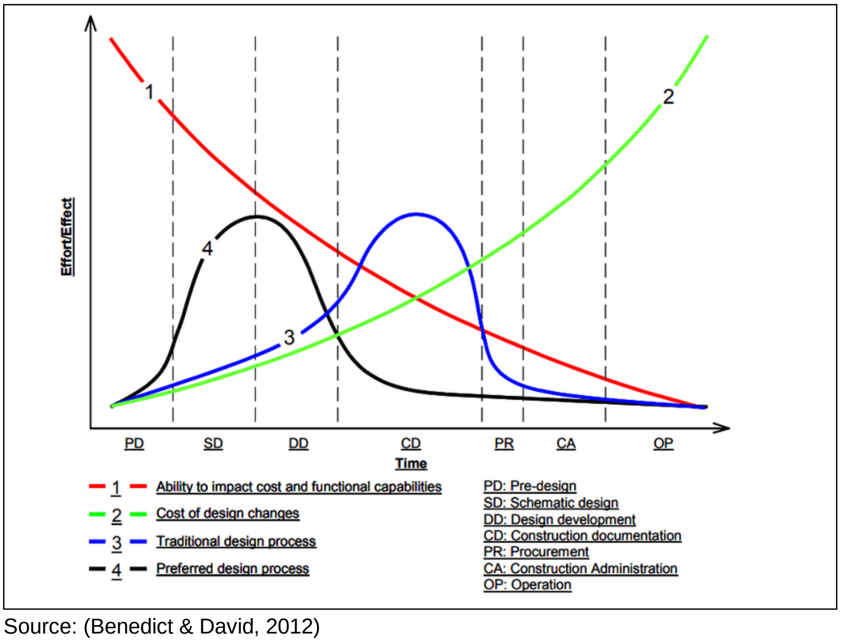
Compared to other digital technologies, BIM is more common for consultants and contractors. BIM serves different purposes for each of the disciplines in the construction industry and is the first 3D digital technology brought into the construction industry.

The Government and the developers in the private sector plays a pivotal role toward the success of digital transformation in the Malaysian Construction Industry. This is because the Government is the policy-maker that has the authority to enforce and accelerate the adoption of digital transformation in the construction industry and the consultants and contractors provide their services based on the needs and requirements of their clients (developers). However, each party has a role to play as the benefits of digital transformation will be returned to all that implement it. As such, every party in the industry should take the initiative and play their role in improving their services and products.

Discussion on The Impact of Digital Transformation in The Malaysian Construction Industry

The advantages of digital transformation includes but are not limited to the increased productivity, higher efficiency, less dependency on foreign labour, better site safety management and better cost and project management. These benefits will be amplified along with the scale of the project. Digital transformation will also help to minimise construction errors and delays that will have high cost and time implications especially for mega projects.

In this digital era, information and data are essential, yet analysing the collected data will be an important step toward making a better business decision. Digital technology can solve the issues of collecting data and information from different departments and past projects which can then be used for analysis becoming meaningful information for the key person to make an insightful and rational decision. Furthermore, such data could be useful for building maintenance works, especially for the old buildings.



Source: (Benedict & David, 2012)

Figure 7. MacLeamy Curve

The MacLeamy Curve above presented the benefits and impacts that can be brought by implementing digital transformation. The “Black Line” (Line 4) represented the method using digital technology. From the diagram, if both Line 3 (Conventional Method) and Line 4 (Modern Method) faced any changes in design, Line 4 can easily diagnose and mitigate the changes earlier yet the conventional method may only discover it at a later stage. Also, the conventional method requires a higher cost of design changes with a lower ability to impact the cost and functional capabilities compared to the method using digital technology.

Discussion on Obstructions to Digital Transformation in The Malaysian Construction Industry

- **Lack of Understanding of Digital Transformation and a Conventional Mindset**
    - The implementation of digital transformation is a top to bottom approach. The transformation can only happened in a company if the management decided to adopt digital technology or make such changes. However, a minimum knowledge and understanding of the digital transformation can stop the process because of the uncertainties a company may be facing after adopting digital technology.

- **Cost and Financial Capability**
    - From the findings, most of the software requires a substantial amount to procure or maintain. The SME companies may not have the financial capability to support the expensive subscription fees therefore halting their digital transformation.

The Government can be the solution to the issues stated above. To activate a conductive environment of digital transformation in the Malaysian Construction Industry, the Government could set up regulations and enforce all the projects regardless of whether private or public sector to adopt digital technology as a mandatory requirement. Besides, incentives should be provided to the SME companies to support them to overcome the initial stage of transformation. Education and manpower training should also be carried out to prepare skilled and competent staff for the industry to adopt digital technology. The ultimate goal here is to encourage all the parties to be involved in digital transformation instead of being left behind in the industry.

Furthermore, the policy and regulations made by the Government should encourage more solution companies to join in software development related to the construction industry. Thus, the subscription fees for each of the software will decrease due to the competition among the software developers and the software will be more suited for the local construction industry's use without much customisation required.

Concluding Remarks

Presently the level of digital transformation in Malaysia is relatively low however the Covid-19 pandemic did accelerate the speed of transformation. Digital transformation has the benefits of cost and time-saving, being productive, collaborative, promotes site safety and a better management tool for on-site activities including human resources and better project management. However, the transformation can be restricted by the factors such as financial considerations and the understanding and mindset about digital transformation. Fortunately, all the obstructions can be overcomed such as the involvement and incentives by the Government and the active participation of all key players in the Malaysian Construction Industry. Digital transformation is a long and hard journey yet there is light and rewards at the end of the journey.

"There is no alternative to digital transformation. Visionary companies will carve out new strategic options for themselves — those that don't adapt, will fail."

— Jeff Bezos, Founder and Executive Chairman of Amazon

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EMPLOYEE ENGAGEMENT IN BUILDING INFORMATION MODELLING (BIM) BASED PROJECTS: A SYSTEMATIC REVIEW

Wong Foo Yeu[1,2,] and Yew Yee Fang[1]
[1]Department of Quantity Surveying, Faculty of Built Environment, Tunku Abdul Rahman University College
[2]Centre of Construction Research, Faculty of Built Environment, Tunku Abdul Rahman University College

Abstract
Building Information Modelling (BIM) has been expanding and revolutionising the global construction industry. Many BIM studies focus on the adoption from different perspectives, but the BIM adoption level remains low. Most of the studies concentrate on top-down approaches, but there are limited studies that focus on bottom-up efforts from the employee level. Few studies have suggested that employee engagement is essential in ensuring the success of BIM adoption. The motivational factor in improving employee engagement is an important element in every business to determine how employees perform their work duties. It is crucial to understand the factors that motivate employees to drive their performance. This paper intends to analyse the existing literature on the motivational factors to improve employee engagement in an organisation and reveal their importance towards BIM adoption. Sixteen journal articles of relevant studies were carefully selected via the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The said journal articles are from prolific academic databases, namely Web of Science (WoS), Scopus, and Emerald. A thematic analysis was conducted to identify the themes and sub-themes of the relevant topic. This paper proposes five main themes, which are work-life balance, training and career development, reward programme, management, and work environment, followed by twenty-five sub-themes suggested from these five themes. Several future directions and recommendations are proposed, such as conducting further research on realistic motivational factors to engage employees towards BIM adoption, narrowing down the search criteria in the context of region and professions, and conducting evidence-based research on the current development of BIM to escalate the proliferation of BIM.

Keywords: *Building Information Modelling (BIM); Employee Engagement; Systematic Literature Review*

INTRODUCTION

With the advent of digital technologies, the fourth industrial revolution, also known as “Industry 4.0”, has emerged as a growing trend across sectors and has become today’s global buzzword (Ibrahim, Esa & Binti, 2019). Industry 4.0 can be characterised as an intelligent approach to revolutionise the world by introducing automation and digital transformation in a wide variety of contexts (Liao, Deschamps, Loures & Ramos, 2017).

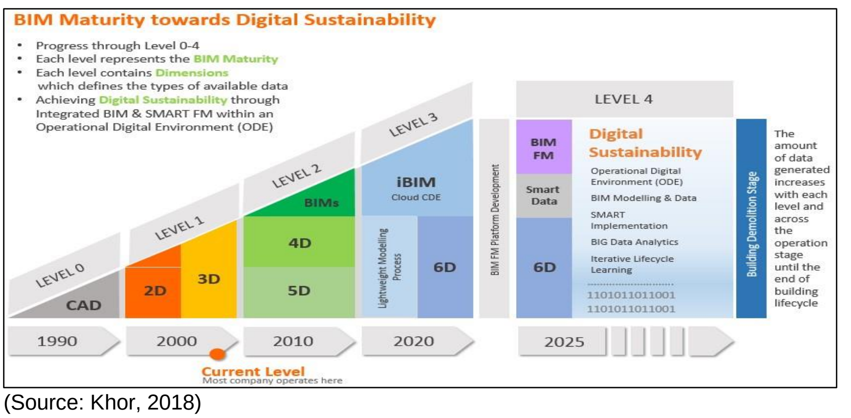
For the past few decades, there have been numerous leading-edge technology advancements wrought upon the various industrial sectors to embrace Industry 4.0 (Craveiro, Duarte, Bártolo & Bartolo, 2019). Yet, unlike other industries, the construction sector has been slow to adopt new technologies and is still at the beginning of digital transformation (Gerbert, Castagnino, Rothballer, Renz & Filitz, 2016). Compared to the immediate adoption of technologies that are used in many other industries, previous studies revealed that the characteristics of construction, such as its uniqueness, complexity, and uncertainty constitute critical challenges, resulting in it lagging far behind overall (Gerbert et al., 2016; Oesterreich

& Teuteberg, 2016). As the construction industry is a cornerstone of any country's economy, prevailing studies have suggested infusing digital technology and advanced automation into the construction sector to improvise and adapt to the ever-changing global economy (McKinsey Global Institute, 2017).

Currently, BIM is the centrepiece of digital transformation in the construction sector, which is used in many developed countries due to its wide acceptance and promising benefits (Ismail, Chiozzi & Drogemuller, 2017). Undeniably, BIM represents a remarkable paradigm that shifts conventional methods towards digitisation in facilitating the interoperability of design data throughout the project's life cycle (Alizadehsalehi, Hadavi & Huang, 2020). As construction projects involve a series of information-intensive activities which require collaboration between every stakeholder, the interoperable and object-oriented nature of BIM serves as a potential practice for improved information sharing, project coordination, and collaboration (Ademci & Gundes, 2018).

Furthermore, numerous studies have proven that the use of BIM throughout the project life cycle mitigates global issues such as delay and cost overrun that may lead to unavoidable disputes and claims. Thus, BIM is able to meet the client's requirements within the allocated budget, time, and quality (Ismail et al., 2017; Tahir, Haron, Alias & Diugwu, 2019). With such advancements associated with BIM, it has become an invaluable process enabler for the construction industry to encompass all design aspects, construction, and operation of the building. Over the years, developed countries such as Japan, France, and Germany have benefitted significantly from the use of BIM and reported a positive Return on Investment (ROI) (McGraw Hill Construction, 2014). It is highly probable that BIM will ultimately become the standard in construction practices for every country, in much the same way as how CAD took over from the drawing board during the 1990s (McPartland, 2014).

Today, BIM technology has evolved from basic 3D and 4D to more sophisticated 5D and even 6D that provide a greater level of information, including scheduling, costing, and facility management (McPartland, 2017). The current trend of BIM maturity consists of 5 levels as the criteria to be deemed BIM-compliant in terms of BIM maturity level. Each level contains BIM dimensions that provide different types of available data (see Figure 1). The previous findings also revealed that BIM adoption in the construction journey is still progressing slowly, where most of the organisations are still at BIM Level 1 in the year 2020.



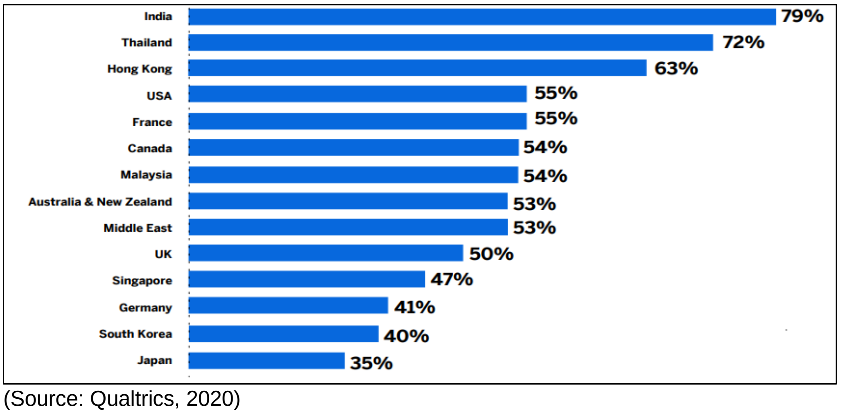
(Source: Khor, 2018)

Figure 1. BIM Maturity Towards Digital Sustainability

However, BIM technology is not exempted from problems and challenges in adoption and implementation as the transition is not solely dependent on mere changing of software and hardware, but also drastic transformation in the industry (Jamal, Mohammad, Hashim, Mohamed & Ramli, 2019). As BIM technology is still evolving, the issues and challenges frequently highlighted in previous studies include shortage of skilful and experienced BIM workforce, high investment cost in software and hardware, reluctance to change, and uncertainties in BIM policies related to contracts and legislation (Awwad, Shibani & Ghostin, 2020; Dainty, Leiringer, Fernie & Harty, 2017; Hochscheid & Halin, 2020).

To mitigate the said barriers, most of the research findings perceived that the government and its agencies should take the lead role as the driving force to ensure successful and complete BIM adoption in the construction industry (Awwad et al., 2020). Several initiatives have been discussed in previous studies, such as organising BIM seminars, workshops and training for various levels of industry players, and developing cross-disciplinary BIM standards. Not only that, major countries such as the USA, the UK, Australia, and Singapore also introduced BIM mandating policies to encourage the industry to participate in BIM (Edirisinghe & London, 2015). However, Dainty et al. (2017) found that BIM-mandating policies at the national level still do not engage smaller firms towards successful BIM adoption. Despite the BIM mandate, Ying et al. (2019) proposed to pay more attention to engage employees in using BIM tools.

Technology adoption not only depends on the assessment of given technology, but also the individual user's attitude towards the technology (Feibert & Jacobsen, 2019). Molino, Cortese and Ghislieri (2020) pointed out that new technologies may fail due to employees' resistance. It often happens because of distrust, inadequate management, lack of technical skills and so on (Molino et al., 2020). As new technologies evolve and change the relationship between individuals and their work, enhancing employee engagement can be a key element towards successful technology adoption in Industry 4.0.



(Source: Qualtrics, 2020)

Figure 2. Percentage of Employee Engagement Among Countries

Recent research released by Qualtrics (2020) concerned a study on employee engagement in several countries (see Figure 2). The term employee engagement can be defined as the degree to which employees are motivated to commit and are willing to make a persistent effort towards their organisational goals (Macey & Schneider, 2008). The study found that the global average of employee engagement among countries is only 53%, in which India has the highest engagement levels (79%), followed by Thailand (72%) and Hong Kong (63%). As the construction industry is entering a new decade of digital transformation, Qualtrics (2020) highlighted that it is important for companies to create an agile workforce by optimising engagement strategies.

Moreover, studies have found that employee engagement positively impacts organisational performance with valuable outcomes such as employee retention, productivity, high performance, customer loyalty, and safety (Markos & Sridevi, 2010; Popli & Rizvi, 2015). There is also evidence that a positive outcome of employee engagement is on the shareholder return, resulting in higher pay, perks, and promotions for employees (Sandhu, Guglani & Singh, 2018). As such, engaged employees tend to perform better with lower turnover, and become advocates of the organisation while enjoying their work (Sandhu et al., 2018). Thus, employee engagement benefits all stakeholders from top to bottom, including the shareholders, top management, and employees (Sandhu et al., 2018). With the right attitude coupled with the right skills and capability in BIM, organisations will be more likely to achieve higher levels of success in their entrepreneurial journey (Construction Industry Development Board [CIDB], 2015). In the long term, organisations must undergo a major change to be BIM-compliant by building up a better-skilled workforce (CIDB, 2015).

Prior to this study, the existing studies tend to focus on top-down initiatives on the grounds of government and clients to overcome the barriers of BIM adoption (Awwad et al., 2020; Hong, Hammad, Samad & Ali, 2019). Besides that, employees' capability, skills, and mindset are extremely and equally important for BIM adoption as they are the ones who use BIM at work (Awwad et al., 2020; Ng, Tobi & Fathi, 2018). In a broader sense, this study is vital for the organisation to build up a highly engaged workforce in adopting BIM as the usage of BIM is expected to escalate and expand over time towards Industry 4.0 (Charef, Alaka & Emmitt, 2018).

In context, this article attempts to fill the gap in research from reviewing the prevailing studies to determine a comprehensive list of motivational factors to sustain high engagement levels in adopting BIM technology across an employee's entire lifecycle. Apart from that, this SLR will provide a greater conceptual basis of BIM as a medium for widespread adoption. The main objectives of this Systematic Literature Review (SLR) are: (a) to reveal the importance of employee engagement towards BIM adoption in an organisation; and (b) to present a bibliometric analysis by empirically examining the motivational factors to engage employees at work. The purpose of conducting a systematic review is explained in this section. Section 2 describes the methodologies and the PRISMA Statement (Preferred Reporting Items Systematic Reviews and Meta-Analysis) approach used to conduct a systematic review of the existing literature. Section 3 discusses and synthesises the existing literature on employee engagement in the organisation for the study. The final section concludes and identifies the future research priorities in the BIM adoption domain.

METHODOLOGY

This section discusses the method used to retrieve articles related to BIM adoption and employee engagement in an organisation. Due to the overwhelming research output in the databases, the PRISMA flow diagram aids to provide a systematic review of relevant searches for the study. The databases used include resources (Web of Science, Scopus, and Emerald

Insight) to run the systematic review using advanced Boolean search techniques to narrow down the searches within the scope of the study. The eligibility and exclusion criteria, the review process, data abstraction and analysis are explained.

Systematic Literature Review

A Systematic Literature Review (SLR) is a structured methodological approach by systematically assessing, interpreting, and synthesising all available resources relevant to given research in order to obtain a comprehensive overview of the literature published for a set of formulated questions (Higgins, 2016). SLR is subject to formal standardisation for adding transparency and reproducibility to the review process, including pre-defined eligibility criteria for documents and search strategies based on keywords, inclusion, and exclusion criteria (Berrang-Ford, Pearce & Ford, 2015). Via a systematic review, authors' knowledge claims can be justified to identify the research gaps, needed directions, and recommendations for further investigation by integrating the existing qualitative data using the quantitative analysis method (Ford et al., 2015).

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)

The literature review was guided by the PRISMA Statement. PRISMA provides a flow diagram of information to follow for systematically planning and analysing the existing articles. This PRISMA Statement is suitable for SLR due to its four unique advantages, which are (i) it defines clear research questions that allow systematic research; (ii) it critically identifies the inclusion and exclusion criteria; (iii) it aims to examine the largest amount of relevant scientific literature in a prescribed time; and (iv) it contributes to the rigorous search by using statistics (Correa & Kintz, 2015).

Resources

The methodology adopted in this article relied on three main journal databases - Web of Science (WoS), Scopus, and Emerald Insight. It is suggested to use more than one database to cover the others' weaknesses as there is no complete academic database (Xiao & Watson, 2019). WoS and Scopus have been the main sources for many citation studies that provide interdisciplinary journal coverage in diverse subjects (Mongeon & Paul-Hus, 2016). With its capability as a resource for the comprehensiveness of research evidence, Emerald was used as one of the databases as it has a vast range of subject areas across the fields of engineering and technology.

Eligibility and Exclusion Criteria

The eligibility and exclusion criteria for existing studies need to be determined to narrow down the searches to conduct a literature review. First, regarding literature type, the selection is only based on journal articles with empirical data where review articles, personal blogs, book series, and chapters in books will be excluded. The second criterion is the language used, which only focuses on English publications and excludes non-English publication to avoid any misunderstanding and difficulty in translating. Lastly, the timeline for the publication year will be set between 2012 and 2021, a period of 10 years to see the evolution of research and avoid any outdated issues in related publications. The selection criteria for literature searches are highlighted in Table 1.

Table 1. Eligibility and Exclusion Criteria

Criterion	Eligibility	Exclusion
Literature Type	Indexed journals (Research Article)	Non indexed journals, Systematic literature review journals, Chapter in book, blog
Language	English	Non-English
Timeline	Between 2012 - 2021	< 2012

Systematic Review Process

The PRISMA flow diagram aids in providing a systematic review of relevant searches for the study (Moher et al., 2009). In the PRISMA flow diagram, four phases are involved as shown in Figure 3, which were performed in June 2021. Firstly, the most important step is to identify the related keywords in the four main databases used to build the search string using the Boolean Operator technique (see Table 2). However, the results shown were insufficient to validate or support the objectives. A systematic review cannot rely solely on strict key terms and may require a broader framework to answer the research questions (Ford et al., 2015). The keywords mainly focus on “employee engagement”, “motivation”, and “organisation” to streamline the search results. Therefore, a total of 522 papers were found in Scopus, Web of Science (WoS), and Emerald. Secondly, 45 duplicate papers were removed in the screening process. Next, 295 papers were excluded due to review paper, book series, book, chapter in book, conference proceeding, thesis, non-English, medical sciences as well as other Social Science which are not related to building construction sector. After that, 166 papers were excluded upon screening the titles and abstracts, which majority are irrelevant to the main topic, and the full text were not available to view. Based on a series of identification, screening, and scoping down through eligibility criteria, a total of 16 journal articles were included to address the research question in this paper. The PRISMA was supported by Correa and Kintz (2015) as it was a systematic approach conducted to clearly define research questions, identifying inclusion and exclusion criteria, and specific time frame was applied attempting to rigorously search literature from large academic databases.

Table 2. Search String and Keywords

Databases	Search String and Keywords
Web of Science	TS=(("employee engage*" OR "worker engage*" OR “job engage*”) AND ("motivation*" OR "drive*" OR "improve*" OR "enhance*" OR "determine*") AND ("enterprise" OR "organisation" OR "company" OR "firm"))
Scopus	TITLE-ABS-KEY(("employee engage*" OR "worker engage*" OR “job engage*”) AND ("motivation*" OR "drive*" OR "improve*" OR "enhance*" OR "determine*") AND ("enterprise" OR "organisation" OR "company" OR "firm"))
Emerald Insight	abstract:"employee engage* OR worker engage* OR “job engage*”" AND ("motivation*" OR "drive*" OR "improve*" OR "enhance*" OR "determine*") AND ("enterprise" OR "organisation" OR "company" OR "firm")

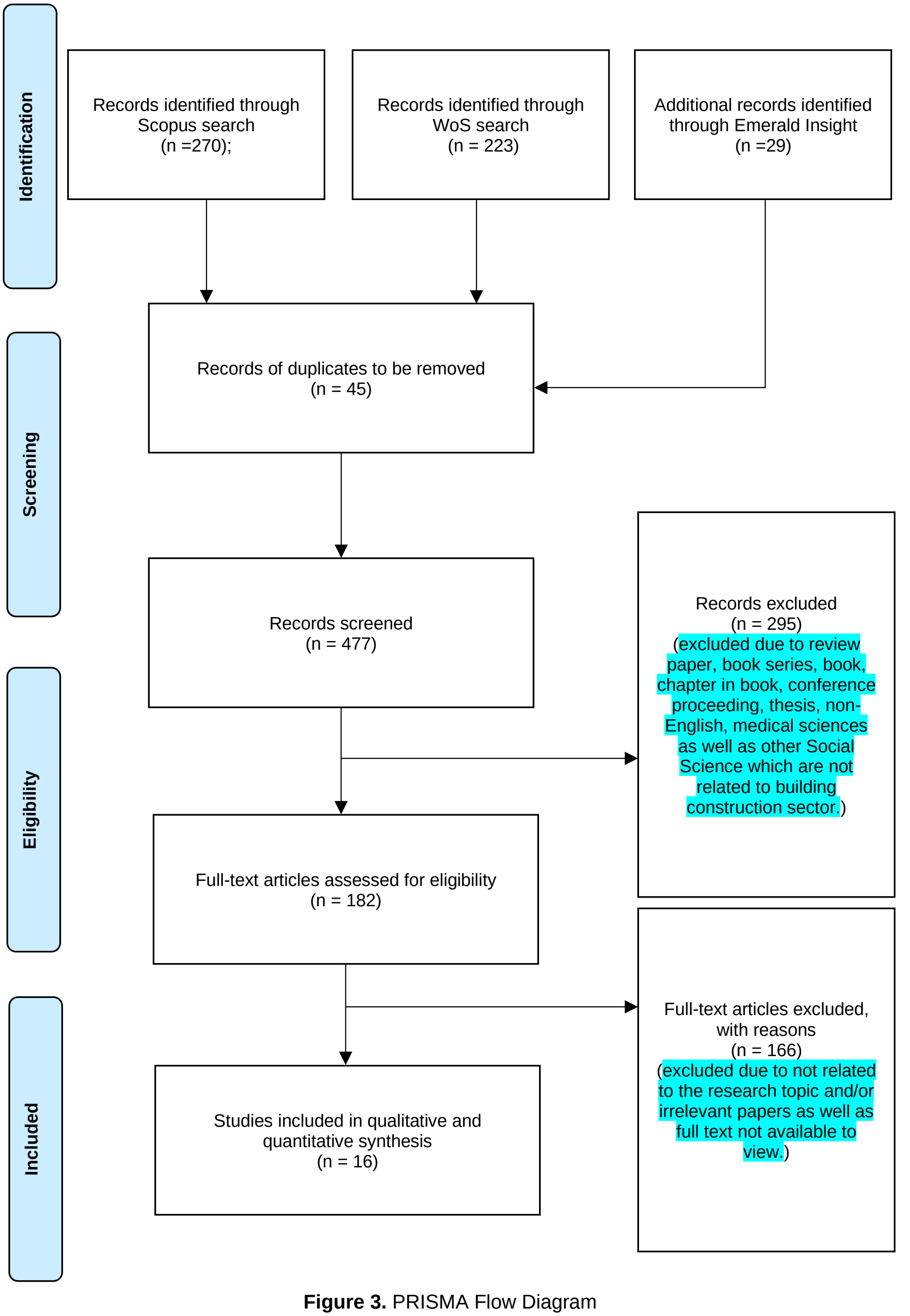


Figure 3. PRISMA Flow Diagram

Data Abstraction and Analysis

The refined articles that focused on specific studies were carefully analysed and examined to answer the formulated research questions. When it comes to data abstraction, it is the best to start with the abstract and then only read the full articles in-depth to get a better understanding of the topic. For data analyses, two methods were adopted, including synthetisation and thematic analyses.

Synthetisation is a qualitative research method that combines multiple studies on a topic to extend knowledge and theory (Drisko, 2020). It is a valuable research methodology that can assist in expanding the drivers of motivational factors to improve employee engagement as guidance for the organisation.

Furthermore, thematic analysis is a qualitative research method that provides insightful findings by identifying, analysing, organising, describing, and summarising the key features of a large data set (Nowell, Norris, White & Moules, 2017). Through its theoretical freedom, it can provide a highly flexible approach in identifying and establishing the themes related to the motivational factors in employee engagement. The authors can then categorise the sub-themes around the main themes through typology.

RESULTS

The review resulted in five main themes and twenty-five sub-themes related to motivational factors in employee engagement. The five main themes are work-life balance (five sub-themes), training and career development (five sub-themes), reward programme (five sub-themes), management (five sub-themes), and work environment (five sub-themes). The findings provided a comprehensive analysis of the motivational factors to improve employee engagement in an organisation.

Among the sixteen papers, a total of four studies discussed the evaluation of employee engagement towards technology (Aromaa et al., 2019; Azis, Prasetio, Gustyana, Putril & Rakhmawati, 2019; Molino et al., 2020; Statnickė, Savanevičienė & Šakys, 2019), four findings concentrated on the impact of employee engagement towards employee retention and organisational performance (Anitha, 2014; Bedarkar & Pandita, 2014; Clack, 2020; Qualtrics, 2020), and another eight studies focused on the determinants of employee engagement (Aguenza & Som, 2012; Dinh, 2020; Dlamini, Oshodi, Aigbavboa & Thwala, 2020; Febriansyah, Pringgabayu, Hidayani & Febrianti, 2018; Li & Yang, 2018; Sandhu et al., 2018; Sia & Kumar, 2012; Weideman, 2018). Regarding the year of publication, two studies were published in 2012, two articles were published in 2014, four papers were published in 2018, three studies were published in 2019, while the remaining five articles were published in 2020. Table 3 summarises the sixteen studies that met the requirements to present and synthesise the data using systematic approaches. In the following section, the motivational factors of employee engagement will be categorised and discussed to answer the review question based on the relevant information found.

Table 3. Review of Existing Literature on Employee Engagement

No.	Authors	Year	Research Focus	Review
1	Aguenza & Som	2012	Determinants of EE	The finding revealed that the most crucial motivational factors are financial rewards, job characteristics, career development, recognition, management, and work-life balance.
2	Anitha	2014	Determinants of EE & Impact of EE	Working environment and team and co-worker relationship are the main variables and had a significant impact on employee performance.
3	Aromaa et al.	2019	Technology & EE	Worker engagement has a positive impact on worker well-being and performance towards Industry 4.0.
4	Azis et al.	2019	Technology & EE	In technology-based companies, the mediation elements to connect leadership and employee engagement are intrinsic motivation and affective commitment.
5	Bedarkar & Pandita	2014	Determinants of EE & Impact of EE	The key drivers of employee engagement are communication, work-life balance, and leadership.
6	Clack	2020	Impact of EE	Employee engagement is the crucial factor that leads to employee retention, morale, and productivity, thus leading to organisational success.
7	Dinh	2020	Determinants of EE	Work-life balance and work stress positively impact employee engagement.
8	Dlamini et al.	2020	Determinants of EE	The study revealed the work-balance practices in the construction sector of Swaziland.
9	Febriansyah et al.	2018	Determinants of EE	One of the determining factors of employee engagement is the organisational climate.
10	Li & Yang	2018	Determinants of EE	This study finds that living a calling, job crafting, and work engagement have mediation effects.
11	Molino et al.	2020	Technology & EE	Providing information, opportunities and training for all employees are the key drivers to transform into Industry 4.0.
12	Qualtrics	2020	Impact of EE	With digitisation, the increase of the remote workforce has a profound impact on the employee experience.
13	Sandhu et al.	2018	Determinants of EE	Leadership is the key driver to achieving the desired level of engagement in an organisation.
14	Sia & Kumar	2012	Determinants of EE	Work pressure and autonomy have a significant contribution towards cognitive as well as emotional engagement.
15	Statnickė et al.	2019	Technology & EE	Work engagement is significantly affected by generation and by mobile learning.
16	Weideman	2018	Determinants of EE	Flexible work arrangement has a positive impact on employee engagement.

*EE = Employee Engagement

DISCUSSION

Employee Engagement in Organisation

Engagement is all about fit. Engaged employees will tend to be more adaptive and enthused to understand the company's direction and fit themselves in their job role, especially when going through change (Clack, 2020). Therefore, the organisation must invest in employee development and optimise employee engagement strategies to generate business growth (Qualtrics, 2020). To be successful, employee engagement can be a key element for an organisation in adopting BIM. As employee engagement has been proven to benefit stakeholders from top to bottom, the contribution of employee engagement may be significant to escalate the BIM adoption process. Employee engagement can be categorised into three types of people: engaged, not engaged, and actively disengaged (Soni, 2013). "Engaged" employees are usually highly productive and characterised with passion in performing their role to drive innovation and move the organisation forward (Soni, 2013). "Not engaged" employees tend to focus on the tasks given rather than the goals, who only do tasks when told to do so (Soni, 2013). The "Actively disengaged" employees are employees with high levels of discontentment on the organisational approach who sow seeds of negativity at every opportunity (Clack, 2020). In general, this study has attempted to systematically analyse the existing literature on motivational factors to improve employee engagement in an organisation.

Key Drivers of Employee Engagement

An employee is considered the most valuable asset in an organisation, if engaged and managed properly. That is to say, the key drivers to engage employees are considered the most powerful determinants to determine the engagement level of employees and to measure an organisation's vigour (Anitha, 2014). A total of 16 studies were reviewed, and the key drivers were classified into five main themes with five sub-themes each. In the following section, each main theme will be further discussed with its corresponding sub-themes and tabulated in Table 4. In Table 4, the five main themes were categorised under the column "Elements", while the sub-themes were listed down specifically according to its main theme under the column "Drivers of Employee Engagement". Under "Sources", the sources that provide relevant information on the related drivers were cited here. The key drivers are as follows:

Work-Life Balance

Work-life balance emerged as a key driver of employee engagement (Bedarkar & Pandita, 2014). Eight out of 16 studies revealed that the determinant to engage employees is creating a healthy equilibrium between personal life and job tasks (Dlamini et al., 2020). When it comes to work-life balance, it usually refers to flexible work options, organisational support for dependent care, and family or personal leave (Bedarkar & Pandita, 2014). Mostly, work-life balance provides flexible working time (five studies), allow working from home (two studies), standard working hours with no overtime (two studies), and job-sharing (four studies). Upon achieving this balance, it will reduce the employees' stress level, lower their turnover, and thus increase job satisfaction (Aguenza & Som, 2012).

Table 4. Key Drivers of Employee Engagement in an Organisation

Elements	Drivers of Employee Engagement	Sources
Work-Life Balance	Healthy equilibrium between personal life and job tasks (8)	Aguenza & Som (2012), Anitha (2014), Bedarkar & Pandita (2014), Clack (2020), Dinh (2020), Dlamini et al. (2020), Li & Yang (2018), Weideman (2018)
	Flexible working time (5)	Aguenza & Som (2012), Anitha (2014), Bedarkar & Pandita (2014), Dinh (2020), Dlamini et al. (2020)
	Allow working from home (2)	Bedarkar & Pandita (2014), Dlamini et al. (2020)
	Job-sharing among employees (4)	Clack (2020), Dinh (2020), Dlamini et al. (2020), Sia & Kumar (2012)
	Standard working hours (2)	Dlamini et al. (2020), Bedarkar & Pandita (2014)
Training and Career Development	Skill augmentation through training programmes (10)	Aguenza & Som (2012), Anitha (2014), Aromaa et al. (2019), Azis et al. (2019), Clack (2020), Dinh (2020), Molino et al. (2020), Qualtrics (2020), Sandhu et al. (2018), Statnickė et al. (2019)
	Proper career planning and development (4)	Aguenza & Som (2012), Clack (2020), Qualtrics (2020), Sandhu et al. (2018)
	Satisfaction of growth needs (5)	Anitha (2014), Clack (2020), Li & Yang (2018), Sandhu et al. (2018), Weideman (2018)
	Career role development (8)	Aguenza & Som (2012), Anitha (2014), Azis et al. (2019), Clack (2020), Li & Yang (2018), Qualtrics (2020), Sandhu et al. (2018), Sia & Kumar (2012)
	Job promotion (3)	Anitha (2014), Febriansyah et al. (2018), Sandhu et al. (2018)
Reward Programme	Fair appraisal system (5)	Aguenza & Som (2012), Anitha (2014), Azis et al. (2019), Clack (2020), Sandhu et al. (2018)
	Pay raise (5)	Aguenza & Som (2012), Clack (2020), Febriansyah et al. (2018), Sandhu et al. (2018), Statnickė et al. (2019)
	Bonuses (6)	Anitha (2014), Azis et al. (2019), Febriansyah et al. (2018),Sandhu et al. (2018), Sia & Kumar (2012), Statnickė et al. (2019)
	Company holidays (1)	Anitha (2014)
	Voucher schemes (3)	Anitha (2014), Dinh (2020), Sandhu et al. (2018)

Table 4. Key Drivers of Employee Engagement in an Organisation (Continued)

Elements	Drivers of Employee Engagement	Sources
Management	Supportive leader (11)	Anitha (2014), Azis et al. (2019), Bedarkar & Pandita (2014), Clack (2020), Dinh (2020), Febriansyah et al. (2018), Nienaber & Martins (2020), Qualtrics (2020), Sandhu et al. (2018), Sia & Kumar (2012), Weideman (2018)
	Clear two-way communication (7)	Aguenza & Som (2012), Azis et al. (2019), Bedarkar & Pandita (2014), Dinh (2020), Molino et al. (2020), Nienaber & Martins (2020), Sandhu et al. (2018)
	Positive relationships with co-workers (7)	Anitha (2014), Azis et al. (2019), Clack (2020), Dinh (2020), Li & Yang (2018), Sandhu et al. (2018), Sia & Kumar (2012)
	Listen to and act on employee feedback (6)	Azis et al. (2019), Dinh (2020), Li & Yang (2018), Nienaber & Martins (2020), Qualtrics (2020), Sia & Kumar (2012)
	Recognition for good work (5)	Aguenza & Som (2012), Anitha (2014), Clack (2020), Qualtrics (2020), Sandhu et al. (2018)
Work Environment	Comfortable working conditions (6)	Anitha (2014), Aromaa et al. (2019), Clack (2020), Dinh (2020), Sandhu et al. (2018), Sia & Kumar (2012)
	Clear job scopes (5)	Clack (2020), Molino et al. (2020), Nienaber & Martins (2020), Sandhu et al (2018), , Sia & Kumar (2012)
	Stress-free environment (3)	Bedarkar & Pandita (2014), Dinh (2020), Sandhu et al. (2018), Sia & Kumar (2012)
	Workplace transparency and openness (5)	Aguenza & Som (2012), Anitha (2014), Azis et al. (2019), Sandhu et al. (2018), Weideman (2018)
	Culture of trust in workplace (4)	Bedarkar & Pandita (2014), Dinh (2020), Sandhu et al. (2018) , Sia & Kumar (2012)

*The numbers in brackets (*n*) indicate the number of relevant sources cited.

Research has shown that work-life balance is a situation that creates the right balance between work and personal responsibilities (Dlamini et al., 2020). In the construction sector of Swaziland, a researcher found that proper work-life balance practices can yield many benefits not only to the employees, but also to the organisation and society (Dlamini et al., 2020). An engaged employee with a healthy equilibrium between life and job will result in better organisational performance, higher quality of life, higher level of commitment, and lower level of stress. The utilisation of work-life balance practice is beneficial to the operation of firms. In agreement with the existing literature, organisations are highly encouraged to utilise work-life balance practices to escalate the process of BIM adoption. In short, organisations are also advised to seek innovative ways to augment the practice of work-life balance to come to a win-win solution for employees and employers in coping with the new norm of working from home, especially given the recent pandemic.

Training and Career Development

In this theme, the most cited determinant highlighted in 10 previous findings is skill augmentation through training programmes. Furthermore, career role development, which is about the development of one's skills and fulfilling the employees' desires to grow and develop, is also one of the drivers that was pointed out in eight studies. Apart from that, employees are more likely to commit and engage in their job through job promotion (three studies), proper career planning (four studies) and satisfaction of growth needs (five studies).

Providing opportunities in training programmes and career movement allows employees to improve and develop their competitive advantages, which constitute a clear value proposition (Anitha, 2014). The employee will tend to be more satisfied by taking responsibility and achieving greater results in their job. Thus, training and career development are among the main factors to attract and retain engaged employees in an organisation. If an organisation does not encourage and respond to the employee's needs, 'career development' will become an underlying reason for resignation (Aguenza & Som, 2012). For BIM adoption, it is suggested that organisations invest in the development of their employees by providing training, workshops, and activities that are related to the new BIM technology. Aguenza and Som (2012) mentioned that many employees prefer to work for employers who offer growth opportunities and improve employees' skills that escalate career development. With that, the lack of a skilled workforce in BIM is no longer a threat, where the employees can enhance their competitive advantage and improve the organisational outcomes in the future.

Reward Programme

Another indispensable attribute of employee engagement is a reward programme or compensation system in terms of financial and non-financial rewards (Anitha, 2014). A combination of financial incentives such as pay raises (five studies) and bonuses (six studies) as well as non-financial awards like holidays (one study) and voucher schemes (three studies) are attractive remuneration to motivate employees to achieve more at work (Anitha, 2014). Most studies noted that financial compensation could establish a feeling of security and recognition, where the organisation values the employees (Aguenza & Som, 2012). Apart from that, five studies also suggest that perceived fairness and objectivity of the appraisal system will enhance employee engagement as well (Sandhu et al., 2018). Hence, employees tend to feel more obliged, and will respond with higher levels of engagement (Anitha, 2014).

From the results, a reward programme remains a popular strategy that is frequently used by most organisations for employee retention. In real life, financial awards are an important matter that gives a sense of security and stability to cover the basic daily needs. As such, reward programmes, especially involving money, are still a fundamental factor that motivates employees to do better work. However, the findings revealed that a reward programme is not a long-term solution to retain highly-engaged employees. Several studies pointed out that a fair appraisal system demonstrated a stronger relationship in employee retention, which indicated that financial rewards are less important than a fair pay system and process (Aguenza & Som, 2012). Back to the topic of BIM, monetary compensation may seem less important, but it remains a factor to consider. As BIM adoption is a challenging process, a reward programme can be an encouragement for employees to overcome the challenges and adopt BIM.

Management

Management roles can be identified as a fundamental factor for employee engagement (Aguenza & Som, 2012). An organisation must select the right managers responsible for ensuring a supportive and trusting interpersonal relationship with the employees (Anitha, 2014). The essential criteria of a manager are having effective leadership (11 studies) and clear two-way communication with the employees (seven studies). Besides, another seven studies mentioned that good leaders should have positive relationships with co-workers, whereas five out of 16 studies pointed out that recognition for good work can engage employees for higher working performance. Furthermore, six studies highlighted that management needs to listen to and act on employee feedback and turn it into action to boost the engagement even more. A qualified manager with integrity and respect will inspire the employees to a higher level of engagement in work (Aguenza & Som, 2012).

From the findings, management plays a significant role in engaging employees. As a key component in the organisation, a good leader can create a blame-free environment by trusting and giving support to one another to enhance employee performance towards organisational goals (Bedarkar & Pandita, 2014). Clack (2020) highlighted that the engagement level of employees lies directly on the manager. The results also demonstrated that the leader-employee relationship directly impacts the level of employee engagement (Clack, 2020; Sandhu et al., 2018). With improper management, it is not uncommon to have disengaged employees in the organisation. In order to be successful in engaging employees, organisations should spare no effort to effectively engage the managers first.

Work Environment

The work environment has come to play a significant role in leading to employee engagement (Sia & Kumar, 2012). The work environment is a mix of physical, social and psychological aspects (Anitha, 2014). In terms of the physical work environment, it is all about the working conditions and job setting, whereas the social and psychological work environment is indicated by the organisational culture, relationship with co-workers, and supervisor support (Sandhu et al., 2018). The findings revealed that the engagement level of employees resulted from various aspects of the work environment. Six studies focused on comfortable working conditions; five focused on clear job scopes; and four concentrated on the culture of trust in the workplace.

Apart from that, five studies revealed that an open and supportive environment could allow employees to voice their concerns in developing new skills and solving work-related issues. This will enhance a harmonious workplace where employees will engage totally with their obligations (Anitha, 2014). Furthermore, three previous findings also highlighted that employee with a high level of stress tend to create a higher turnover. Thus, a stress-free environment is compulsory to have a positive impact on employee engagement. The results demonstrated that the working environment and management factors are interrelated. A supportive working environment highly depends on the management to display concern for employees' needs and provide comfortable working conditions. With such harmony in a working environment, employees will feel safe and highly engaged in their work.

From the review of the findings, it is observed that the most significant drivers are supportive leaders in the organisation, followed by skill augmentation through training programmes, healthy equilibrium between personal life and job tasks, and career development for individuals. However, it is important to note that all these drivers are not directly related to employee engagement towards technology adoption but applied to a broader context of employee engagement in the organisation.

The findings revealed the importance of employee engagement towards the technology adoption, and in this case BIM adoption was referred. Undeniably, an organisation's main concern is to build up the culture of engagement and drive employee engagement with realistic measures. Despite the strategies to enhance BIM adoption that involve only the role of the client and government, special attention shall be given to the possible influential factors to drive employee engagement towards technology adoption. Thus, this further supports the statement of Hong et al. (2019) to engage employees in adopting BIM.

At the same time, BIM exhibits its strength with its promising benefits in terms of productivity, efficiency, and effectiveness, which has been widely adopted and proven successful in many developed countries. Therefore, it is an indubitable truth that engaging employees to adopt BIM would be the key towards organisational effectiveness and success in construction practices.

LIMITATIONS AND RECOMMENDATION FOR FUTURE STUDIES

There were two methodological limitations were identified. The literature search and thematic analysis were based on the certain keywords as explained in the methodology section. Thus, the review may have missed out some useful papers. To recall, the keywords such as "employee engagement", "motivation", and "organisation" were used to search literature in this review. Secondly, there was a gap on the authors' level of access to the existing literature in the data collection stage, especially the most recent publication where to those are not available to view yet. It was suggested that future studies may focus on more connected keywords to identify existing literature as well as identifying the latest development of the topic.

There remains much that is unknown about how to engage employees to adopt BIM. Further research on the motivational factors to engage employees towards BIM adoption are recommended to reveal the underlying factors or other potential variables that may affect the employee engagement. The employee's engagement is important to construction firms so that the firm s may have a better idea on how to engage their employees and lead to success in the BIM journey.

CONCLUSION

The role of employees is important for organisations to undergo massive change for their survival in the construction industry as employee performance will directly determine the overall success of the organisations. As BIM is expected to be the predominant technology of the future, it urges the need for organisations to engage employees to adopt new BIM technology.

This systematic review has pointed out the importance of employee engagement in an organisation. In response to that, a comprehensive list of motivational factors to improve employee engagement was identified and classified into five main aspects: work-life balance, training and career development, reward programme, management, and work environment. These five main themes were further extended to 25 sub-themes. Based on the systematic reviews performed, the findings were proven to enhance the engagement level of employees and drive their performance.

The review suggests several future directions and recommendations. First, research on motivational factors to engage employees towards BIM adoption is needed to prove the factors are workable in the real construction industry. Second, research on the low BIM adoption in SMEs should be conducted to fill the digital divide gap in the construction industry. Third, the search criteria for future studies can be narrowed down in the context of region and profession for explicit results from different perspectives, and lastly, an in-depth analysis of the current development of BIM is recommended to conduct from time to time to expand the BIM knowledge and skills. It is highly encouraged to transform the construction industry in the direction of greater digitisation to upsurge the construction productivity level towards global competitiveness and contribute to its economic status.

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PROPOSED METHODS IN ENHANCING THE BIM-BASED QUANTITY TAKE-OFF

Lam Tatt Soon, Wan Jing Ng and Book Tik Leong
School of Architecture, Building and Design, Taylor's University, Selangor, Malaysia

Abstract
Building Information Modelling (BIM) is creating a sea change in the construction industry through its disruptive technology in the present time. As one of the intelligent tools of BIM, BIM-based quantity take-off (QTO) is becoming more common in the Quantity Surveying profession because of its efficient use in carrying out quantification. BIM-based QTO performs the taking-off process automatically and eliminates human mistakes in cost estimation to ensure the actual project cost will not run beyond the estimation. Although BIM-based QTO owns the unique auto computation of calculation feature, the estimation process is yet to be fully automated because of its constraints which restrict the continuity of development. This research aims to discover the methods to overcome the constraints of BIM-based QTO with the adoption of the qualitative method via an exploratory case study in a residential project. In addition, the research is conducted to identify the factors affecting the quantities differences in manual QTO and BIM-based QTO through a taking-off process following Standard Method of Measurement Building Works Second Edition (SMM 2) and ascertains the constraints of BIM-based QTO from the taking-off process. The findings are expected to allow professional bodies to enhance the BIM-based QTO in Malaysian Construction Industry by developing practical guidelines and strategies to maintain their competencies in this essential and expanding digital era.

Keywords: *Building Information Modelling; BIM-based Quantity Take-off; Identify; Constraints; Methods*

INTRODUCTION

Over the past decade, digital technologies have disrupted the construction industry fundamentally and radically. The acceleration of processes and improvement of productivity contribute to the evolution and transformation of a rapidly changing industry environment. Presently, BIM is commonly adopted to facilitate the exchange and interoperability of information into digital format. As indicated by Pratoom and Tangwiboonpanich (2016), quantity take-off (QTO) is one of the most powerful functions of BIM. Hence, it shortens the time involved in quantification as compared to the conventional measurement method. It also eliminates the time-consuming issue of revising the Bill of Quantities (BOQ) to suit the design stages that occurred in the manual process (Kulasekara et al., 2013).

Generally, quantification is an error-prone process, but it is no longer a cumbersome task with the emerging of BIM-based QTO. As mentioned by Khosakitchalert et al. (2019), BIM-based QTO provided more reliable outcomes and reduced time spent on quantification through its speed of response and accuracy of measured quantities. This boosts the process of cost estimates to improve the accuracy and completeness of quantities because cost estimates are crucial to a project, especially during the early design stage due to approximately 70% to 80% of construction costs determined at that stage (Choi et al., 2015).

The widely use of BIM-based QTO acknowledged that it has caused seismic shifts to perform an accurate cost estimate in which a taker off an individual is benefited from its unique features. BIM-based QTO has changed the mind of construction practitioners through the change of ways in conducting QTO from paper to computer screen. Thus, BIM-based QTO is advantageous to the industry via the elimination of all those paperwork and efficient performance of cost estimation.

During these years, BIM-based QTO was popularly adopted in the industry. However, it is yet to be fully automated due to the substandard quality and inadequate information available in BIM models (Monteiro & Martins, 2013; Wu et al., 2014). It is argued that the output data of BIM models is non-conformity with the standard method of measurement (SMM) (Ogunsemi et al., 2010 as cited in Kulasekara et al., 2013). It was supported by the study of Lu et al. (2018) and Olatunji et al. (2010), in which SMM is the obstacle faced by Quantity Surveyors in the use of BIM.

Since BIM-based QTO is not fully automated, the estimators are required to consider the reliability of extracted quantities that are put in BOQ and overcome the gap issues with manual input (Ma et al., 2011). For instance, the coating surface on the wall and slab took directly on the elements' surface, resulting in overestimation due to the elements such as frames and skirting are not deducted (Monteiro & Martins, 2013). Therefore, those extra elements shall be manually deducted from the quantities.

In modelled-based estimating, constraints are always the concerns in the construction industry as the modelled based QTO with 100% accuracy is hard to achieve in real daily practices (Czmoch & Pekala, 2014), and the result of QTO may not be expected to be an accurate representation of the 3D model (Almeida Sampaio, 2016). There is numerous research conducted on the limitations of BIM-based QTO. Khosakitchalert et al. (2019) discussed the modelling issue causing the inaccuracy of extracted quantities for compound elements with multiple material layers, such as walls and floors. Monteiro and Martins (2013) studied the limitations in taking-off quantities such as excavation, reinforcement, formwork, and backfill that cannot be directly extracted from the BIM model. COBIM (2012) highlighted the modelling issues in space surfaces, roofs, stairs, and curtain walls.

Since there are many BIM-based QTO constraints identified based on the previous research, this paper aims to discover the methods to overcome the constraints of BIM-based QTO, associated with two objectives, notably to ascertain the constraints of BIM-based quantity take-off and to propose methods to enhance the BIM-based quantity take-off.

FACTORS AFFECTING QUANTITIES DIFFERENCES IN MANUAL QUANTITY TAKE-OFF AND BIM-BASED QUANTITY TAKE-OFF

Manual QTO and BIM-based QTO are the two types of QTO methods that are commonly applied in the construction industry for the preparation of BOQ and cost estimates. However, the output data from these methods are always not tally with each other.

Automative Feature of BIM-Based QTO

Ismail et al. (2015) studied that the information derived from BIM models is more presentable than the non-objective interpretation of traditional 2D drawings as it offers efficient and accurate cost predictions for construction projects by eliminating constraints commonly found in conventional methods. BIM-based QTO can reduce error-prone issues that frequently occur in manual QTO (Kottathara and Gunavel, 2017) as long working hours are required to perform the manual QTO (Zainon et al., 2016). For example, the quantities for sundries can be taken directly from the model instead of counting one by one in the 2D drawing. Therefore, the automatic feature of BIM-based QTO can eliminate the lengthy and tedious process of manual QTO, which then reduces human error efficiently (Zainon et al., 2016).

Non-Conformity with SMM in BIM-Based QTO

Ogunsemi et al. (2010 as cited in Kulasekara et al. 2013) pointed out that the output data of BIM models are not fully relevant to SMM, which then restricts the trustworthiness of Quantity Surveyor (QS) to the quantities extracted from models. It was supported by the study of Autodesk (2012), in which the requirements included in SMM are an obstacle in the process of extracting quantities from the model. Most BIM models are presented in object-based descriptions rather than following the activity-based estimation procedures stated in SMM (Olatunji et al., 2010), which is not user-friendly to transfer the quantities from models into BOQ. The model forms of elements are measured as a whole and not considered the measurement of sub-components of elements. Thus, it requires QS to alter the descriptions and quantities in BIM-based QTO to achieve accurate cost estimates based on the rules in SMM.

Substandard and Inadequate Information in BIM-Based QTO

As indicated by Jellings and Baldwin (2009 as cited in Wu et al., 2014), a properly configured model shall be fulfilled with adequate information to project the construction cost with a precise cost estimate or cost plan. Wu et al. (2014) mentioned that necessary information for cost estimation is hard for QS to collect from a substandard model due to the quality and information embedded in models usually do not conform to QS’s requirements. For instance, doors and windows are measured in sets rather than separated into components such as frame, glazing, ironmongery (Lin, 2013; Monteiro and Martins, 2013). The issue was proposed to be solved in different ways, which include defining and modelling the door and window's configurations manually, calculating with the data of the model on a spreadsheet, calculating manually and adding to the model with labels, classifying openings, and modelling them with a standard frame, however, those solutions may vary according to the complexity of the project (Monteiro and Martins, 2013).

CONSTRAINTS OF BIM-BASED QUANTITY TAKE-OFF

BIM has its flaws associated with several implementation constraints (Yan and Demian, 2019). As the most crucial feature that BIM put forward, BIM-based QTO eliminates and relieves human errors and time-consuming issues in QTO; however, there are many limitations restricting the taking-off process. Table 1 identifies the constraints that were collected from different journals.

Table 1. Constraints of BIM-Based QTO by Different Journals

Constraints \ Author	(Cerqueiro, 2014)	(Eastman, Teicholz, Sacks, & Liston, 2011)	(Golaszewska & Salamak, 2017)	(Khosakitchalert, Yabuki, & Fukuda, 2019)	(Kim & Park, 2016)	(Kula, Ilter, & Ergen, 2018)	(McCuen, 2015)	(Migilinskas, Popov, Juocevicius, & Ustinovichius, 2013)	(Monteiro & Martins, 2013)	(Olatunji; Sher; Gu, 2010)	(Olatunji; Sher; Ogunsemi, 2010)	(Porwal & Hewage, 2013)	Total
Automation constraints	x	x		x	x	x	x		x	x	x		9
Modelling constraints				x					x				2
Unfamiliarity with the bill of quantities constraints			x						x				2
Lack of standard and rules constraints								x	x			x	3

Automation Constraints

Although BIM-based QTO is advanced with its automatic feature, the automated quantities in BIM models are still a tricky issue from the QS sides as part of the quantities cannot be taken directly from models, which require efforts from QS in checking the dimensions in models and rely on the use of 2D drawings. The different methods of building up models will result in different quantities (Autodesk, 2012) and hinder the consistency of quantities due to the discrepancy of quantities (Kim et al., 2019). There are various journals that concluded that automatic QTO is the most important improvement offered by BIM (Cerqueiro, 2014), which means the authors agreed on the automation constraints that affect the development of BIM-based QTO. Typically, most BIM models are created by architects, and the models often lack sufficient properties, which give rise to confusion in the quantities extracted automatically (McChuen, 2015). Since BIM models only provide the theoretical quantities based on the attributes of models, the reliability of quantities will become inconsistent (Olatunji et al., 2010).

Modelling Constraints

Modelling issues are the concerns in BIM-based QTO. The modelling composition and incomplete detail of the elements in BIM models can affect the accuracy of quantities extracted from models and lead to deviations from the actual quantities (Monteiro and Martins, 2013). During the design stage, modellers may not include every detail of elements in models and create a model through inappropriate methods. This can give rise to the incompleteness and incorrectness of models and then lower the accuracy of quantities extracted from models (Khosakitchalert et al., 2019). In the study of Khosakitchalert et al. (2019), it has found that the compound elements are always overmeasured as they can be created overlapped between building elements.

Unfamiliarity with The Bill of Quantities Constraints

Golaszewska and Salamak (2017) indicated that the model elements should be described with appropriate descriptions to enable the other tools to interpret the information correctly. The absence of complete element descriptions in the model can lead to mistakes or inaccuracies in QTO and cost estimates. During the modelling process, BIM models can be prepared with descriptions easily in the base design software. However, when it comes to the interchange with other software, such as AutoCAD, the options downloaded or copied from other programmes are limited (Golaszewska and Salamak, 2017). Additionally, most BIM models only consist of fundamental dimensions and units of measure (Cajayon, 2018), which can delay the process of transferring quantities into BOQ.

Lack of Standard and Rules Constraints

Currently, the implementation of BIM-based QTO is still considered under usage due to the lack of global standard regulation for design measurements (Alshabab et al., 2020; Monteiro and Martins, 2013) and the absence of standard BIM contract documents (Porwal and Hewage, 2013) in the construction industry. The public sector organisations are hesitant to adopt BIM as it is impotent to use BIM on proprietary software or standards (Porwal and Hewage, 2013). Lack of information about the strict BIM implementation standards and rules for certain project participants, contract obligations, or unified documentation in certain regions (Migilinskas et al., 2013) restricts the flow of adoption of BIM in the construction industry. On this account, the need for standards with common language within the software packages is necessary to communicate with construction practitioners (Porwal and Hewage, 2013).

METHODS TO OVERCOME THE CONSTRAINTS OF BIM-BASED QUANTITY TAKE-OFF

Even BIM is powerful, but BIM is unable to overcome the issues of QTO comprehensively, and part of the extracted quantities from the BIM model may not be relevant to use. Thus, quantity specialists are still required to assess the validation of the source data and source materials with their expertise to ensure the coverage of the take-off, propose alternative solutions and analyse the results (COBIM, 2012).

BIM Guideline

Royal Institution of Chartered Surveyors (RICS) first published a BIM guideline, ‘BIM for cost managers; requirement from the BIM model’ for a source of reference for QS and cost managers to improve and enhance their knowledge on the influences from BIM on their work scopes and service delivery (RICS, 2015). It is advised for QS or cost managers to involve themselves in the preparation of the BIM Execution Plan (BEP), which is a live document that updates along the work stages during the pre-contract and post-contract stages to proceed with the activities in BIM smoothly (RICS, 2015). Since not all the quantities in the BIM model are automated quantities, some are derived quantities that need manual adjustment to the quantities generated (RICS, 2015). Additionally, even the design team followed exactly planned on the BEP. However, it still needs QS or cost managers to confirm the quantities via visual check on the model, which means they are still responsible for the data in the model (RICS, 2015).

Quantity Surveying BIM Attribute Requirements

Quantity Surveying BIM Attribute Requirements (QSBAR) was introduced by Singapore Institute of Surveyors and Valuers (SISV) (Cajayon, 2018). QSBAR shall be included in BEP to provide guidance for design consultants to work on BIM models that meet the requirement of QS through the explanation in the requirement of BIM in cost management and detailed Cost Breakdown Structure of the elemental attributes and geometry required within a BIM model according to SMM (Cajayon, 2018). Moreover, the level of development (LOD) was also included in QSBAR to increase the LOD of elements according to stages that include the schematic design, design development, and construction stage. LOD can be applied in BIM models to act as a booster to facilitate the communication within the team to obtain usable information from the characteristics of the model itself (BIM Forum, 2018). As stated by Kim et al. (2019, p.1), “the more detailed building information modelling (BIM) is, the more accurate are the quantities that can be extracted in BIM-based quantity take-off”. It clearly noticed that details of elements in BIM models are crucial to the accuracy of quantities.

Manual Rectification

The inconsistency in the quantities extracted from BIM models requires the inspection from QS to utilise their expertise to assess the information that is applicable for the estimating and procurement processes (Wu et al., 2014). The element that could not be modelled correctly can be overcome by employing alternative tools in the software. Khosakitchalert et al. (2019) found that the overlapping issue of the finishing layers of walls, beams, and columns can be solved through the Split Element or Join Geometry tool in Revit Software. Monteiro and Martins (2013) studied that the absence of formwork modelling tools in the software can be solved via alternative tools such as Wall, Beam, and Roof to create the vertical, horizontal, and sloping formwork respectively to assemble the formwork model in ArchiCAD software.

RESEARCH METHODOLOGY

Regarding the study goals being subjective in terms of understanding, experience, and view and calculation, the combination of qualitative method and quantitative method were adopted for this study. Qualitative research is emphasised with subjective experiences (Starman, 2013) To accomplish the goals of the study, the primary data was obtained through a case study of a residential project. The experiences of constraints and errors of developing the 3D model for quantities take-off are recorded as the research outcomes. It lowers the uncertainty issue that commonly occurs in the 3D modelling process and ensures the accuracy of the measurement.

On the other hand, the quantitative method, which aims to measure or calculate the raw data is adopted (McCusker & Gunaydin, 2015). The scope of the study is limited to the structural and architectural elements, which include column, beam, structural floor, structural wall, architectural floor, architectural wall, door, and window, as they are the main elements of a building. At the data gathering stage, the taking-off process based on the standard method of measurement on the building elements was conducted via Microsoft Excel and Autodesk Revit, to compare the quantities differences between the methods for the identification of the factors affecting the quantities differences in manual QTO and BIM-based QTO.

Through the comparison of both methods, the information related to the constraints of BIM-based QTO was ascertained. After that, the solutions to overcome the constraints of BIM-based QTO were achieved via the repetitive process, 'observe', 'think', 'test' and 'revise'. The data collected from the case study was analysed with the desk analysis method. New ideas and insights can be inspired through desk analysis with the production of alternatives to test and improve the literature review findings to broaden the field's understanding (Travis, 2020).

DISCUSSION AND FINDINGS

In this research, a residential project located at Selangor is selected in this research. The BIM model is modelled with Revit 2020 and take-off with Microsoft Excel to collect and analyse the data related to the research objectives. The manual QTO and BIM-based QTO are only conducted for the construction elements of a SOHO high-rise building with GFA of approximately 30,000 m^2. The general information of the project is stated in the Table 2.

Table 2. General Information of The Project

Building Components	Building Materials
Structure Type:	Reinforced concrete building
Column Material:	Reinforced concrete
Beam Material:	Reinforced concrete
Structural Floor (slab) Material:	Reinforced concrete
Architectural Floor (floor finish) Material:	Porcelain tiles, cement screed
Exterior Wall and Covering Material:	Cement and sand, plaster and paint
Interior Wall and Covering Material:	Cement and sand, plaster and paint
Exterior Door Material:	Fire rated
Interior Door Material:	Aluminium frame, timber, glass, fire-rated
Window Material:	Aluminium frame and glass

Comparison of Quantities in BIM and Manual

Table 3, Table 4, and Table 5 show the comparison between the outcome of the taking-off process conducted in Autodesk Revit and Microsoft Excel.

Table 3. Comparison of Quantities in Revit and Excel

Element	Autodesk Revit – Microsoft Excel	
	Concrete Volume (m^3)	Formwork Area (m^2)
Column	< 5.52%	Incomparable
Beam	> 5.04%	Incomparable
Slab	> 0.11m^3	> 7.10%
Lift Core Wall	> 1.05%	> 1.05%
Shear Wall	> 2.18%	< 0.01%
Parapet Wall	< 0.02%	< 0.01%

Table 4. Comparison of Quantities in Revit and Excel

Element	Autodesk Revit – Microsoft Excel
	Area (m^2)
External Wall	> 4.84%
Internal Wall	> 12.99%
Floor Finish	> 0.19m^2

Table 5. Comparison of Quantities in Revit and Excel

Element	Autodesk Revit – Microsoft Excel
	Number
Door	Tally
Window	Tally

According to the data collected, it was found that the automatic feature of Revit, non-conformity of SMM, and substandard information of BIM models are the main factors that cause quantities differences. The automatic feature of Revit can reduce the common quantification errors found in manual QTO. This finding is in line with the study by Kottathara and Gunavel (2017) and Zainon et al. (2016), who argued that the BIM-based QTO could reduce the high risk of human error that commonly occurred in manual QTO. However, the automatic feature can also lead to modelling issues as the connection of elements is inconsistent via the observation in the case study. Moreover, it was discovered that certain quantities of BIM models are non-conformity with SMM, which led to quantities differences. This finding corroborates the view of Ogunsemi et al. (2010 as cited in Kulasekara et al., 2013) that the output data of BIM models have lowered the reliability of QS to the extracted quantities. Furthermore, the lack of adequate information of elements has restricted the extraction of quantities for model end-users. For instance, the dimension of the area is not shown in the properties of column and beam, which cannot be taken as the formwork area of the element itself. This finding agrees with Wu et al. (2014) that the quality and information in models is always a concerning issue from QS in preparing cost estimates.

Constraints of BIM-Based QTO - Analysis

Generally, BIM-based QTO is recognised as an intelligent technology to measure element quantity in a shorter time as compared with the traditional manual QTO. However, the constraints of BIM-based QTO remain, which limit the utilisation of BIM-based QTO to take-off quantity. In this case study, Revit 2020 was applied to ascertain the constraints of BIM-based QTO with the information gathered through the case study of a SOHO high-rise building. The constraints are explained in detail in the following sections.

Automation Constraints

In BIM-based QTO, the quantities of elements are challenging to be extracted directly from the model as they are not categorised automatically according to their type in the respective family. Even the quantities can be obtained through the schedule of elements, but the process still involves time as there are several fields required to select manually. The number of doors can be extracted from the model and included in the schedule, but the quantities are not grouped together with its type, which troublesome the process of QTO and putting them into BOQ. Therefore, it is necessary to check the model and dimensions of elements manually to guarantee the accuracy of quantities.

Since the dimension of most of the elements in Revit only includes length, area, and volume, the quantities of finishing material are likely to be extracted from the dimension of area. The quantity of finishing material of the wall is taken from the area of the wall. In this condition, the extracted quantity will be inaccurate because it will over measure the intersection part of the wall with the architectural floor and the structural floor. Hence, the lack of sufficient properties in Revit leads to the inconsistency of quantities and discrepancy with actual quantities.

Due to the Revit model only contains fundamental dimensions, the formwork quantities are generally taken from the dimension of area in the element properties. However, in the condition where two elements intersect each other, the extracted quantities are over-measure due to the intersection area of elements not being deducted. The formwork quantities extracted directly from the area are considered an excessive measure because the intersection area of beam and slab are not deducted. Thus, the concept of formwork quantities that are taken from the area of elements is not applicable to the elements that intersect with each other.

Moreover, some of the elements are only counted in number instead of covering all components of elements. These elements include doors, windows, and staircases. For doors and windows, the accessories components such as lintel, frame, and glass panel are not covered in the quantities as the doors and windows are counted in a whole number. While for staircases, it was measured in number as well and did not include the number of treads and risers.

Modelling Constraints

The modelling issues arising from BIM-based QTO have lowered the reliability of the quantities extracted from the model. The automated joining function in Revit that is used to connect elements in the model has hindered the consistency of quantities which causes deviation from the actual quantities. The beams with the same dimension are placed under Slab A and overlapped with Slab B, respectively. The latter was over-measured in concrete volume. The beam should place under the slab instead of overlapped with the slab. Hence, the connection of elements must be checked manually to ensure the elements are correctly connected.

Besides, the sequence of modelling has led to modelling errors with the automatic connection in Revit. The external wall was modelled after the shear wall, and the outcome is the walls were connected correctly. However, the external wall was not connected correctly due to a small part of the wall being intersected with the shear wall. Thus, the connection of elements must check manually before extracting out the quantities.

Furthermore, since the model is modelled manually, it constitutes a high chance of human error in the process of modelling. The overlapping part of two different floor finishes was detected by the software, but it did not show that the part of overlapping and correct the error automatically. It requires redrawing the floor finishes to ensure they do not overlap with each other. Thus, it showed that BIM-based QTO is not fully automated in correcting errors.

Unfamiliarity with The Bill of Quantities Constraints

As discussed in the automation constraints, the output data of BIM-based QTO is not directly applicable to BOQ due to it only containing fundamental dimensions. The dimension of length, area, and volume cannot be taken for certain quantities of elements in BOQ. Since the absence of formwork quantities in Revit, the formwork area is typically taken from the dimension of area of elements. However, the extracted quantities are not suited with formwork quantities for certain elements. For example, the formwork of slab is categorised into formwork to the edges and formwork to the soffit of slabs with the unit of meter and meter square respectively, but the dimension of area is only applicable for formwork to the soffit of slab. Columns also encounter the problem of extracting formwork quantities as it only consists of the dimension of volume.

Generally, the architect modelled the BIM model instead of the quantity surveyor, which leads to the descriptions for elements that are not in compliance with SMM and cannot directly be applied in BOQ. The descriptions of windows do not fulfil the requirement of SMM, and the windows were counted one by one instead of totalled up according to their types. The diameter of glass and glazing were also not stated in the schedule, which struggled the end-user and needed to refer back to drawings. Besides, even the floor finish can be taken directly the dimension of area, but the quantity of skirting is not obtainable in the model due to the opening such as doors and windows was not deducted from the perimeter of the floor finish.

Lack of Standard and Rules Constraints

As mentioned in the literature review, there is a lack of global standard regulation for design measurements such that the rules of modelling models are in the "grey area". This has derived the issues such as the descriptions for elements are non-conformity with SMM, lack of dimension that applicable for other parts of elements and these have stated in the constraints stated previously. Additionally, several types of design measurement are available in the market, limiting the standards being used commonly due to the lack of common language between the packages. In common practice, the BIM model can import into QS software for the extraction of quantities. However, the model that imports may incur incorrect quantities when the object IDs are not unique for each object in the model.

Constraints of BIM-Based QTO – Discussion

In the case study, it was found that the quantities of elements modelled in Revit were unable to be extracted directly as the quantities were not grouped according to their types. This has hidden the accuracy of quantities as a manual assortment of the element types is required. In the study of Cerqueiro (2014), it has concluded that the automatic function in BIM-based QTO is the most improvement offered by BIM. It can be inferred that the automatic feature of the software is required for the development of the software and overcoming the issue with alternative solutions.

Besides, the surface treatment of elements was taken directly from the dimension of area of the elements due to the model only consisting of theoretical dimension, but it has constituted to over measure in the quantities. Olatunji et al. (2010) expressed that the theoretical quantities that are extracted based on the attributes of models have decreased the reliability of quantities. Additionally, the issue of over measure is indicated in the study of Monteiro and Martins (2013) and Kula et al. (2018), the excessive quantities are not deducted automatically in BIM models. As such, the quantities included in the element properties of the model could not be relied on completely to avoid discrepancy with the actual quantities.

Moreover, the quantity of formwork is also another concern. The problem has been faced while modelling the beam and slab, the formwork quantities of slab that extracted from the dimension of the area are considered over measure because the intersection area of slab and beam is not eliminated. It is consistent with the study of Monteiro and Martins (2013), it concluded that the concept of taking formwork quantities from the surface of elements could not be applied for the elements that are intersected, such as the intersection of beam and wall as it can cause over measure in the quantities. Thus, the formwork area is not recommended to be extracted directly from the surface area of elements that intersected each other.

Modelling Constraints

As mentioned in the literature review, modelling is one of the concerns in BIM-based QTO. In the modelling process in Revit, it has been noticed that the connections of elements in the BIM model are usually joined incorrectly. As per the study of Khosakitchalert et al. (2019), the overestimation is usually caused by the model that is not created by following the sequence and condition of the actual construction. In the case study, it was found that the connections of slabs and beams are inconsistent even though the slabs are modelled after the beams. This is because few slabs have joined at the interfaces incorrectly, but some of the connections of slabs and beams are correct. Hence, it shall be taking note of the connection of elements in the modelling process.

Moreover, the automatic joining feature in Revit has misconnected some of the elements in the model. Beam is one of the elements that involved this connection problem as a few beams were connected wrongly after using the alignment function in the software. This is mainly due to the incomplete details of elements in the model. Khosakitchalert et al. (2019) has shared the view that incompleteness and incorrectness of models will lower the accuracy of quantities extracted from models. Therefore, the automatic joining feature in the software cannot be fully relied on as different methods of building up models will result in different quantities (Autodesk, 2012).

Unfamiliarity with The Bill of Quantities Constraints

BOQ is considered a crucial part of the tender document as it will affect the activities afterwards. As such, a complete and accurate BOQ is required to be prepared by QS. In the case study, it was discovered that the issue of lack of detailed dimension in the BIM model causes the dimension of elements is inapplicable for extraction of quantities from QS. The slabs in the BIM model only consist of the dimension of area and volume, which led to the quantities of formwork to the edges that could not be extracted from the model. The columns also faced the issue of extraction of formwork from the model because the columns only consist of the dimension of volume, which can only be taken as the concrete volume. Cajayon (2018) expressed that the fundamental dimensions in BIM models have delayed the preparation of BOQ. Therefore, the quantities in the model shall be checked before transferring the quantities to BOQ.

Besides, the insufficient properties of elements in the model can give rise to confusion while extracting quantities from the model. In the case study, it was perceived that the description and unit of measure of elements are non-conformity with SMM. The description of windows was incomplete in the model as it only included the types and sizes of windows. In the view of Golaszewska and Salamak (2017), the model elements have to be described with appropriate descriptions to enable the other tools to interpret the information correctly. Thus, the description shall be inserted with the information that is required in SMM to avoid misunderstanding of end-users of the model towards the information.

Furthermore, the windows were measured in number in the model, and details of components were also not provided. The skirting of the floor finish is also not extractable from the dimension of the floor finish. These conditions accordant with the study of Olatunji et al. (2010), the reliability of quantities will become inconsistent as BIM models only provide theoretical quantities based on the attributes of models.

Lack of Standard and Rules Constraints

In the case study, it was realised that the absence of a standard regulation for design measurement could lead to issues in the outcome of the model. It is consistent with the statement of Alshabab et al. (2020) and Monteiro and Martins (2013) in the low implementation rate of BIM-based QTO. Additionally, the information in the BIM model may face the chance of losing data when opening the model with another software due to the lack of common language between the software available in the market. Porwal and Hewage (2013) provided that the common language between software is crucial to facilitate communication between project team members. Therefore, the information of the model shall be checked when inserting the model in another software.

Solutions to Overcome the Constraints of BIM-Based QTO

Table 6. Solutions to Overcome the Constraints of BIM-Based QTO

Constraints		Solutions
Automation Constraints	Element types are not categorised in schedule	Assort via formula set in spreadsheet
	Over measure in finishing area at the intersection part of material	Manual deduction via spreadsheet
	Over measure in formwork at the intersection part of elements	Manual deduction via spreadsheet
	Lack of components of few elements	Manual measurement via spreadsheet
Modelling Constraints	Incorrect connection of elements	Manual checking, use split element tool to remove unwanted parts
	Not automated to correct errors	Manual checking
Unfamiliarity with the bill of quantities constraints	Absence of dimension for formwork of elements	Manual measurement via spreadsheet
	Absence of components for elements	Manual measurement via spreadsheet
	Dimension is incomplete	Manual adjustment via spreadsheet
Lack of standard and rules constraints	Lack of complete description and dimension	BIM execution plan, QSBAR
	Absence of common language between the packages	BIM execution plan, QSBAR

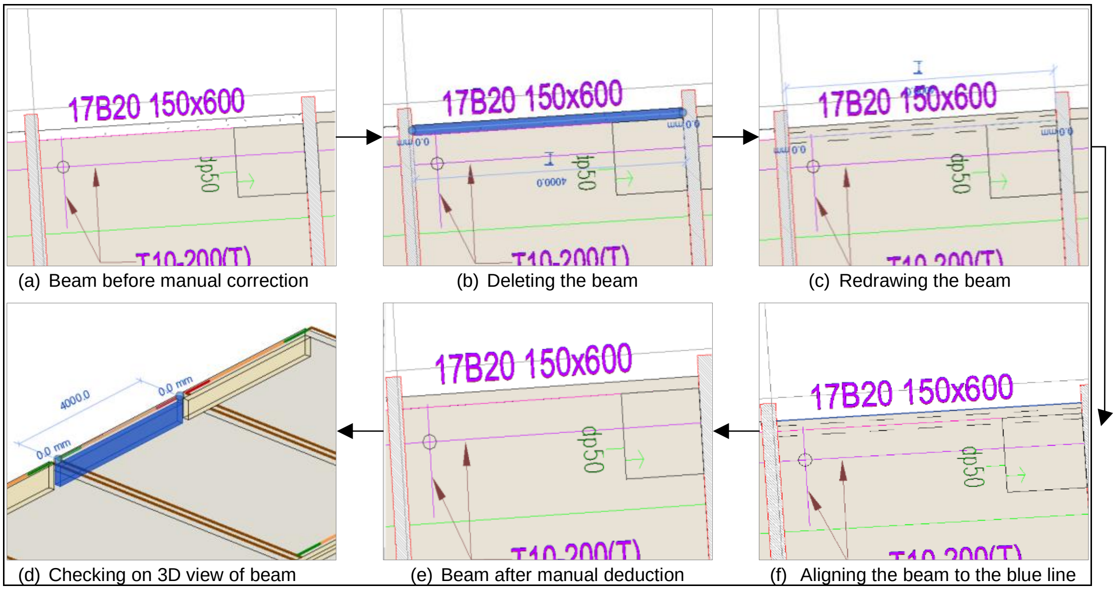
The solutions to overcome the constraints of BIM-based QTO were proposed in this study. By referring to the information gathered in the literature review, the findings were analysed with the desk analysis to improve the methods. Table 6 includes the solutions to overcome the constraints of BIM-based QTO.

As mentioned in the table, the issues related to automation constraints can be overcome with the use of spreadsheets. The non-categorisation of element types can be solved with the formulas set in the spreadsheet to provide clear and precise quantities of each element type, and it is easier transferred to BOQ. The over measure at the intersection part elements can be amended with manual deduction via the spreadsheet. The lack of components for certain elements in the BIM model can also be calculated manually through the spreadsheet. Thus, all the quantification issues that could not be solved in BIM models (Wu et al., 2014) require manual rectification to be conducted on inconsistent quantities.

Besides, the modelling constraints of the BIM model can be solved via manual checking in the model. The connection of elements should be checked manually to ensure the elements are joined with a correct connection. As mentioned by Khosakitchalert et al. (2019), the split element tool is an alternative tool to overcome the overlapping issues. In the case study, it was found that the split element tool can be used to amend the connection of elements. Although Revit is featured with the automatic clash detection for overlapping, it does not correct the error automatically. Hence, manual checking is required to correct the error manually in the software.

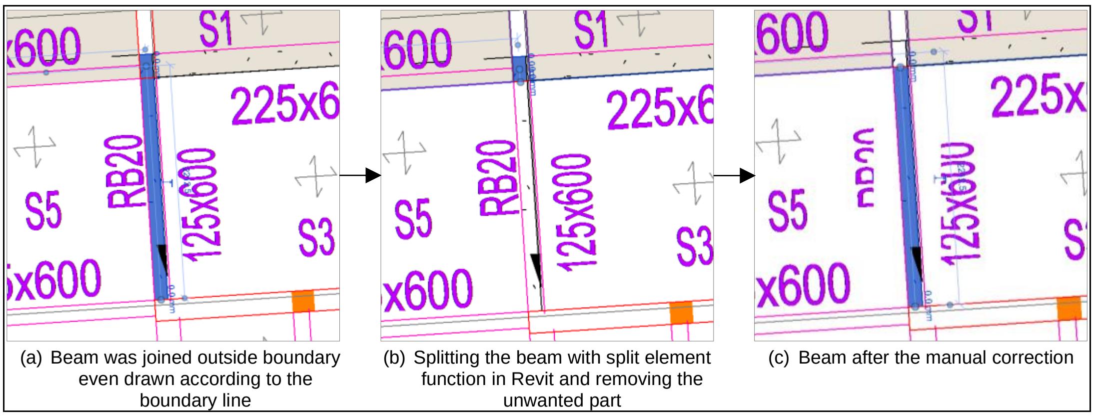
Moreover, the data of elements in the BIM model are non-conformity to SMM, which led the quantities cannot be applied directly in BOQ. Generally, the formwork area is not extractable from the model as most of the structural elements are only consisting of volume dimension, and the absence of components is also common in the model. These problems can be eased via manual measurement in spreadsheets. It was also found that the formwork is easier and faster to be measured in spreadsheets instead of creating formwork models with the alternative tools in the software. As such, the issue of the unavailability of formwork quantities in BIM models can be overcome by using spreadsheets. Additionally, manual adjustment can be conducted to correct the errors in the BIM model with the use of alternative tools in the software. Figure 1 and Figure 2 demonstrate the process of correction for the incorrect connection via the split element tool and manual checking.

Furthermore, the description and dimension in the BIM model do not fulfil the standard of QS. The QSBAR can be the reference for inserting additional information in the model. The LOD can also be provided for QS to determine elements that may need to be measured manually. Additionally, the BIM execution plan provides constant updates for team members to carry out work smoothly. The design team and QS can adjust accordingly once they notice the errors. Apart from the BEP, visual checking on the model is also a good practice to confirm the reliability of quantities. Thus, the modellers can refer to this guidance while creating models. Lastly, the BIM execution plan (BEP) and queries regarding the model in the BIM guideline published by RICS can act as a reference to provide information for non-technical end-users of the model, which mitigate the issues of lack of standards and rules.



(a) Beam before manual correction (b) Deleting the beam (c) Redrawing the beam
(d) Checking on 3D view of beam (e) Beam after manual deduction (f) Aligning the beam to the blue line

Figure 1. Correction on Incorrect Connection



(a) Beam was joined outside boundary even drawn according to the boundary line (b) Splitting the beam with split element function in Revit and removing the unwanted part (c) Beam after the manual correction

Figure 2. Correction on Incorrect Connection

CONCLUSION AND RECOMMENDATION

BIM-based QTO has changed the measurement from drawings into 3D visualisation. Through the full application of BIM-based QTO in QS firms, a computer is only the tool for QS to take-off elements rather than using a calculator, highlighters to measure the quantities on a table that is full of hard copy drawings. However, BIM-based QTO is not commonly adopted in QS firms due to its constraints in measuring element quantities. As such, this research was conducted to ascertain the constraints of BIM-based QTO through the comparison of element quantities measured in manual QTO and BIM-based QTO. Several methods were proposed to overcome the constraints that were found in the case study. Hence, the construction practitioners should consider the constraints of BIM-based QTO, especially for QS, in taking quantities directly from BIM models. The software developer shall also be aware of the constraints to modify the software for excessive use by construction professionals.

The findings of this research have increased the understanding of the issues of BIM-based QTO for QS in extracting element quantities from BIM models. Future studies related to this field can cover all the elements to come out with comprehensive data. It is also suggested that to have the model that architects created as the input of the study in that BIM models are usually drawn by architects in the actual practice. Therefore, the result of the study will be more precise as compared to the model created by non-technical users.

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IDENTIFICATION OF ECO-INNOVATION (EI) COMPONENTS WITHIN CONTRACTOR'S SCOPE OF WORK

Aimi Shahirah Fisol and Nazirah Zainul Abidin
School of Housing, Building and Planning, Universiti Sains Malaysia, 11800, Pulau Pinang, Malaysia

Abstract
Eco-innovation (EI) pushes innovation for the benefit of the environment without compromising the need to perform better. EI has been well established in the manufacturing industry in which it blends innovative solutions to produce environmental-friendly products and processes. The construction industry is beginning to appreciate this concept by integrating it at both firm and project levels, although most studies are focused more on firm-level application. However, the impact of on-site practices on the environment calls for further attention to EI adoption at the project level. The contractor's role as a "middleman" between clients, consultants, suppliers, and subcontractors validates the importance of EI practices being embedded within the contractor's scope of works. This conceptual paper aims to recognise the component of EI at construction project within contractor's scope of work by reviewing current literatures. It was suggested that generally, product EI, process EI and management EI are the primary principal of EI. Within these three main components, the sub-components are sustainable product procurement, sustainable product management, implementation of environmental-friendly technology, sustainable site operation, implementation of sustainable project policy, project collaboration and networking as well as sustainable management of human resources. Understanding these EI components will aid contractors to comprehensively adopt EI practices within the scope of their works and support better quality and performance of the construction sector towards a more sustainable future which contributed to better economic and environmental value.

Keywords: *Eco-innovation; eco-innovation components; construction project; contractor; environmental sustainability*

INTRODUCTION

Environmental degradation has been widely addressed as a global issue (Cheng & Shiu, 2012), while construction operation has been identified as one of the contributor to this issue (Saadi, Ismail & Alias, 2016). The application of conventional methods in construction activities are generating pollution in the form of noise, air, solid waste and water pollution (Abidin, Yusof, & Afandi, 2015). According to the International Energy Agency (IEA, 2021), buildings and construction sectors accounted for more than one-third of global final energy consumption and nearly 40% of total direct and indirect CO^2 emissions. Thus, it is evident that present practices need to change towards reducing environmental degradation without suppressing the need to continue development. Innovation has been dubbed as a way forward away from the confine of conventional method.

Innovation is a word derived from Latin word, "innovare", which means "to make something new" (Salah & Rahim, 2019). Damanpour (1992) defined innovation as "the adoption of an idea or behaviour, whether a system, policy, program, device, process, product or service, that is new to the adopting organisation. Organisation for Economic Co-operation and Development, (OECD, 1997) stated that innovation is not just merely the degree of technological improvement but rather the exploitation of an ideas that are new to a particular enterprise, and with these processes, the result of innovation will emerge. In construction industry specifically, Slaughter (1998) defined innovation as the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution. From the definitions of innovation provided by the scholars, it is apparent that innovation in construction industry is regard as the implementation of improvement in terms of utilising idea that is new to the organisation to enhance the process, product, and organisational system in conducting the construction processes.

According to Stenberg (2016), innovation aids to solve future problem that may happened by integrating the present accomplishments with past experiences, thus, reducing possible mistakes that may impact the time, cost, and quality of the construction project. Furthermore, innovation aids construction practitioners in lowering their costs, achieving faster completion times and developing their brand in construction products (Yusof & Shafiei, 2011). However, the surge of construction projects during this highly competitive climate has led to various environmental problem such as soil erosion and deforestation, flash flood, sedimentation, consume high amount of energy, generation of solid waste, increase in greenhouse gas (GHG) emission and resource depletion (Afandi, 2015; Bahaudin, Elias, Nawi, Zainuddin, & Nadarajan, 2017; Sfakianaki, 2015). These situations had increase public's concern. The good news is that innovation is seen as a way to promote the environmental protection. Isa & Abidin (2021) highlighted that eco-innovation (EI) is a concept that integrates eco-consciousness within innovation development, thus, the implementation of EI concept within construction industry has the potential to minimise the environmental impact cause by this sector.

Conventional construction practice is going nowhere, unless it embraces innovation (Kamal, Yusof & Iranmanesh, 2016). As the "frontline" for the practical realisation of the construction project (Powmya, Abidin & Azizi, 2017), contractor is responsible in prioritising the environmental aspect for the project. Advanced techniques are required throughout the construction process to move towards sustainable construction (Zhang, Shen & Wu, 2011). Thus, it is necessary for the contractor to have the competency in fulfilling the requirement for the sustainable construction project progress (Hasan & Zhang, 2016) particularly for large contractor companies as Ajibike et al. (2020) stated, these type of companies are more capable of adopting sustainability element due to their size and resource adequacy. Using literature review, this paper identifies the components of EI at construction project within contractor's scope of work as to ensure the practices are being implemented effectively.

UNDERSTANDING ECO-INNOVATION

Researchers have used the phrases "eco-innovation," "sustainable innovation," and "green innovation" interchangeably, with "eco-innovation" being the most commonly used term among the three (Pansera, 2016). According to Keshminder & Chandran (2017), there is no universally standard definition of EI. Kemp & Pearson (2007) defined EI as "the production, assimilation or exploitation of a product, production process, service or management or business method that is novel to the organisation (developing or adopting it) and which results, throughout its life cycle, in a reduction of environmental risk, pollution and other negative impacts of resources use compared to relevant alternatives". Another definition of EI from Eco-Innovation Observatory (EIO, 2010) stated EI as "the introduction of any new or significantly improved product, process, organisational change or marketing solution that reduces the use of natural resources and decrease the release of harmful substances across the whole life-cycle". Inherent in both definitions are the improvement or change expected from the normal practices with the environmental reduction intention. The definition of EI in this study is adopted from Isa & Abidin (2021) that defined EI as an innovation that is introduced to firms or projects in the form of new or improved versions of products, services or processes, or organisational management practices which produces better or more efficient services that contributes to environmental improvement.

EI is originally dominated by manufacturing industry such as chemical manufacturing, green technology manufacturing, automotive manufacturing, and steel manufacturing industry. Recently, the EI concept has been diffused and adapted into service-based industry such as construction sector. Due to the difference in work scope between the manufacturing and construction industries, EI components used in the manufacturing industry may be considered as unsuitable for the application in the construction setting (Isa & Abidin, 2021). Hence, it is necessary to recognise the components of EI within construction sector.

For Malaysian construction industry, despite rapid advancement, the majority of construction projects still continue to use traditional methods which are no longer suitable (Isa, Zainul Abidin & Yahaya, 2019). Most of EI in Malaysia have been discussed in the chemical, automotive, and green technology sectors (Klemm & Almeida, 2018; Rashid, Jabar, Yahya & Shami, 2015; Singh, 2017) where the study on construction industry is barely limited (Isa et al., 2019). Successful EI implementation in construction will contribute to reduce the project duration and cost by simplifying the construction work, improving quality, efficiency, productivity, competitiveness and bring positive influence towards the environment (Fang, 2015). Thus, there are various efforts that have been made to encourage the industry to move towards sustainable construction. According to Abidin, Yusof, & Othman (2013), the government had lead the way of the effort including the launched of Construction Industry Transformation Programme (CITP) (2016 – 2020) and Green Technology Master Plan (GTMP) which highlighted the commitment of the government to shift the Malaysia’s construction industry towards greener condition.

EI in construction industry has been focusing at the firm level by the scholars such as Isa & Abidin (2021) and Ma, Wang, Skibniewski & Gajda (2019). Less study had emphasised on the implementation of EI at the project level, whereas, according to Hazarika & Zhang (2019), the guidelines and procedures for EI approach should be inclusive of both firm and project levels. In addition, although all construction project players should work together to achieve sustainability in this sector, Powmya, Abidin & Azizi (2017) mentioned that contractor is in the position which act as the “hand” that turns the design into the actual structure. Thus, being at the “strategic” position that link between client, consultants, sub-contractors, and suppliers during the project progress makes it crucial for the contractor to recognise the EI components that are within their scope of work. The contractor’s scope of work covered the aspects such as project planning, project management, project monitoring, ensuring for health and safety of the workers, complying with the legal and regulatory matter including the environmental requirements. Therefore, it aids to steer the construction project operation towards more sustainable practices and raise potential to spearhead EI at construction projects.

METHODOLOGY

This article is exploratory in nature and a wide range of materials including journal articles, conference papers and internet resources has been included into this conceptual paper. The referenced sources were discovered using searchers of electronic databases available through the author's university library system. According to Furner (2004), conceptual analytical approach is applied to comprehend the nature, scope and function of a particular issue addressed. This conceptual analysis is used to grasp better understanding of EI components at construction project. Considering the method mentioned, this study investigates the components of EI at construction project level within contractor's scope of work.

COMPONENTS OF EI AT CONSTRUCTION PROJECT WITHIN CONTRACTOR'S SCOPE OF WORK

Contractors play dominant role at construction projects. This is because, at project level, contractor's scope of work includes various aspects from completing the project within the stipulated time, cost and budget including adhering to the expected project quality from the client. Contractors also have to liaise and work with many parties while responding to the challenges imposed by the governmental regulations and pressures (Powmya, Abidin, & Azizi, 2019; Qi, Shen, Zeng & Jorge, 2010). To meet these expectations, the contractor would have to master the construction process, apply new technologies, procure materials, manage the site including the human resources at the construction project. Generally, contractors' responsibility is extended towards protecting the site and its environment as they are the site "operator". To move towards sustainable construction practices, the element of innovation is needed as to strategize the EI implementation in the construction industry.

EI practices should be assimilated with the contractor's scope of work as they are responsible for delivering successful completion of a construction project (Isa et al., 2019). However, since EI is a new concept in the construction industry, challenges are expected to arise before EI can reach a level of success. As highlighted by Pacheco, Caten, Jung, Navas & Cruz-Machado (2018), among the barrier to EI are lack of awareness, unwilling to invest, having reactive attitude instead of proactive attitude from industry players, and the culture to achieve quick results and a short term vision of management. Cost is the common barrier for EI adoption (Hasan & Zhang, 2016). The resistance to innovate will impede the industry from moving forward. Nevertheless, innovation is required to jolt sluggish sectors out of ruts of low productivity (Kumaraswamy, Love, Dulaimi & Rahman, 2004).

EI is critical for the contractor's competitive advantage (Xue, Zhang, Yang & Dai, 2014). By becoming an early mover of EI, it can make organisational images more impressive, improve future decisions and increase client's satisfaction (Bamgbade, Kamaruddeen & Nawi, 2017). Moreover, as any other innovation, EI contribute to the general objectives of the organisation including cost reduction and increase in revenue (Del Río, Peñasco & Romero-Jordán, 2016). From the aspect of innovation in construction industry, most of the construction innovation is co-developed at the project level (Xue et al., 2014), hence, contractors need to realise the components of EI at construction projects within their job scopes as they are the party that have the control over the sustainable practices during construction project.

Within contractor's scope of work, there are 3 main components of EI that contribute to the sustainability of the construction project: product EI, process EI and management EI. Table 1 lists the main and sub-components derived from the literature review.

Table 1. Components of EI at Construction Project within Contractor's Scope of Work

EI Components	EI Sub-Components	Sources
Product EI	Sustainable product procurement	(González & García Navarro, 2006; Isa & Abidin, 2021; Kalfa & Kalogirou, 2017; Muerza & Guerlain, 2021; Razali, Khalil, Mohamad Bohari, & Husin, 2021)
	Sustainable product management	(Gambatese & Hallowell, 2011; Isa & Abidin, 2021; Liyin, Hong, & Griffith, 2006; Sieffert, Huygen, & Daudon, 2014)
Process EI	Implementation of environmental-friendly technology	(Isa & Abidin, 2021; Powmya et al., 2017)
	Sustainable site operation	(Glavinich, 2008; Li, Chen, Chew, & Teo, 2014; Wang, Yuan, Kang, & Lu, 2010)
Management EI	Implementation of sustainable project policy	(García-Granero, Piedra-Munoz, & Galdeano-Gomez, 2018; KeTTHA, 2017; Powmya et al., 2017)
	Project collaboration and networking	(Segarra-Oña, Peiró-Signes, & Cervelló-Royo, 2015; Xue et al., 2014)
	Sustainable management of human resources	(Bossink, 2007; Chang, Soebarto, Zhao, & Zillante, 2016; Cheng, Yang, & Sheu, 2014; Darko, Chan, Ameyaw, He, & Olanipekun, 2017; Glavinich, 2008)

Product EI

Product EI refers to the implementation of new or significantly improved products in regards to the products' characteristics, technical components and material use (Carrillo-Hermosilla, Del Río & Könnölä, 2010; Cheng & Shiu, 2012). In this research context, product EI at construction project refers to the adoption, implementation, and management of the new or improved construction product with the consideration of the product's technical aspects which reduces the environmental impact. Within product EI, there are two sub-components of EI that has been recognised within contractor's scope of work which are sustainable product procurement and sustainable product management.

Sustainable Product Procurement

The general sustainable procurement concept is described as the purchase of goods, services and related works with the consideration on protecting the environment and natural resources while at the same time, minimising and mitigating the negative effects of human activities (Razali et al., 2021). In this study's context, the sustainable product procurement refers to the act of contractor in selecting and procuring the construction product for the project with the consideration of the content and technical components including the logistical aspect with minimal impacts towards the environment. Among the example of the products are pollution absorbing concrete, bamboo reinforced concrete, bio-receptive concrete, low-emitting adhesives, sustainable sealants and urea-free formaldehyde composite wood (Bamigboye et al., 2019; Glavinich, 2008).

It is important for the contractor to procure the correct construction products because as according to Kaliba, Muya & Mumba (2009), issues with material procurement is among the factor that can lead to project delays and cost overruns. In ensuring the sustainability of the construction project, the aspect of procuring the right construction product and materials should be emphasised. Furthermore, the selection of environmental friendly construction products and materials can reduce the rate of emissions by up to 30% throughout the construction process (González & García Navarro, 2006). This is because these sustainable products and materials are less resource intensive, more-energy efficient, and own higher recyclable property within their content (García-Granero, Piedra-Munoz & Galdeano-Gomez, 2018). These construction products can be categorised into a few classifications such as recycled or remanufactured products from construction waste stream (European Commission (EU), 2016) and the improved products in terms of their content and technical components that are less hazardous. However, there are much more unsustainable construction product in the market and according to Bahaudin et al. (2017), awareness of the sustainable aspect in Malaysian construction players is still lacking. Thus, as the source of guidance for the selection for these sustainable product and materials at project level, Isa & Abidin (2021) stated that the contractor can recommend to client and consultant on the usage of sustainable products from MyHijau Directory and Green Pages Malaysia. It is important for the contractor to procure the construction product based on the correct resources and to have a proper system for the products procurement aspect as to ensure the efficiency of the construction project progress.

The "green" aspect within sustainable product procurement is not limited to the consideration of product's characteristics only, but according to Muerza & Guerlain (2021), it also covered the element of the transportation and movement of the products and materials to the project location. The products and materials used for a sustainable project need to be procured locally and within the radius of 800 km from the site location (Kalfa & Kalogirou, 2017). This action will reduce the usage of fuel in transporting the material to the site which indirectly decrease the greenhouse gas (GHG) emission and air pollution to the environment (Waris, Liew, Khamidi & Idrus, 2014). Thus, contractor may recommend these improvised type of construction products and materials to the client and consultant with the consideration on the transportation aspect for a sustainable construction project.

Sustainable Product Management

Apart from the sustainable product procurement, another sub-component for this product EI within contractor's scope of work also covers the aspect of sustainable product management. In the context of this study, the term sustainable product management refers to the methods and procedures that the contractor applies to handle and store the construction product to reduce unnecessary waste, decrease pollution and avoid the risk of health problem surrounding the project's area.

The sustainable product management concern on the aspect of handling, storing, and controlling of the construction product and material. These include~~s~~ practicing the improved and proper guidelines on the product handling and storing (Isa & Abidin, 2021) as according to Gambatese & Hallowell (2011), product's handling guidelines will lessen the pollution and unexpected waste on-site. Some of the construction products consist of higher chemical content. Thus, Liyin et al. (2006) stated that proper instruction and specification to transport and store this type of product is needed. Without the proper guidelines for the construction products' storing and handling, the dust, particles and pollutants emitted during the project progress can lead to health problems of the people surrounding (Yu, Lu & San, 2014) and according to Kowalik et al. (2019), a research had confirmed that the chemical content from the construction product such as formaldehyde, can cause cancer in human. Therefore, the existing guidelines should be improved as to prevent from these negative effects.

Other than the proper guideline, the use of new technology for product management such as phone, laptop, or other appropriate technologies including Radio Frequency Identification (RFID), Global Positioning System (GPS) and Geographical Information System (GIS) are among the tracking technologies that available to assist the contractor in handling the construction products and materials, as well as to detect the positioning and arrangement of the construction materials (Donyavi & Flanagan, 2009). Construction with environmental improvement is frequently associated with high costs due to the need to invest in newer technologies (Hwang & Tan, 2012), however, for project related industry which is temporary and only lasts for specific duration, the contractor may only need to invest for the technology once, and the technology can be deploy to the next project. By implementing this new and improved technologies for the sustainable product management at construction project, it will aid to reduce the possibility of material loss (Sieffert et al., 2014) which will avoid from additional cost, minimise the probability of chemical pollution (Kowalik et al., 2019), decrease the material handling duration (Yu et al., 2014), including improve the environmental condition for the workers and public surrounding the construction area. This investment will bring cost efficiency for the project including ease the contractor's work.

Process EI

Process EI is defined as changes in the organisational operation, processes, and systems, that produce new or significantly improved "eco-products" and reduces environmental impacts (Negny, Belaud, Cortes Robles, Roldan Reyes & Ferrer, 2012). In this study, the "eco-products" in the stated definition refers to the building structure that are constructed. This study adopted the definition from Isa & Abidin (2021) that defined process EI at construction project as the improvement of existing construction processes or implementation of new technique or technology that fully or partially change the way buildings are being constructed with minimum adverse impacts on the environment. Within this process EI, there are two sub-components that have been identified such as application of environmental-friendly technology and implementation of sustainable site operation. These sub-components are discussed further in the next paragraph.

Implementation of Environmental-Friendly Technology

According to Iravani, Akbari & Zohoori (2017), environmental friendly technology refers to the improvement and application of equipment, systems and products to save the natural environment and resources which minimise the negative effect of human activities. The environmental-friendly technology in this study refers to the usage of latest technologies that increase the efficiency of the contractor's work and decrease the environmental impact from the project progress. Within this environmental-friendly technology, there are two elements that have been emphasised such as the implementation of new construction technologies and utilisation of databases for the project's documentation.

The implementation of new construction technologies refers to the technical utilisation of computer-aided or sustainable tools, plants, machineries, or systems by the contractor when delivering the project. Nowadays, diverse technologies have been developed such as the Industrialised Building System (IBS), Building Information Modelling (BIM), 3D printing, drones, rainwater-harvesting, solar panel and others. These latest technologies focus on enhancing cleaner construction practices, reduces solid waste, liquid waste, environmental pollution, including decreasing labour cost and increasing the efficiency of the project progress (Delgado Camacho et al., 2018; Fikri Hasmori et al., 2020). Focusing on BIM as an example, it acts as the resource of shared knowledge and information including a reliable basis for decisions making for the building's life-cycle. At construction project level, BIM aids to increase the project efficiency and reduce the possibility of defect that may happened. Hence, contractor will be able to gain the benefit of all the positive impacts mentioned by applying these new construction technologies in the project. Furthermore, Khoso, Md Yusof, Chai & Laghari (2021) stated that application of advanced technology will enhance the industry's competition in the global market. Therefore, aside from gaining project's efficiency and sustainability, contractor will also gain positive image from their new technological construction implementation.

Besides, the utilisation of server and database also play major roles for construction project. This practice refers to the process of digitization of document keeping throughout the project progress. It is essential to record the important documents for the progress of the project as according to Boh (2007), data codification can be useful for storing a huge amount of information and create an organisational memory for employees. It also helps in achieving effective communication. This application of technology will enhance the quality of the service offered to the stakeholders (Powmya et al., 2017) and eventually improve the communication to meet the client's and consultants' needs more effectively (Kale & Arditi, 2002). Besides, since the construction project involve with multidisciplinary profession from different team, Isa & Abidin (2021) stated that it is important for the contractor to utilise the system of centralized database for green technology and knowledge as a source of information for multidisciplinary team. In the case of any discrepancies arise, the data recorded in this system will help to expedite in solving the issue as the document are being stored and can be reached from the database. Hence, time spend on the problem could be lessen and increase the project's efficiency.

Sustainable Site Operation

Other than the aspect of new technology discussed above, another sub-component within process EI is the sustainable site operation. This sustainable site operation concern on the aspects of waste management as well as pollution control. According to Solid Waste and Public Cleansing Management Corporation of Malaysia, approximately eight million tonnes of construction wastes generated per year from construction project (Saadi et al., 2016). Thus, innovative action should be taken by the contractor regarding this issue.

Proper management of construction site is crucial to ensure for successful completion of projects (Yu et al., 2014). At project, the aspect of waste management is incorporated as one of contractors' responsibility. To innovate in this aspect, Wang, Li & Tam (2015) mentioned that the construction waste management procedure and pollution prevention practices involve the application of reducing, reusing, and recycling as well as sorting of the construction waste created at the project. These practices are viable to minimise the amount of waste to be sent to landfills (Rodríguez, Alegre & Martínez, 2011) and prevent the depletion of mineral resources (Blum & Stutzriemer, 2007). Li et al. (2014) mentioned that the reused materials needed to be incorporated into the project progress. With this improved waste management as a part of EI practices, it aids in reducing materials consumption, carbon footprint and prevent pollution from the new materials production processes (Miao, Fang, Sun & Luo, 2017). Moreover, it has been reported that consumers are now opting for high-quality housing that supports local ecosystems, uses sustainable energy, and is constructed from recyclable materials (Heffernan, Pan, Liang & de Wilde, 2015). Thus, it is an advantage for the contractor that practice this EI as it can further enhance their organisational image.

Management EI

Management EI refers to the creation or adoption of new management approaches with the goals of decreasing negative environmental consequences while improving working condition and workers' wellbeing (Roscoe, Cousins & Lamming, 2016). Within the context of construction project, this study adopted the operational definition of management EI from Bamgbade et al. (2017) that defined management EI as facilitating and re-organising the construction project progress such as activities, routines, procedures, structures, policies, managements, or systems to comply with the environmental requirements. There are three sub-components that contribute to this management EI, which are implementation of sustainable project policies, project collaboration and networking, and sustainable management of human resources.

Implementation of Sustainable Project Policy

Implementation of sustainable policy is defined as the adoption of business' commitment and strategy towards the area of sustainability. Within the context of this study, there are two elements that contribute towards this sustainable project policy which are compliance to voluntary green rating tools and implementation of Environmental Management System (EMS) in the contractor's project operation. To this date, there are various voluntary rating tools that have been developed in promoting green construction project practices. In Malaysia specifically, the common green rating tools are Green Building Index (GBI), Malaysian Carbon Reduction and Environmental Sustainability Tool (MyCREST), Penarafan Hijau (pH) and Green Real Estate (GreenRE) (KeTTHA, 2017). The commitment for EMS is being portrayed through the implementation of ISO 14001 in the contractor's project operation (García-Granero et al., 2018). These policies act as the guidelines and establish direction for the other components of EI to be practiced at construction project by the contractor. Zhang, Wu & Shen (2015) reported that the commitment to these environmental aspects will enhance the company's image and attract more customers. Therefore, the implementation of this sustainable policy into contractor's project practices is an innovation for contractor's operation as it will not only avoid from the regulatory compound from the authority due to negligence, but it will also improve the contractor's competitive advantage in the industry.

Project Collaboration and Networking

Another element within management EI is project collaboration and networking. This project collaboration and networking is referred to as the cooperation among project team players such as contractor's collaboration with sustainable-oriented client or suppliers to enhance eco-innovative capability. According to Segarra-Oña et al. (2015), the healthy relationship between contractor with the suppliers, clients and competitors, known as "market information sources", has been proven where it was reported by Freeman (1994) that this situation enrich the win-win approach among contractor and the other parties. Xue et al. (2014) stated that the establishment of such networking provide contractor with resources, opportunity to new knowledge and information on potential networks in the industry as according to Fadhilah & Ramayah (2012), the way organisation engages with external stakeholders influence its environmental initiatives. Through this "market information sources", the contractor will be able to gain knowledge and adopt the latest EI practices that they learn from the other green experts in the construction industry.

Sustainable Management of Human Resources

Human resource management is defined as a strategic, integrated and coherent approach to the employment, development and well-being of the people working in the organisation (Armstrong, 2014). From the context of this study, sustainable management of human resource referred as the strategic approach in developing eco-innovative culture within the contractor's organisation. Successful EI requires effective cooperation and working relations among different stakeholders within a specific project (Miroshnychenko, Barontini & Testa, 2017). Lack of training and education (Gan, Zuo, Ye, Skitmore & Xiong, 2015) will cause unfamiliarity with EI element. To combat with such problem, Darko, Chan, Ameyaw, He & Olanipekun (2017) suggested that education and training are important to reduce the problem mentioned. This is because contractor need to be equipped with EI knowledge and awareness to avoid any negative impact due to the contractor's activities at the project. Therefore, it is important for the contractor to conduct educational programme and training as to influence the EI practices (Cheng, Yang & Sheu, 2014) and innovate in their daily work routine.

Furthermore, it is important to hire a leader that has knowledge on green construction to ensure for the implementation of efficient and sustainable project progress (Tan, Ochoa, Langston & Shen, 2015). Hiring a well-experienced and capable project contractor to be in charge of the organisation's environmental aspect is crucial (Garcés-Ayerbe, Scarpellini, Valero-Gil & Rivera-Torres, 2016) due to the knowledge that they own on EI. The human resources such as the project workers and staffs are among the most important asset for the construction project (Ozorhon, Oral & Demirkesen, 2016). This will bring advantageous to the contractor's organisation as from the project perspective, an efficient project operation will result from that type of employees that are able to carry out their responsibilities and make decisions while fully aware of the impact on the environment (Sarkis, Gonzalez-Torre & Adenso-Diaz, 2010). Therefore, acquiring the expert or green knowledgeable leader into the team is an important EI practices to maximise the sustainable project compliance.

Aside from that, health and safety are also crucial aspects within this sustainable management of human resources. For example, in ensuring the sustainable practices are being comprehended at construction project, Glavinich (2008) highlighted that easy-to-read bilingual signs need to be put on at suitable places. This will improve the understanding of the workers with different languages. Besides, it is within the contractor's scope of work to take the responsibility on establishing the safety education systems as well as to conduct regular safety check and inspection for the record (Chang et al., 2016). This EI practice is crucial because the materials are not the only wastages generated from construction activities Glavinich (2008). Waste of labour's productivity is also the waste that should be reduced to enhance EI practices within the construction project. Therefore, with EI practices in this management of human resources, the sustainability and productivity of the project will be enhanced.

DISCUSSION AND CONCLUSION

All the components found are aligned with Tatum (1987) and Rennings (2000) explanations. According to these scholars, the elements of contractor's EI composed of two parts, namely the aspect of management innovation and technological innovation. There are many directions and guidelines to achieve the goal of sustainable construction project. Through this review, it was discovered that there are three main components and six sub-components of EI within the contractor's scope of work. The components are product EI, process EI and management EI, while the sub-components are sustainable product procurement, sustainable product management, implementation of environmental-friendly technology, sustainable site operation, implementation of sustainable project policy, project collaboration and networking including sustainable management of human resources.

In a study by Horbach (2014) that compared the determinants of EI in 19 different European countries based on the Community Innovation Survey (CIS) found that the reduction of energy use is an important innovation field in nearly all the European Union (EU) countries and the recycling sectors seems to be important for the Czech Republic, Germany, Hungary, Ireland, Luxembourg and Portugal. Besides, according to the United Nation Environment Programme (UNEP), the benefits of EI are exemplified by a Columbian company that participated in EI project and achieved 75% reduction in hazardous chemicals consumption, 20% reduction in water consumption and 50% cut in wastewater generation (UNEP, 2017). Therefore, EI concept may bring the same benefits within construction sector which directly improve the rate of environmental condition affected by this industry.

For the contractor, the market is always competitive and is constantly developing with more additional ideas and environmental value. Thus, by having the extra elements, which is the knowledge and the implementation of EI at the construction project, these advantages will improve the value of the contractor's organisation. The study's future work will identify the factors that affect contractors' capability to influence EI at the construction project level, which will enable contractors to be more proactive in delivering and meeting sustainable development goals associated with construction project.

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CHALLENGES OF IMPLEMENTATION ENERGY RETROFIT IN EXISTING BUILDINGS IN MALACCA MALAYSIA

Kai Chen Goh[1], Nadzirah Zainordin[2] and Sui Lai Khoo[2]
[1]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Malaysia
[2]School of Architecture & Built Environment, Faculty of Engineering, Technology and Built Environment, UCSI University, Kuala Lumpur, Malaysia

Abstract
As the world's population has grown, so has the demand for energy around the globe. Building energy consumption has recently become a big concern due to rising energy demand, as many existing buildings throughout the world are not energy efficient. Malaysia is no exception. In addition, the majority of Malaysia's energy was generated by burning fossil fuels. When fossil fuels are used, greenhouse gases are released into the atmosphere, further contributing to global warming. As a result, under the 10th Malaysian plan, the Malaysian government created Energy Efficiency Initiatives (EEI) to increase Malaysian buildings' energy efficiency. Malacca was one of the states that joined the plan and was the main state in this plan; thus, it was chosen as the scope of the study. The study's goals were to determine the energy company's problems and how satisfied the building owner was with the results after using energy retrofitting technology. This study employed a semi-structured interview as a method, with twelve interviewees being the energy service firm hired to complete the project in Malacca. The study's findings revealed that the foundational document was the primary driver and source of most of the project's problems in Malacca. However, the building owners received the retrofit project well, and each one had a chosen system that was retrofitted as part of the energy conversion project due to the structure's primary use. This research aims to provide insight into the issues retrofit participants had during the projects in Malacca or elsewhere in Malaysia in the future.

Keywords: *Challenges; energy retrofit; existing building; Malacca; Malaysia*

INTRODUCTION

Retrofitting old structures entails transforming them into sustainable models. Green retrofit is a sustainable strategy that has been implemented in several developed countries, including the United States of America (Adabre et al., 2020). Numerous types of green retrofits have been implemented to improve the building's systems. There are several types of retrofits, including energy retrofits, seismic retrofits, and power plant retrofits. Seismic retrofit refers to the process of modifying existing structures to increase their resistance to seismic activity, ground motion, or soil failure caused by an Act of God. The primary purpose of power plant retrofits in coal-fired power plants is to collect carbon dioxide emissions.

Due to Malaysia's development status, the most appropriate retrofit for the current state of the country's building is energy retrofit. As a developing country, the demand for infrastructure has increased to stimulate the economy. As a result, Malaysia's energy requirements to power the facilities would become a crucial concern. Malaysia can benefit from energy retrofits. There are two types of retrofits in use throughout Asia and the Pacific. There are numerous methods for doing energy retrofits, but the most prevalent strategy that market owners are using presently is to bundle together energy-saving devices to achieve deeper savings through a complete approach. Retrofitting older buildings has several advantages, including a reduced environmental footprint and greenhouse gas emissions, fewer running costs, and improved indoor environmental quality.

However, a new technology called deep energy retrofit became popular in the construction sector over the last four decades. This form of retrofit refers to energy consumption that occurred during the construction process, from the commencement of design to the completion of the project, even if the building is no longer in use. This type of retrofit was developed to accomplish the goal of energy efficiency. Rather than focusing exclusively on one area of energy management, such as lighting or HVAC, this strategy addresses the entire building's energy usage, which can dramatically reduce energy consumption in construction. Thus, renovating old buildings in Malaysia was necessary to attain sustainability.

According to Oh, Lalchand and Chua (2014), Malaysia's total energy generation and consumption are predicted to expand further shortly. Additionally, according to Malaysia's statistics agency, the country's population is 31.6 million and is predicted to reach 32.3 million by 2020. (Department of Statistics Malaysia, 2019). While Malacca state's population was 842,500 in 2014 and is predicted to grow to 0.93 million by 2020 (Nayan et al., 2020). More than 75% of the Malaysian population is anticipated to reside in urban areas by 2050. (Hassan, Zin, Majid, Balubaid & Hainin, 2014). This means that energy consumption will increase due to the increased use of contemporary home equipment in metropolitan areas, particularly air conditioners and refrigerators, which consume the most energy. According to Tenaga National Malaysia's statistics records, 94 percent of the power generated in our country is generated by fossil fuels, and this ratio is predicted to remain stable over the next decade.

Green retrofits or energy retrofits were adopted in other industrialised countries in the early 2000s, and those countries saw an increase in energy efficiency. The Iskandar Regional Development Authority (IRDA) in Malaysia has suggested a Low Carbon Society (LCS). This plan included five measures, one of which was EEI of existing buildings by retrofitting. On the other hand, retrofit projects entered the Malaysian market in 2015, when the Malacca government-contracted Danish Energy Efficiency Partners Sdn. Bhd. (DEEP) to implement a retrofit programme in support of the city's green city goals. It is the first time it has been implemented in Malaysia, or what we can refer to as a pilot programme. As this is the first retrofit project to be implemented in Malaysia, there may have been some issues encountered by the energy management business retrofitting the project due to the company being from abroad and unfamiliar with Malaysia's existing buildings, legislation, culture, and climate.

In conclusion, this research aims to ascertain the obstacles that an energy service provider faces when undertaking a retrofit project on an existing building. Based on the situation described above, there were concerns about whether the retrofit technology achieved the target established by the building owner in his or her energy conservation strategy. As a result, the research was conducted to ascertain the building owner's satisfaction after installing an energy retrofit, especially in Malacca, Malaysia.

LITERATURE REVIEW

In Malaysia, environmental practices began in three waves. There are three waves: the first wave, which lasted from 1900 to the 1980s, the second wave, which lasted from 1990 to

2005, and the third wave, which lasted from 2005 to the present (2006 onwards). The objective of each of these three waves was distinct. The first wave's objective was to safeguard the environment and curb pollution, and the Malaysian Environment Quality Act 1974 was enacted and implemented. The second and third waves shared the same goal but with a greater emphasis on sustainability. The term "sustainability" refers to economic growth that continues while having a minimum impact on the environment. On the other hand, the third wave was more focused on achieving long-term advantages through green investment. The long-term benefit was defined as the building's minimal influence on the environment from the design stage through its disposal.

As described by Canada Natural Resources (2014), energy retrofitting is the process of updating a building's energy-consuming systems. Retrofitting may entail enhancing or replacing lighting fixtures, ventilation systems, windows, and doors, and adding insulation where economics dictate. Retrofitting also entails incorporating energy-saving strategies into all remodelling and repair projects.

Green Retrofit Design (GRD) research is still in its infancy compared to what has been developed for Green Buildings and energy conservation analysis. This research aims to determine the optimal solutions for GBD utilising multi-objective genetic algorithms (Yu, Li, Jia, Zhang & Wang, 2015). Economic and environmental standards are developed using a life-cycle analysis technique. GRD integrates design processes with retrofitting, rehabilitation, and refurbishing while considering customers' needs, policy-driven incentives, and construction behaviour (He et al., 2019).

GRD should answer existing building energy challenges from a technological standpoint, including rainwater reuse technology, energy-saving air conditioning and heating technology, shading technology, roof ground insulation technology, and lighting system modification technology (Bu, Shen, Anumba, Wong & Wang, 2015). When the investigation unit building results are integrated with the local climate conditions, a suitable economy is established that is beneficial for energy conservation, climate protection energy-saving reform plans, and retrofitting of unique design.

The contact person is critical at the initial stage of enrolling. This individual may be a consultant or a technician from the GRD's Energy Team. For analysis, it is essential to have existing systems approaches to retrofit buildings, functions of system performance, and mechanism records. As the point of contact for coordination, the initial responsibility is to conduct a site assessment. The outcome of this assessment would include fundamental information about the building, such as its shape, size, and age, and information about the property's existing building services systems. The design team would consist of a diverse group of specialists. Prior to the project proposal phase, it is critical to establish an energy team. The team would be comprised of individuals with experience in engineering, purchasing, operations and maintenance, facility management (FM), environmental health and safety, corporate real estate and leasing, construction management, contractor and supplier management, and utility management, among other fields (Energy Star, 2016).

Drivers for Energy Retrofit

Despite criticisms of the Carbon Reduction Commitment Energy Efficiency Scheme, it was important in the EPSRC Retrofit research for pushing change (Dixon, 2014). There was a clear sense that retrofit was a landlord-driven project, particularly for more extensive and “deeper” modifications, and that cost was closely linked to the desire to reposition the asset in the portfolio (Dixon, Britnell & Watson, 2014). Economic incentives were virtually as essential as investment results in Asia Region. They did not want to put in the extra effort to make their buildings more energy-efficient without any payoff. Meeting legal and regulatory criteria is vital for administrators since it ensures they don't make mistakes while responding to government development trends can help them improve their political achievements.

RESEARCH METHODOLOGY

This study takes a qualitative approach, operating within an "interpretivist" research paradigm and employing data collection techniques that are adaptable and sensitive to social context. The researcher interacts with the subject of the study to ascertain the perspectives of persons involved in the events under investigation. Qualitative research entails an in-depth examination of a small number of respondents using a variety of approaches, including interviewing, focus groups, observation, oral history, ethnography, and archive or document analysis (Mohajan, 2018).

In this study, interviews were conducted in-person and via email response. All acquired data were analysed using a content analysis approach and discussed in relation to this study's literature review. The conclusions were generated using quantitative methods, while qualitative methods added context to the findings. The research population in this case is existing buildings, and the research samples are existing buildings in Malacca that have been selected for energy retrofit. The sample was chosen to include subsets of the variables "Energy Service Company," "energy retrofit project," and "in Malacca," all of which matched the research aims and title. Twenty potential stakeholders involved in energy retrofit were selected; however, only twelve respondents, including three building owners, were willing to participate in the interview session. They are primarily engineering background with some of them in managerial level, all of them have more than ten years of experience related to energy retrofit. The research instrument is the most critical criterion in the methodology section since it quantifies the study's variables, traits, or information. Instrumentation for data collection, such as checklists for observation or interview guides, must be identified and defined. By utilising established data collection instruments, you can save time and boost the credibility of your study.

Experienced lecturers and industry stakeholders pilot the semi-structured interview prior to the actual interview session. The goal of this study was to have a better understanding of Malaysia's current-actual energy retrofit scenario. A recording method was employed during interview sessions to capture the entire dialogue to gain more accurate data when evaluating raw interview data. The interview session's contents should be listened to and interpreted several times before transforming the raw data to systematic data.

FINDINGS AND DISCUSSIONS

The project began in 2015 and ran until the end of 2016. The retrofit project was procured through the Energy Performance Contracting (EPC) method. The EPC method entailed the company installing equipment or technology that aides the building owner in reducing energy consumption as measured by the electric bill. After installing the retrofit equipment, the ESCO company will receive a 100 percent payback from the building owner in the form of reduced electric bills. The building owner benefits by lowering maintenance costs, simplifying management, and extending the equipment warranty period.

According to respondent A, it is an extremely exciting contracting method for Energy Efficiency contracts for existing buildings. This is because the building owner not only saves money on electricity, but also on maintenance costs by acquiring new equipment and a longer warranty period from Respondent A. It is a win-win situation for both the ESCO and the building owner. Respondent A stated that this EPC method was the current trend in the Malaysian market.

Challenges of Energy Retrofit Project in Malacca

The respondent company encountered numerous roadblocks during the energy retrofit process. There are two broad categories of challenges. Consideration must be given to both technical and non-technical issues. The difficulties encountered by technical professionals are technical in nature, whereas those encountered by non-technical professionals are non-technical in nature. The respondent company's first obstacle was the building's fundamental document.

> *"In all of these nine historic buildings, one of the main issues we noticed is that when trying to find floor plans, the drawings aren't quite right." (Respondent A)*

All these nine buildings were faced with a myriad of difficulties. The fundamental documents of the buildings were the drawing and the problem that faced by the respondent there was no proper drawings of the building when they come in and carry out the auditing process for the building.

> *"… You can't blame the building owner because in a way these are government building. The management is a centralised body, such as JKR or other body. JKR will have tons of drawings in their office. Sometime if the handover was not proper, it will go missing" (Respondent B)*

These difficulties arise as a result of the centralised management of the building. The centralised body referred to here is the JKR, and hundreds of designs were retained in the JKR office for one year in case the handover did not go smoothly. To circumvent these roadblocks, the corporation was forced to compensate its engineers in order to regain access to the designs.

Furthermore, the majority of the structures included in these projects were between 20 and 30 years old. Over those years, the higher management level has changed numerous times, and when the respondent company comes in and requests the drawings, the building owners require time to locate the building's updated drawings, and some building owners were unaware of where the drawings were stored in the building. As a result of this circumstance, the respondent company will require additional time to acquire the building's designs.

> *"... strangely we discovered almost the entire hospital drawings about 50% to 70% of the cooling drawings and hot water system drawings in the hospital parking system. It was locked in a like a storage in the parking system..." (Respondent C)*

Additionally, several building owners misplaced the drawings, such as in the parking lot storeroom. These types of issues necessitated additional time for the respondent company to obtain the necessary drawings. If the required drawing is not available, they must hire an expert to create the necessary drawings for conducting measurements on the building.

Additionally, the respondent company ran into a second impediment: the culture of government building owners. The issue was that none of these building owners desired to convert their controllable structures to more energy efficient structures. According to the building owners, their obligation to the respondent company is to maintain the structure, not to innovate or improve it. Respondent A had a difficult time convincing them to join this programme as a result of this issue. Respondent A corporation must work in conjunction with the Malacca Green Technology Council to convince the building owner to join the programme. Additionally, the responder company became a member of Malacca's green initiative. This added leverage in persuading the building owner to join the initiative.

> *"We knew that dealing with human is complicated especially with building owner especially when we are getting into their building it is their zone and we as outsiders, who come to tell them look here we can did something better to your building in our investment, sometime it is okay sometimes it doesn't go well…" (Respondent D)*

The third category of challenges was human-related. It became a challenge because the respondent is a stranger to the local building owner, and their professional opinion on how to improve their building will astound them. It is because that building is their safe haven that if an intruder enters, they will revolt against the intruder. It is our basic human instinct, and we have the ability to change it.

> *"So we were actually deal with the building owners to tell them this is the best way for you and we somehow have to train them to raise the capacity to understand what we were doing…" (Respondent E)*

As a result, respondent company cannot rush to persuade them to do what they desire. It will take time and effort to increase their capacity for understanding the energy retrofit project undertaken by respondent F. This challenge took half a year to complete.

> *"… We don't only install part of equipment and bring investment, we also train the client and building owner to understand what we were doing…" (Respondent F)*

Raising the building owner's awareness is also a component of their work. These actions were designed to educate the building owner or client about the retrofitting and sustainable concepts.

Additionally, a challenge occurred exclusively at the hospital. The difficulties came from dealing with the doctors. In the project, company respondent G would retrofit a hospital, and the retrofit work would have to coexist with doctor collaboration. This is because, during the retrofit project, company respondent G was required to shut down the hospital for approximately eight hours to allow for the retrofitting work to be completed, which included installing a new air handling system in the hospital. As a result, they were forced to transfer some patients from the intensive care unit to a neighbouring hospital. Along with the patient switch, some doctors were also required to switch patients because they had been caring for them from the start of the treatment. However, some of the physicians were unwilling to change, making this session difficult.

According to respondent G, the fourth challenge in the project was the project's timeline. This is because the project timeframe provided to Respondent G was deemed to be too condensed.

> *"…right now I'm supposed to finish all 9 buildings by June 2017… Ya, we are bound by time within the two years it was remaining 6 months. We not only implement the project and train the building owners. But it was manageable" (Respondent G)*

The project was scheduled to be completed in June 2017 and as of November 2016, there was still much work to be done to achieve the desired energy performance and to train the building's owner. However, respondent H was confident that they could complete it on time. The factor that gives respondent H confidence is that they completed the project in phase 1 and the two largest buildings of those nine were their flagship buildings. As a result, respondent A asserts that the time constraint was manageable.

Then came the economic difficulties. This is because while every business owner desires to invest in a venture that will yield a profit in a short period of time, the payback period for some retrofit projects was lengthy. As a result, many building owners took a step back due to this type of concern.

> *"For instant, non-technical people usually was easy for us to gap why we just put all source of sensor to the buildings. This kind of thing was not feasible in the EPC concept." (Respondent H)*

Nowadays, many people who were not proficient in energy efficiency asked why we couldn't just install the sensor into the building. However, to the expertise, particularly for the EPC concept, this was not feasible because the concept was based on cost savings. Additionally, this type of sensor may require more than 15 years to pay for itself. As a result, energy service companies will refrain from investing.

> *"Insulation works is not easy usually the payback was quite poor. The general rule of thumb the faster payback was the lightning system usually use 2 or 3 years to get the payback. (Respondent I)*

> *"Mechanical system, you get your payback 5 to 7 years based on rule of thumb. When dealing with building outline, windows, this will take up to 10 years…" (Respondent J)*

According to Respondent I and J, the measures were chosen based on their payback period. They cannot simply implement the measure following the audit; they must consider the measure's feasibility. As a result, the economic challenges were quite difficult. If the building owner required a quick payback, there were only two options.

The first five challenges were classified as non-technical. Regarding technical difficulties, the respondent stated that technical difficulties occurred throughout the project. The technical difficulties stemmed from the possibility of a conflict between the drawings and the actual situation. This occurred as a result of an inadequate fundamental document for government formation. When the respondent company uses their expertise to recreate the necessary drawings that were lost, incorrect measurements may occur. This may delay the progress of equipment installation, as equipment installation requires accurate drawings to ensure that the equipment does not damage the building's structure during installation.

Additionally, technological difficulties arose during the retrofit project. According to the respondent, technological challenges have always occurred in every project. However, the respondent asserts that this challenge's impact on the project is negligible in comparison to non-technical obstacles.

> *"I would say the non-technical challenges like I mentioned human related factor and fundamental documents are the biggest challenge." (Respondent K)*

> *"In the technological challenge is something you can overcome. It through knowledge. You see technological challenge is always there, but you considered as an issue because as long as you have a proper technical expert and you will get it done…" (Respondent L)*

This is because the respondent company was a highly technical company. The majority of employees hired by the company were engineers, and anyone who is not an engineer must also possess strong technical knowledge. As a result, when it comes to technological challenges, they can overcome them more easily than other types of challenges as shown in Figure 1.

Figure 1. Challenges of Energy Retrofit Project in Malacca

All previous studies identified that economic challenges were one of the challenges, as shown in Table 1.

Table 1. Challenges of Implementing Energy Retrofit Project in Different Countries

Challenges	MALACCA	SINGAPORE	CHINA	UK
Economic		√	√	√
Fundamental Documents	√			
Time management	√	√		
Organisation issue				√
Responsiveness of building owner	√	√	√	
Technical	√		√	
Lack of Funding	√	√	√	√
Tenants' cooperation	√	√		
Legislation	√	√	√	√
Accidents/ emergency	√	√		

According to research conducted in the United Kingdom, the most significant barrier or challenge to their energy retrofit project was economic challenges (Dixon, 2014). While research in Singapore discovered that economic factors were also a deterrent to undertaking energy retrofit projects, they were not the primary obstacles. This is because a sizable sum of money was invested in the project and the project's payback period was unknown. According to research conducted in China, the cost of retrofit is also a barrier or a challenge for energy retrofit projects. China cited the same reason as Singapore: the payback period was excessively long. However, no one mentioned in my research that the economic barrier hinders the project. The differences may be since the contracting method used for those projects was different. The energy retrofit project that I researched occurred in 2015 and was completed using Energy Performance Contracting (EPC). However, because those three projects began between 2011 and 2013, and EPC was not established at the time, financial constraints may have slowed investment in retrofit projects. The EPC contract method was when the building owner paid for the project through savings, and the building owner could implement measures with a shorter payback period.

The second barrier discovered in the United Kingdom was an organisational issue, which means the funds will be compatible with other funds used for organisational development (Dixon, 2014). Singapore, China, and even my own research in Malacca makes no mention of organisational challenges. This may have occurred because the policy or objective of the organisation in the United Kingdom was more focused on the revenue aspect of the organisation when conducting the research. Additionally, the retrofit budget may compete with other large projects that generate significant revenue for the organisation. As a result, higher management will abandon the retrofit project in favour of one that will generate significant profit for the organisation. Additionally, the research was conducted in 2013. While the research in Singapore and China was conducted later than the research in the UK, the awareness of going green may have been implanted in the minds of research respondents as a result of the government's implementation of sustainable policies. As a result, the organisations selected for the project had established a fund to enhance the building's performance, and there was no overlap with the other funds.

The fundamental document factor was discovered to be a challenge that was not encountered in any other country but in my study. This factor was not discovered in research conducted in China, the United Kingdom, or even Singapore. When an improper handover occurs, this challenge occurs, and this challenge occurred in the Malacca retrofit project. This occurred because in Malaysia, the government's building drawings were managed by a centralised body responsible for managing hundreds of building drawings each year. Additionally, the buildings in the retrofit project were on average 20 to 30 years old, and at the time, the centralised body manage drawings were not computerised, making it difficult to locate missing drawings. Additionally, the officer in charge of the drawings for the project's buildings might have retired due to the buildings' age of more than 20 years.

According to research conducted in Singapore, time management is another factor that contributes to the failure of a retrofit project. Malaysian research respondents also mentioned this factor. However, this factor was not discovered in research conducted in the United Kingdom and China. This occurred because the expertise in Singapore and Malaysia is still immature in terms of time management, and respondents stated that while they felt the pressure when there was limited time available, it also became a source of strength for them to complete the project on time. This is because my respondents also had another responsibility during the project to train the building owners.

ASEAN's logistics infrastructure is less developed compared to countries like China and the United Kingdom. Additionally, retrofit projects are viewed as a developing industry in the ASEAN region. Thus, the time period specified may be irrelevant, as the period may be based on the country in which the energy service company completed the project rather than the ASEAN country's conditions. Additionally, the UK and China did not perceive it as a challenge because their country's technology in retrofit or construction is superior to that of Malaysia and Singapore, and their material mobilisation is also ideal to that of Singapore and Malaysia, since the Industrial Building System (IBS) in China and the UK can be considered mutual. As a result, mobilisation of retrofit materials or equipment was more seamless than in Singapore or Malaysia.

Following that was the human-related obstacle. There were two areas where research revealed the factor. These are my findings and those from Singapore. The first factor in this category is the building owner's responsiveness. The responsiveness of the building owner refers to the ability of an open-minded and receptive building owner to respond quickly and accept suggestions from building professionals (Low, Gao & Tay, 2014). If the building owner is the polar opposite of the receptive building owner, as some of the building owners in my research retrofit project were, it will take time for my respondent company to educate them about the concept and purpose of greening the building. The situation was similar in Singapore, as the energy retrofit industry was still in its infancy, and before that, everyone was familiar with the concept of sustainable development, but no one truly understood it in these two countries. Compared to China and the United Kingdom, building owners in these two countries were more educated about sustainable concepts because their governments introduced the concept earlier than Malaysia and Singapore, making building owner responsiveness less of a challenge.

The second human factor to consider was the tenants' cooperative nature. This factor was also identified in Singapore's research in the chapter 2 literature review but was not considered a challenge in the United Kingdom or China. For this research, tenant cooperation is also a factor in the success of energy retrofit projects because some retrofit measures may affect the original working hours of the building's tenant. For instance, the incident occurred where a building was used as a hospital, but following the audit, the respondents stated that the hospital cooling system should be shut down for up to eight hours to cooperate with the retrofit project. There were a limited number of doctors available at the time, and several ICU patients were transferred to the nearest hospital for a period of time. If the patient and doctors did not cooperate with the respondents' company at that time, the project would have been impossible to complete. The UK and China studies determined that it was not a challenge because tenants were educated about the green concept and were willing to work with the building owner to create a green future for their children. They also understood their responsibility to the environment.

> *"Legislation in Malaysia as far as energy efficiency was not very tight right now. We have one or two legislation that was governing electrical management in Malaysia..." (Respondent A)*

Other than that, all the research found a lack of funding for the energy efficiency project. In Singapore, various GM funding schemes were introduced by the government. As a result, many building owners now are better able to afford green retrofits (Building and Construction Authority, 2021). There is a lack of adequate capacity to assess future earnings of EPC projects in buildings in the UK and China, so they are cautious about making loans for such projects. In Malaysia, there is also a lack of funding support from the government for energy efficiency projects because the government was too focused on funding the development of new facilities and ignored the importance of continuing improvement of the existing building performance to achieve sustainable development.

> *"I was a bit say and frustrated because there was no mentioned of energy efficiency and renewable energy funding in recently national budget. I was hoping the along the way revision can happens and we hope prime minister will be able to see this…" (Respondent K)*

He hoped the federal government would look into it so that more building owners would have the financial resources necessary to implement energy efficiency projects.

In terms of legislation, the research revealed that Malaysian legislation was receptive because the country's energy efficiency legislation was lax compared to other countries. Additionally, Respondent K states that only one EE policy was officially released: the one announced in 2008. The content is that if a building's installations consume or generate 3 million kWh or more of electricity over six months, the building owner or company is required to engage an electrical energy manager who is responsible for analysing the total consumption of electrical energy, advising on the development and implementation of measures to ensure efficient energy management, and monitoring the effectiveness of those measures. However, it was not a requirement for the building owner or business. Additionally, there was no federal funding to support this EE policy. As a result, it was convincing the building owner to participate in the energy retrofit project presented a challenge for the energy service company.

As a result, stricter EE legislation had to be enacted to encourage building owners to undertake energy retrofit projects.

In Singapore, the government has introduced numerous Green Mark funding schemes (Building and Construction Authority, 2021). This policy drew the attention of many building owners because it enables building owners to afford green retrofits through funding provided by the Singapore government (Building and Construction Authority, 2021), which the Malaysian government does not provide. Additionally, research in China discovered that legislation contributed to the success of green retrofit projects by removing the building owner's obligation to improve energy savings continuously. If there was no constraint, the building owner might choose not to invest in a retrofit project because the project's return cannot be determined. In the case study research in the United Kingdom, there was no mention in the literature review that compliance is a challenge for energy retrofit projects. This could be because the UK's legislative system was more comprehensive than that of the other research country. Numerous countries, including the United Kingdom, used their standards to develop energy retrofit projects in other countries.

The external factor was the final factor discussed. External factors included workplace accidents or emergencies that jeopardised the retrofit project's success. It is a factor in Singapore research, but not in Malaysia. Respondents L applied safety precautions throughout the construction period and did not cut corners; they took all necessary steps to ensure that no accident occurred during the construction period. Respondents L is aware that the cost of an accident would be greater than the cost of safety precautions.

For the level of satisfaction of the building owner, the most delightful part was the savings on the electricity bill. However, one of the building owners was not as pleased as the other two because his electricity bill was not within budget. The electricity bill increased due to the volatile crude oil price. Additionally, the government intends to reduce excessive operating expenses, and when the results are released, they are overjoyed to see that the electricity bill has decreased.

Numerous measures will be implemented throughout the project to retrofit the existing building into a more energy-efficient structure. Air conditioning was the most desired retrofit component following the project in those measures. The satisfaction of the building owner with their new air-conditioning system is shown in Table 2.

Table 2. Statements on The Satisfaction of Air-Conditioning System Retrofitting in Energy Retrofit Project

Building Owner	Statement
BO 1	"Yes I was satisfied the result of the new air-conditioning system…after changing the chiller, the air-conditioning system can provide a better cooling for the indoor environment"
BO 2	"Yes, I'm glad on the air-conditioning retrofit because you know Malaysia was had a tropical weather. The office will feel hot even though switch on the air-con last time. Now, it was no happen again after install the new water cooling package"
BO 3	"Yes. It was because the room temperature in the bus terminal was more even compared to last time. Last time there was some of the corner in the building was not feel the cool now they can feel it"

The table demonstrates that all the air-conditioning systems in those three buildings were experiencing problems, and that the retrofit project resolved the issue while also saving money on the electricity bill. According to respondent A, when they audited the project's buildings, the air-conditioning component consumed most of the energy. As a result, the electricity bill is reduced when the air conditioning system is retrofitted.

The second system retrofitted in those three buildings was the building's lighting system. Prior to the retrofit, the light bulbs used in those structures were CFL and GLS. Those light bulbs were not energy efficient and consumed excessive energy. When the lighting system is upgraded to an LED light bulb, the energy bill decreases because the LED light bulb consumes less energy. Apart from the electric bill, it also affects the working environment, according to the three-building owners. Table 3 contains the building owner's statement regarding the lighting system retrofit.

Table 3. Statements on The Satisfaction of Lighting System Retrofitting in Energy Retrofit Project

Building Owner	Statement
BO 1	"After the lightning system retrofit, I feel that all the patient in the hospital were feeling more happy compared to last time and I was no struggle that I want to switch off the light or not during the morning time"
BO 2	"I would say that the lightning system now in the office was very suitable and perfect for the office building. Last time, if I was working under the CFL, I will feel my eye pain after a few hours but now I was no happen after retrofit it to LED…"
BO 3	"For the lightning part, I can say that I was satisfy because it not just cut down the electric bill it also had create a new working environment for me and the employee in the bus terminal"

According to Bleyl et al. (2019), retrofitting a building can increase the tenants' productivity or employees who work there. Not only does the retrofit reduce the electricity bill, but it also creates a new environment for work and for the hospital, resolving the dimness issue with the hospital's lighting system. As a result, we can conclude that the building owners satisfied with all lighting systems retrofitted in those buildings.

The building's hot supply system was the final system to be retrofitted in the project. However, the hospital's hot water supply system is limited. The other two buildings were not included because their primary function was not as reliant on the hot water supply system as the hospital. Building owner 1 was overjoyed with the hot water supply system because it resolved the issue of the hospital's hot water supply being insufficient to supply all of the wads. According to respondent J, the issue was that the hospital's water pump was out of date, incapable of providing sufficient water pressure to all the wads and was inefficient in terms of energy consumption. The hot water supply issue was resolved after replacing the water pump.

There has been no prior research on the level of satisfaction of building owners following the implementation of an energy retrofit project. However, I believe that satisfaction with the building owner is critical for a retrofit project because it is the best indicator of how the building owner will react. If the building's satisfaction level is high, they may introduce you to the other building's owner. Finally, more existing buildings will be retrofitted to be more energy-efficient, which will result in cost savings and increased energy generation for supply.

Additionally, suppose the building owner is satisfied with the project. In that case, it can increase the project's acceptability among other building owners in Malaysia because if the project truly saves money on electricity bills, they may attempt to understand and open their minds to accept new things that they were previously unfamiliar with. Additionally, operating costs are high nowadays due to the high cost of electricity. If energy retrofit projects truly save money on utility bills, businesses will attempt to incorporate energy-efficient technology into their buildings.

The level of satisfaction of the building owner will also improve, allowing the Malaysian energy retrofit market to become more collaborative in terms of technical skills and competitiveness among energy service companies. This is because the energy service can ascertain the area of dissatisfaction from the building owner and work to improve it on the next project. This continuous cycle will improve Malaysia's current energy retrofit trend. Employee satisfaction was also critical because it increased employee productivity. According to Bleyl et al. (2019), retrofitting a building can increase the tenants' productivity or employees who work there. This statement was also established during the course of this project. The BO 2 reports that the take-leave rate among employees working in the office has decreased since the project's completion, and he also notes that employees are happier working in the new environment.

CONCLUSION

According to the report, successful resource management requires the participation of numerous professionals and human resources. As a result, conflict is an inescapable fact of life. Negotiation talents are crucial, as demonstrated by the research. The findings of this study provide insight for builders such as developers and building owners such as homeowners interested in performing energy retrofits on existing buildings. The study details the challenges encountered during the retrofits project and the level of satisfaction the building owner gains following implementation. Additional research, such as the viability of executing deep energy retrofits in Malaysia's construction industry, can be undertaken on this subject. Subcontractors' rate of adoption increases as they gain experience in a specific field. With the expansion of people's contact networks and the increased likelihood of conflict, negotiation has become an increasingly required and critical skill for human resource management. Decision-making, and problem-solving talents are required for resolving conflict and related challenges. Additionally, the future trend in the construction sector human resource management is toward practice dispersion.

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A SUSTAINABLE DECISION MAKING MODEL FOR THE IMPLEMENTATION OF INNOVATIVE TECHNOLOGIES IN THE MALAYSIAN CONSTRUCTION INDUSTRY – A PILOT STUDY

Nur Hidayah Idris, Rohana Mahbub and Norfashiha Hashim
Centre of Studies for Quantity Surveying, Faculty of Architecture, Planning and Surveying, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Abstract
Innovative Technologies such as Building Information Modelling (BIM), Cloud Computing, Modularisation, Automation, Robotics, Augmented, Virtual and Mixed Reality have appeared globally as key contributors in improving not only productivity but also quality and safety in the construction industry, including Malaysia. However, despite the acknowledged benefits, the implementation of innovative technologies is still lagging behind other industries and many construction organisations are still indecisive on the implementation of innovative technologies in their projects. The purpose of this study is to address the lack of data on the decision-making criteria for the implementation of innovative technologies in the construction industry, and finally to bridge the gap of the limited formal decision-making model within the Malaysian context. To achieve this objective, five constructs and 50 sub-constructs were identified through a systematic and comprehensive literature review of all pertinent elements within the integrated Diffusion of Innovation (DOI) theory and the TOE (Technology-Organization-Environment) framework and other related information. The literature findings indicate that apart from Technology-Organisation-Environment constructs, two other constructs that play an equally important role in the implementation of innovative technologies decision-making model; which are economics construct and security construct, resulting in technology, organization, environment, economic and security (TOEES) as the five constructs of the conceptual framework developed. Based on the conceptual framework, an instrument is developed in the form of a questionnaire survey and a pilot study is carried out. Out of 100 respondents, 31 responded to the questionnaire survey. Internal consistency reliability, which is determined by alpha coefficient reliability or Cronbach Alpha, is used to assess the instrument's reliability. The results of this pilot investigation suggest that the instrument is both valid and reliable. Descriptive Statistical data in this study shows that Malaysian Construction Organisations reached a consensus on TOEES framework where Economic and Security constructs are equally important as the other three constructs. The results reveal that Organisational Constructs; Leadership vision & Managerial Relations is the most important criteria upon deciding for the implementation of innovative technologies. The proposed TOEES decision making framework and identification of decision making criteria are expected to facilitate the construction decision-makers in deciding the implementation of innovative technologies in the future.

Keywords: *Innovative technologies; Emerging Technologies; decision making; decision-making model; technology adoption; Construction 4.0; Construction Industry*

INTRODUCTION

The Malaysian Construction Industry Development Board (CIDB) has recently launched the Construction 4.0 Strategic Plan (2021-2025), the aim is to embrace the Fourth Industrial Revolution (IR 4.0) in ways that would transform its productivity and competitiveness by accelerating technological advancement in the Construction Industry. The recent introduction of Construction 4.0 Strategic Plan 2021-2025 was specifically created to accelerate the application of innovative technologies by focusing on Strategic Plan that is separated into four strategic thrusts, which has replaced the previous Construction Industry Transformation Plan

2016-2020. They are Capacity Building, Excellence in Research, Innovation, Commercialization and Entrepreneurship (RICE), Smart Integrated Technologies, Innovation and Infrastructure, and Enhanced Business Environment.

With the Construction 4.0 Strategic Plan 2021-2025, the Malaysian construction industry is set to be highly productive and competitive globally, through the adoption of emerging technologies. Aligned with the Twelfth Malaysia Plan, Sustainable Development Goals (SDG), Shared Prosperity Vision 2030 (SPV 2030), Malaysia Digital Economy Blueprint, and the implementation of the National Policy on IR 4.0 (Industry4WRD). Construction 4.0 is coordinated towards Innovation and Sustainability issues. Construction 4.0 covers twelve emerging technologies and their implementation plan within the short, medium, and long term. Introduction of Construction Industry 4.0 (CI 4.0) concepts are predicted to affect the future of construction positively (Sawhney et al., 2020) and would transform its productivity and competitiveness. Well-known as a labour-dependent industry, the construction industry has recorded persistent poor productivity throughout the years. According to CIDB (2017), these are due to the inadequate adoption of modern technologies and practices.

For the year 2018/2019, The Malaysia Productivity Report reported the construction industry as the lowest contributor towards national Gross Domestic Product (GDP) at 4.9%, as compared to services, manufacturing, agriculture, mining, and quarrying industries. In addition, in the recent report for the year 2020/2021, the construction sector recorded the biggest decline by -15.7%, being one of the factors which dragged the overall national productivity performance. The sector's contraction in its added value by -19.4% was the effect of the restriction in activities during the Movement Control Order (MCO) and rescheduled activities due to quarantined employees with positive COVID-19. The GDP contribution mirrors the current poor productivity of the industry. However, despite the benefits, the construction industry tends to be laggards in adopting innovative technologies. In fact, contrary to other industries, construction has been slow to adopt new technologies and has never undergone a major disruptive transformation. (Oesterreich & Teuteberg, 2016).

The present COVID-19 pandemic has been an eye-opener to the construction industry on how technologies can support construction companies to survive during this pandemic. It raises a serious question for construction companies when deciding whether to adopt/implement or reject emerging technologies (Sepasgozar, 2020). Decision-making has always been a focal research topic in various fields as well as construction. The need to facilitate the decision-making process related to technology adoption is suggested by recent studies (Ezcan et al., 2020; Sepasgozar, 2020). Presently, studies were based on individual perceptions to analyse the innovation adoption decision rather than on an organization experience from a managerial perspective (Sepasgozar et al., 2018).

Previous studies also have been limited in their focus on a single technology case such as building information modelling (BIM) (Lee et al., 2020), or a single event called a technology acceptance phenomenon (Elshafey et al., 2020), rather than investigating the processes involved in an entire sequence of using the technology, called technology adoption (Shirowzhan et al., 2020). As many of the researchers focused on a single innovation or technology, however, there are adoption models unique to the construction industry being formulated to conceptualise the process in a holistic manner (Sepasgozar, 2016).

Therefore, this study is the first step of its aim to bridge that knowledge gap by proposing a holistic conceptual decision-making model for the implementation of innovative technologies in the Malaysian Construction Industry (based on – theoretical models at the organizational level) to push forward the use of technologies in the construction projects by identifying decision criteria for a successful implementation of innovative technologies concerning the specific characteristics and requirements of the construction setting to increase construction productivity and to materialise our Government's vision to be a developed nation and government's aspiration to transform Malaysia into a digitally-enabled and technology-driven high-income nation, and a regional leader in the digital economy.

REVIEW OF LITERATURE ON RELATED WORKS

The origin of the term Construction 4.0 has been traced back to the year 2016, and the first mention of construction as a field of Industry 4.0 to 2014. However, the seven key concepts that aim at defining Construction 4.0 were devised before: IoT (1999), computer-aided design technologies (1960s), 3D printing (1980), big data (2011), artificial intelligence and robotics (1980s), and virtual and augmented reality (1990s); only in the case of new materials related to industrialization is the origin unclear. In such a way, Construction 4.0 could be defined as a dynamic cluster of concepts that were developed from the early 1980s, with big data being the most recent. The term was also first conceptualized as a particular application of Industry 4.0 (2011) and, at the moment, is still trying to find its true definition. First mentioned in 2016 by Roland Berger, Construction 4.0 was founded on construction businesses' recognition of the industry's digitization and encompassed four essential concepts: digital data, automation, connection, and digital access. Due to the novel phrase, its definition has developed through time, but it may still be defined as a meta-concept that encompasses significant topics.

Similarly, Montgomery (2017) opined that the construction industry 4.0 involves the digitalization of the industry towards producing a smart and intelligent way of assembling data by using sophisticated and new gadgets; thereby, facilitating easy analysis of data towards making prompt decisions that enable the establishment of a smarter, efficient and responsive built environment. Oesterrich & Teuteberg (2016) posited that Construction industry 4.0 is based on the principles of creating a smart construction site, simulation, and virtual data storage, which allows construction companies to organise and evaluate data from different stages of the construction project as well as data from end-users after the project is completed, with the aims to deliver a faster, more flexible, and lower-cost construction project.

The very recent approach by Sawhney et al. (2020) defines Construction 4.0 as a "transformative framework" where three transformations take place: industrial production and construction, cyber-physical systems, and digital technologies whilst Forcael et al. (2020) stated that all technological improvements connected to the deployment of new work methods that are related to processes, materials, and markets are referred to as Construction 4.0. To sum up, the majority of the researchers associate innovative technologies in construction with productivity, safety, and sustainability enhancement in construction projects. In this paper, innovative technologies term is interchangeable with new technologies, modern technologies, or emerging technologies in construction.

According to the Handbook of research on technologies for improving the 21st-century workforce, innovative technologies are defined as technologies that are either newly invented or are being utilized in new ways. Innovative technologies discussed in this paper are based on research by Forcael et al. (2020), CIDB Malaysia (2020), and Oesterreich & Teuteberg, (2016). They are Modularisation and Prefabrication (M&P), Building Information Modelling (BIM), Automation and Robotics (A&R), Cloud Computing (CC) – Equipment/material connectivity tracking, Internet of Things (IoT) – Mobile Technology, platforms, Virtual Reality/Augmented Reality (VR/AR), Big Data (BD) – Integrated real-time data and analysis, and reporting, Additive Manufacturing (AM) – 3D printing/ Laser Scanning /Photogrammetry, Human-Computer/Robot Interaction (HCI/HRI), RFID and Simulation and Algorithm (S&A) - Drone. The identified innovative technologies are then divided into 3 main clusters namely Smart Factory Cluster (C1), Simulation and modelling Cluster (C2), and Digitisation and Virtualisation Cluster (C3).

Based on the previous review of recent studies, many innovative technologies could be applied throughout the construction stages such as Modular Construction, Prefabrication, BIM, RFID, Robotic and Automation, Simulation technologies (Drone), VR/AR. Previous studies focused either on factors affecting one specific technology/type of technology adoption and implementation or factors influencing safety technologies adoption and implementation. Mahbub (2015) conducted out a preliminary study in Malaysia on Industrialised Building System (IBS) implementation decision criteria. The results from the study revealed that 10 factors under three main categories (Technological Organisational, and environmental) as decision criteria before IBS implementation. Similarly, Pan & Pan (2020) have investigated eleven determinants (under three main categories – Technological Organisational, and Environmental) of construction robot adoption from the perspectives of building contractors. While in a study carried out by Mabad et al. (2021), there are thirteen factors influencing RFID adoptions in construction. The identified factors were organised into four dimensions: technological, organisational, environmental, and innovation factors. On the same note, Nnaji & Karakhan (2020) have identified significant Technology Adoption predictors for safety technologies which include RFID, VR/AR, Robotics & Automation, UAV, Drone, and BIM implementation in the United States. The predictors were grouped into four categories – External, Individual, Organisation, and Technology. The result indicates that 12 out of 26 predictors are highly influential in safety technology adoption decision-making.

Parallel with studies in other industries, Slowey (2015); Akanmu & Anumba (2015); Sardroud (2012); Smith (2014); Lasi et al. (2014); Aripin et al. (2019); Alaloul et al. (2020), stated the cost-saving potential of technology as a primary factor that influences an organization's decision to adopt a technology in the construction industry. In addition to cost savings, several studies indicated that skills & expertise (Chan et al., 2019; Lau et al., 2019; Olawumi et al., 2018; El Abidi & Ghazalia, 2015), government support (Salamak & Januszka, 2018; El Abidi & Ghazalia, 2015; Zakaria et al., 2017), top management support (Chan et al., 2019; Lau et al., 2019; Olawumi et al., 2018) and organisation readiness (Pan & Pan, 2020) play a big part in the adoption and implementation of innovative technologies in the construction industry. And due to the nature of the Construction Industry that is resistant to change (Bakhaty & Kaluarachchi, 2020; Chan et al., 2019; Lau et al., 2019; Olawumi et al., 2018), many previous studies stressed on compatibility and interoperability of innovative technologies with existing systems (Son et al., 2015; Al Yahya et al., 2018; Nnaji, 2019).

Some of the identified factors are challenges, barriers, or enablers of wider technology adoption in construction i.e. Gbadamosi et al. (2020) identified challenges of implementing IoT for smart construction, and Aripin et al. (2019), who reviewed benefits and barriers as factors influencing the implementation of technologies behind Industry 4.0 in the Malaysian Construction Industry rather than decision-making criteria in innovative technology adoption and implementation. Despite the increasing trend in the number of studies on innovative technologies in construction, however, those studies have not adequately addressed the deciding factors or decision-making criteria for innovative technologies implementation by the construction organisations. Relatedly, Oesterreich & Teuteberg (2016) in their study, stated that there is a future need to investigate the key factors and enhance understanding of these factors on successful implementation of Industry 4.0 technologies in the construction environment i.e. readiness of the construction companies.

They suggested a guideline for the successful implementation concerning the specific characteristics and requirements of the construction environment could be provided for companies to be considered before the implementation of innovative technologies.

DECISION MAKING IN CONSTRUCTION INDUSTRY

Decision-making is defined as the process of determining the best alternative among all possible choices but in practice, achieving an optimised result can be problematic as decision-makers are often confronted with various decision-making problems (Angelis and Lee, 1996; Darko et al., 2019). According to Milch et al. (2009) groups that lack a predefined decision-making mechanism default to using subjective methods such as experiential knowledge and personal judgement that may not be necessarily supported by empirical data. Although useful in certain domains, making decisions solely based on experiential knowledge and personal judgement without field experiments and empirical data could hinder effective adoption and implementation of innovative processes as a result of its implicitness (Rooke et al., 2006; Lam et al., 2007; Nnaji et al., 2018).

Construction decision-making problems in particular have been characterized as being complex, ill-defined and uncertain (Chan et al., 2009). The ability to make sound decisions is crucial to the success of construction activities and operations (Darko et al., 2018). In deciding on whether or not to acquire innovative technologies, the construction industry players are faced with the need to make short-term decisions that may have huge consequences in the long term, but they may lack a firm basis for making these decisions (Mahbub, 2015). At each decision level, decision-makers need to be aware of criteria that are specific to their scope. Lack of awareness of the criteria that are considered across the decision-making continuum as well as lack of transparency in decision making can potentially create tensions among stakeholders (Tanios et al., 2013; Stratil et al., 2020). Identifying which criteria are used across decision-makers is a first step to paving the road for more explicit decision-making (Stratil et al., 2020).

According to Chen et al. (2008); Li et al. (2000); and Nnaji et al. (2018), the construction industry generally lacks effective procedures for supporting decisions. To the best of the researcher's knowledge, only a limited number of studies have focused on identifying decision-making criteria for innovative technologies implementation in construction projects. There is also an absence of a formal decision-making model specifically in the Malaysian context. Currently, decision-making models in use in the construction industry rely almost entirely on subjective judgements using personal experience (Haymaker et al., 2013; Nnaji et al, 2020).

THEORITICAL BACKGROUND & CONCEPTUAL FRAMEWORK

In the innovation literature, the term adoption refers to the steps a decision-maker takes to make a decision to accept or to reject an innovation (Damanpour and Schneider, 2006). Many theories are applied in examining new technological innovation diffusion and adoption, including the theory of planned behavior (TPB), The technology acceptance model (TAM), the technology organization-environment/external (TOE) framework, diffusion of innovations (DOI), and the unified theory of acceptance and use of technology (UTAUT). The theories that provide a framework for technology adoption at an organizational level include the following – DOI theory, is one of the oldest social science theories that aim to convey how the likelihood of a new concept(idea) or product (good/service) gains momentum in its acceptance as it diffuses.

The TOE framework comprehensively defines the likelihood of a particular firm adopting and utilizing innovations based on technological-organisational-environmental/external and sociocultural factors. The combination of both of these theories is sometimes employed to achieve the same purpose (Oliveira et al., 2014). However, in the recent survey of research into technology adoption, these researchers found that the vast majority of the articles they reviewed (82.5% of the 285 articles reviewed) lacked a theoretical framework (Senyo et al., 2018). Among the reviewed articles which used a theory, only 8.3% used DOI, TOE, or a combination of both (Senyo et al., 2018).

For that reason, DOI theory and the TOE framework are employed. TOE framework was initially introduced by Tornatzky and Fleisher (1990) to understand the factors impacting new technology adoption in organisations. According to this framework, adoption of any technological innovation should be predicted from three different perspectives as Technology, Organisation, and Environment/External. TOE is the most well-known theory which has been widely used at organizational level innovation adoption studies in different contexts (Yadegaridehkordi et al., 2019).

The DOI theory attempts to explain the speed, diffusion method, and reasons for innovation spreading, considering both individual and organizational levels of adoption (Rogers, 2003). Most studies on organization adoption of new technologies use or draw on the DOI model (Tsai et al., 2010; Mabad et al., 2021). The extant literature also offers strong empirical support for the validity of the DOI model (Low et al., 2011; Mabad et al., 2021).

Authors believe that Songer et al. (2001) and Qin et al. (2020) argument to introduce economic factors into the technology adoption framework is valid, considering that firms may attempt to use the technology if at a low cost (Mahbub, 2015; Chan et al., 2019; El-Abidi & Ghazali, 2015; Hossain et al., 2020; Abanda et al., 2018); Extreme high initial investment will directly impact on organizations' decisions (Li, 2014). Since the TOE framework believes that the adoption of new technologies by organizations is primarily influenced by technology, organization, and environment, nevertheless organizations usually have a stronger willingness in trying a lower-cost technology due to lower risk of loss (Songer et al., 2001; Aripin et al., 2019). Return on investment means a new technology that brings quantifiable benefits could significantly offset relevant application costs (Cao et al., 2015; Pan & Pan, 2020). The technological context describes the characteristics of the innovative technologies and identifies the factors that affect an organisation's decision to adopt these technologies. As innovation laggards, construction organisations prefer to use technologies that have proven performance (Rogers, 2003; Nnaji et al., 2018).

Apart from that, several empirical studies found that some of the biggest barriers to Innovative Technologies decision are privacy and security concerns, such as resilience to attacks, data authentication, risk of data misuse, leaked information, access control and client privacy in various activities, like personal activities, business processes, transportations, and information protection would pose a threat to construction companies. (Chan et al., 2019; De Pace et al., 2018; Gamil et al., 2020; Alaloul et al., 2020; Sun et al., 2020; Nnaji & Karakhan 2020). Security and privacy ethical issues have not been prominent before but arose in Sun et al. (2018) study. Previous researchers, Alaloul et al. (2018) also mention that redundancy relating to privacy and data protection should be removed to ensure that the factors refer towards only a specific subject. Hence, considering the above, this study will also add Security as part of the conceptual framework.

To sum up, in this study, grounded by DOI theory and TOE framework as a basis, economic and security constructs are appended, resulting in technology (T), organisation (O), environment (E), economic (E), and security (S) as five constructs of the proposed TOEES conceptual framework as Figure 1 below.

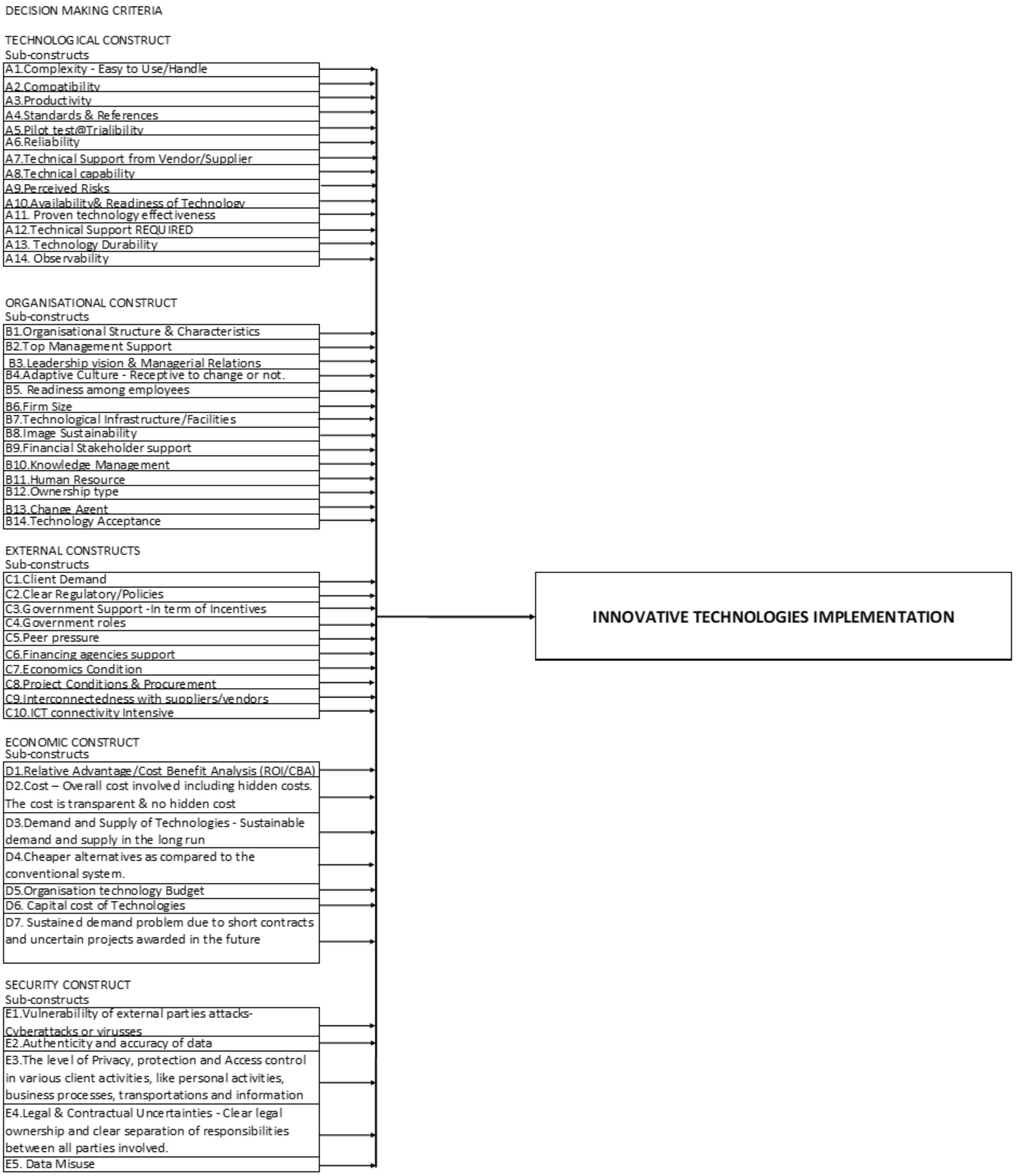

Figure 1. Conceptual Framework of The Research

METHODOLOGY

To achieve the objectives of the study, a review of existing literature on the topic was conducted to identify factors that influence the adoption and implementation decision-making of innovative technologies. The identified factors were then classified into five constructs (Technological, Organisational, Environmental/External, Economics, and Security) that influence the decision-making of innovative technologies implementation. A pre-test is carried out on eight (8) experts in the research field for face and content validity. Those experts are asked to give feedback and comments on the questionnaire. An expert from the statistic department is also referred to on the instrument scale. In terms of language, a language expert is referred to in ensuring the clarity of the instrument. Changes are made according to expert recommendations and suggestions. Finally, a pilot survey was conducted to determine the face and construct validity. For this purpose of study, a questionnaire is structured and the items are closed-ended type. The survey questions were designed to verify the identified factors and quantify the level of agreement on the decision-making criterion of each respondent by using a 5-point Likert scale ranging from 1 to 5 where '1' represents Strongly Disagree, "3" represents neutral, "5" represents Strongly Agree. A descriptive statistical analysis and a reliability analysis were performed using IBM Statistical Package for the Social Sciences (SPSS version 26.0). Reliability analysis was performed to ensure the overall internal consistency of the decision-making criterion prior to the next stage of data collection as it is important to measure the accuracy and consistency of feedback before pursuing the next level of analysis because for a test to be reliable, it also needs to be valid (Taherdoost, 2017). The purpose of measuring the validity of the instrument is to prove that the items are measuring what is intended to be measured (Field, 2005; Nawi et al., 2020). It is also, enlightens us on whether the item needs to be dropped or modified by examining its validity. Even though pilot study can be a bit tedious most of the time, it is very critical to check the validity, reliability, and practicality of an instrument (Ghazali, 2016; Nawi et al., 2020).

RESULTS AND DISCUSSION

Reliability Analysis

As for reliability analysis, SPSS version 26.0 output shows that 50 decision-making criteria under the five constructs identified in this pilot study were found to be having a quite good internal consistency were in each category scored a Cronbach alpha coefficient of .80 and above, with only one construct scored 0.759 but it is still within the acceptable range (Pallant, 2011). A five parts questionnaire was sent to 100 targeted respondents. The Technological (T) construct consisted of 14 items ($\alpha = .917$), Organisational (O) construct consisted of 14 items ($\alpha = .942$), External (E) construct consisted of 10 items ($\alpha = .887$), Economic (E) construct consisted of 7 items ($\alpha = .759$) and lastly, Security (S) construct consisted of 5 items ($\alpha = .914$).

Descriptive Analysis

100 sets of questionnaires were distributed to the targeted respondents. In return, 31 respondents responded. The distribution of the respondents is as follows, Project Managers (32%), General Managers (19%), Construction Managers (16%) and Senior Managers (Project) (13%), Technical Director (3%), Chief Executive Officer (3%), Chief Operating Officer (3%), Director (3%), Technology Manager (3%) and Associate Project Architect (3%). Almost half of the respondents have more than 20 years of experience in the construction industry (14%), followed by those having 11-15 years of experience (10%). The annual revenue recorded ranges between RM 1 million to above RM 1 billion. The respondents' involvement ranged from civil & infrastructure works, residential, commercial, highways, marine, and industrial projects.

In terms of the current implementation of innovative technologies in the Malaysian Construction Industry, survey data shows that 58% use modular & prefabrication in their projects, 65% use BIM in the majority of their projects, 48% use drones to monitor their construction projects, 35% use cloud computing, 45% use big data, 16% use Addictive manufacturing (AM) and 3D printing, only 10% use automated or robotics, 29% use virtual reality to foresee their ongoing projects' status and only 48% use internet of things to monitor their construction sites or to track equipment and materials on site. It is a clear evidence that innovative technologies implementation among construction organisations is still low in Malaysia. Even though Modular & Prefabrication and BIM technologies have been in the industry for quite some time now and reached the maturity level, the statistic shows the opposite trend. It can be concluded that the Malaysian Construction Industry has yet to stretch out and comprehend the opportunity of the innovative technologies implementation.

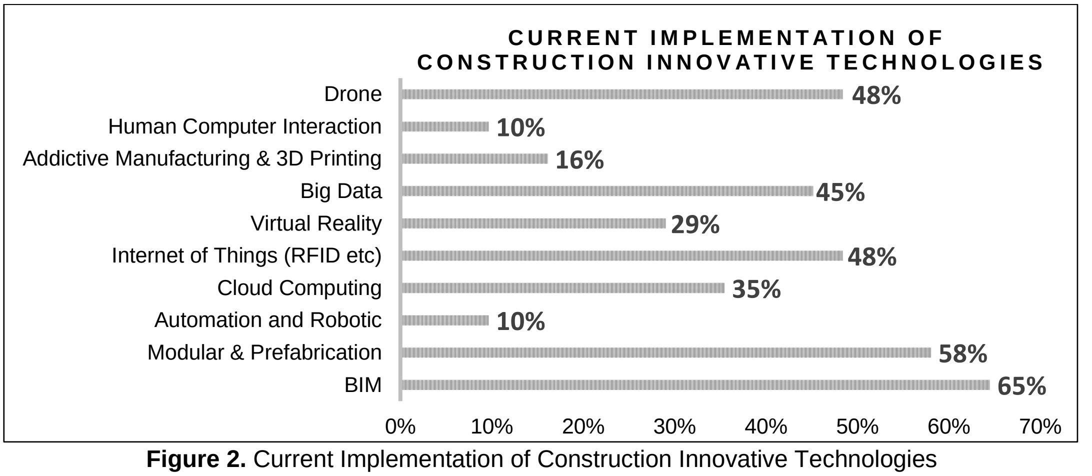

Figure 2. Current Implementation of Construction Innovative Technologies

Respondents are asked on the method(s)/strategy(ies) do they typically apply when deciding to implement a technology, 97% of the respondents stated they practice Cost-Benefit Analysis (CBA), 81% answered they weigh the pros and cons before the decision, 65% answered they use experiential knowledge, 32% use their personal judgement/intuition, 29% answered they are based on the need, 3% stated that multicriteria decision-making method and 3% stated they have no specific strategy.

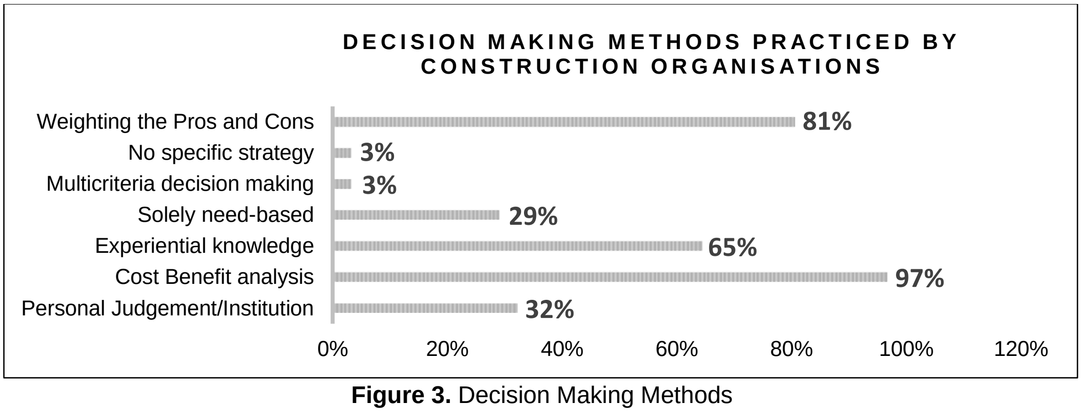

Figure 3. Decision Making Methods

Currently, two (2) most commonly used decision-making methods are cost-benefit analysis (CBA) and weighing on the pros and cons of technologies before their implementation. It is important to note that Cost Benefit Analysis (CBA) is a method translating quantitative costs into financial representation, however many important implications on innovative technologies that are qualitative in nature and are not included in the return of investment (ROI) indicators. This fact may have a negative impact in company decisions on the implementation of these technologies. It is difficult to compare these benefits with financial costs on investments. The perception of costs in this perspective is slightly ambiguous (Maresova, 2014). Despite weighing pros and cons of innovative technologies prior to the implementation, it seems that majority of the respondents are still unable to grasp the benefits of those technologies and this fact is actually affecting implementation decisions. Apart of that, 65% use their experiential knowledge to make decisions while 29% relying on their personal judgement for decision making. Only 3% (1/31) of the respondents answered they apply multicriteria decision-making method. This data finding reflects that, as construction decision-making is always time-consuming (Ghodoosi et al., 2021), there is a need to identify decision making criteria prior to innovative technologies implementation among construction organisations. By having a set of pre-determined criteria upon deciding innovative technologies implementation in their organisations, the decision making process can be expedited in the course of time.

Results of descriptive statistical analysis show that the identified decision-making criterion was found to be either important or very important based on the median value. One criteria was rated 5 out of 5. That is **- B3**. Leadership vision & Managerial relations – a clear vision and measurable innovation objectives (Organisational construct) with a mean value of 4.45, while the rest were rated 4 out of 5. The top 10 decision-making criteria for innovative technologies implementation are, **B4**. Adaptive culture – receptive to change (Organisational construct) with a mean value of 4.41, **A3**. Productivity – can improve other performance indicators i.e. time saving as well as promote health and safety of a project (Technological construct) with a mean value of 4.387, **A8**. Technical capability – have minimal defect and interoperability downtime to avoid problems in my projects (Technological construct) with a mean value of 4.387, **A7**. Technical support from vendor/supplier-availability i.e. round the clock technical support from vendor/supplier (Technological construct) with a mean value of 4.35, **B2**. Top Management support (Organisational construct) with a mean value of 4.35, **D2**. Cost – overall cost involved including hidden costs. The cost is transparent and has no hidden cost (Economic construct) with a mean value of 4.35, **A6**. Reliability - consistently meets performance requirement (Technological construct) with a mean value of 4.29, **C9**. Interconnectedness with suppliers/vendors **-** Continuous exposure and knowledge about those technologies (External construct with a mean value of 4.29, **B7**. Technological infrastructure/facilities to support the implementation (Organisational construct) with a mean value of 4.25 (refer to Table 1 to Table 5 below).

Table 1. Technological Construct Decision Making Criteria – Descriptive Statistics

CODE	SUBCONSTRUCTS	Median	Mean	Std Deviation
T	A3. Productivity - Can improve other performance indicators i.e. time saving as well as promote health & safety of a project	4	4.387	0.558
T	A8. Technical capability - Have Minimal Defect & Interoperability Downtime to avoid problems in my projects.	4	4.387	0.558
T	A7. Technical Support from Vendor/Supplier - Availability i.e. Round the clock Technical Support from Vendor/Supplier	4	4.355	0.709
T	A6. Reliability - Consistently meets performance requirement	4	4.290	0.588
T	A4. Standards & References -Complete manuals/guidelines on the operational processes	4	4.226	0.617
T	A5. Pilot test@Trialibility - Can be tried prior to purchase to be rest assured that I have made the right decision	4	4.226	0.617
T	A9. Perceived Risks - Acceptable perceived risks; no extra or special setting involving with the high cost	4	4.194	0.654
T	A13. Technology Durability	4	4.161	0.779
T	A12.Technical Support REQUIRED	4	4.129	0.763
T	A11. Proven technology effectiveness	4	4.129	0.718
T	A14. Observability -End user can observe performance prior to implementation	4	4.065	0.814
T	A1. Complexity - Easy to Use/Handle	4	4.000	0.817
T	A10. Availability& Readiness of Technology - Already in the in the Malaysian market, easy to obtain and ready to use at any time without any waiting period	4	3.871	0.991
T	A2. Compatibility - High level of Interoperability with existing technologies and will fit in seamlessly into the current operation	4	3.839	0.779

Table 2. Organisational Construct Decision Making Criteria – Descriptive Statistics

CODE	SUBCONSTRUCTS	Median	Mean	Std Deviation
O	B3. Leadership vision & Managerial Relations – A clear vision and measurable innovation objectives	5	4.452	0.6239
O	B4. Adaptive Culture - Receptive to change or not	4	4.419	0.67202
O	B2. Top Management Support - the degree of involvement in championing	4	4.355	0.66073
O	B7. Technological Infrastructure/Facilities to support the implementation	4	4.258	0.68155
O	B9. Financial Stakeholder support - Financial stakeholders' support by Investing on research centre or technologies databank	4	4.226	0.80456
O	B5. Readiness among employees - The level of training required by the employees	4	4.226	0.61696
O	B8. Image Sustainability - Competitive Advantage derived from using the technology	4	4.161	0.63754
O	B1. Organisational Structure & Characteristics - Practicing collective decision making	4	4.129	0.71842
O	B10.Knowledge Management - Knowledge on products and process-related to procure technologies	4	4.129	0.80589
O	B13.Change Agent - Dynamic team of think tanks and change agents is a must	4	4.065	0.81386
O	B14.Technology Acceptance - The potential level of resistance from employees	4	4.032	0.79515
O	B11.Human Resource - Ability & Capability to recruit Expert, Qualified and Trained workers	4	4.032	0.79515
O	B12.Ownership type	4	3.839	0.77875

Table 3. External Construct Decision Making Criteria –Descriptive Statistics

CODE	SUBCONSTRUCTS	Median	Mean	Std Deviation
E	C9. Interconnectedness with suppliers/vendors - Continuous Exposure and knowledge about that technologies	4	4.290	0.58842
E	C8. Project Conditions & Procurement - Suitability of projects, appropriateness of Technology and the procurement method is clear	4	4.194	0.65418
E	C10. ICT connectivity Intensive - High speed connectivity is provided by the respective authority	4	4.194	0.60107
E	C4. Government roles - Promotion by the Government	4	4.097	0.74632
E	C3. Government Support -In term of Incentives	4	4.097	0.70023
E	C2. Clear Regulatory/Policies	4	4.032	0.75206
E	C1. Client Demand	4	3.968	0.75206
E	C6. Financing agencies support - Incentives from Insurance companies as it will reduce workers' compensation	4	3.968	0.60464
E	C7. Economics Condition -Current Market Turbulence, Economic downturn, pandemic etc	4	3.968	0.65746
E	C5. Peer pressure - Other competitors have started implementing in their projects	4	3.839	0.86011

Table 4. Economic Construct Decision Making Criteria – Descriptive Statistics

CODE	SUBCONSTRUCTS	Median	Mean	Std Deviation
E	D2. Cost – Overall cost involved including hidden costs. The cost is transparent & no hidden cost	4	4.355	0.60819
E	C8. Project Conditions & Procurement - Suitability of projects, appropriateness of Technology and the procurement method is clear	4	4.194	0.65418
E	D6. Capital cost of Technologies	4	4.194	0.47745
E	D1. Relative Advantage/Cost Benefit Analysis (ROI/CBA) - A certain return on investment (ROI)	4	4.161	0.63754
E	C3. Government Support -In term of Incentives	4	4.097	0.70023
E	D5. Organisation technology Budget	4	4.032	0.60464
E	D3. Demand and Supply of Technologies - Sustainable demand and supply in the long run /has a long shelf life	4	4.000	0.8165
E	C6. Financing agencies support - Incentives from Insurance companies as it will reduce workers' compensation	4	3.968	0.60464
E	D4. Cheaper alternatives as compared to the conventional system	4	3.968	0.98265
E	D7. Sustained demand problem due to short contracts and uncertain projects awarded in the future	4	3.936	0.67997

Table 5. Security Construct Decision Making Criteria – Descriptive Statistics

CODE	SUBCONSTRUCTS	Median	Mean	Std Deviation
S	E2. Authenticity and accuracy of data	4	4.097	0.53882
S	E5. Data Misuse	4	4.097	0.74632
S	E4. Legal & Contractual Uncertainties - Clear legal ownership and clear separation of responsibilities between all parties involved	4	4.065	0.67997
S	E3. The level of Privacy, protection and Access control in various client activities, like personal activities, business processes, transportations and information protection	4	4.065	0.67997
S	E1. Vulnerability of external parties' attacks- Cyberattacks or viruses	4	3.871	0.84624

Interestingly, this finding is not parallel with the previous studies by the other researchers. Results from Venkatesh & Davis (2000) and Nnaji (2018b) studies indicate that technology attributes (technological construct) are the most important predictor of successful adoption and diffusion of technology. In this study, the Organisational construct topped the list. Surprisingly, cost or financial factors indicated as the most important by Mahbub (2015) in her study, also not included in the top five criteria. This is perhaps due to respondents' background – as they are those at top management level (managers) thus their point of view is inclined towards managerial perspectives. Productivity of innovative technologies is the third most important decision-making criterion. Technologies are expected to be highly productive and can enhance other performance indicators i.e. time saving as well as promoting the health and safety of a project. (Alalaoul et al., 2020). Technical capability is ranked as the fourth most important criterion. It portrays that the respondents prefer technologies that are capable as they are supposed to be with minimal defects & interoperability downtime to avoid problems in their projects or to cause a delay in their projects. Availability of round-the-clock technical support from a manufacturer ranked as the fifth most important decision-making criteria is consistent with Nnaji & Karakhan's (2020) study. In their study, it is ranked as the third most significant barrier to the adoption of technology for Occupational Safety and Health management that hinders stakeholders from adopting technology. It is not surprising for Top Management support sub-construct to be in the top 10 criteria as an organisation with robust support from its top management will have more opportunities to successfully reach its goal. Ranked seventh most important criteria upon deciding innovative implementation decision making is Cost or overall cost involved including hidden costs. This sub-construct expresses respondents' concern on the hidden cost of innovative technologies such as upgrading the existing facilities, technologies' accessories, training cost, maintenance cost, etc that would have impacted on organisations' finances. As for reliability, in DOI theory, Rogers (2003) also stressed on reliability sub-construct where technologies must be consistently meet the performance requirement. The respondents also felt that interconnectedness with suppliers/vendors or continuous exposure and knowledge about technologies is important. Lastly, technological infrastructure/facilities to support the implementation must be prepared beforehand so that the technologies will be fully utilised and will not be abandoned once acquired.

CONCLUSION

Generally, decision-making in construction has always been short-term and quickly done, with no room for indecisiveness. The same goes for innovative technologies implementation. The use of innovative technologies in the construction industry needs to be accelerated as low productivity continues to be a major issue. Therefore, it is time to expand knowledge in the field of construction innovation by identifying and quantifying decision criteria prior to innovative technologies implementation among construction organisations. This way, the decision-making process in light of innovative technologies implementation in construction projects by construction stakeholders can be expedited. Having a set of pre-defined criteria to look into would be beneficial for construction decision-makers in the future.

The pilot study results reveal that, besides the Technological-Organisational-Environmental/External (TOE) constructs, the two (2) newly added constructs, Economic (E) and Security (S) play an equally important role upon deciding the innovative technologies implementation in the Malaysian Construction Industry. In general, it can be concluded that, the majority of the respondents reached a consensus on the proposed TOESS decision making framework. It is an attention-grabbing that even though certain innovative technologies such as Modular & Prefabrication and BIM technologies have been in the industry for quite some time now and reached the maturity level, the statistic shows the opposite trend. The Malaysian construction organisations are currently relying on Cost Benefit Analysis (CBA), weighing the pros and cons, experiential knowledge and personal judgement rather than having pre-defined criteria to make decisions. To conclude, all 50 sub-constructs are important based on their median values. Leadership vision and positive attitude towards innovative technologies implementation are found as the most important decision making criteria for successful implementation of innovative technologies in the construction industry. However, sub-constructs of each construct will be reviewed again in the next stage to determine whether to be modified or removed completely based on the relationship strength between the other items.

This pilot study set a foundation for the development of a mature decision making model, however, as this is a pilot study, in the future, a larger sample size is needed to generate more accurate results within the Malaysian context. This study anticipated to serve as a guideline or checklist for construction industry stakeholders for technological adoption and implementation. It will also help to facilitate the use and stimulate higher implementation of innovative technologies by equipping construction organisations decision makers with crucial deciding criterion prior to technological implementation. Future research will be focusing on triangulation in order to obtain a better and more comprehensive research output.

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SUSTAINABLE SMART CITY (SSC) ATTRIBUTES VIA SYSTEMATIC LITERATURE REVIEW

Nadzirah Zainordin[1], Sui Lai Khoo[1], Zairra Mat Jusoh[1], Irna Nursyafina Rosdi[1], Ika Diyah Candra Arifah[2] and Kai Chen Goh[3]
[1]School of Architecture & Built Environment, Faculty of Engineering, Technology and Built Environment, UCSI University, Kuala Lumpur, Malaysia
[2]Digital Business Department, Faculty of Economics and Business, Universitas Negeri Surabaya, Indonesia
[3]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Malaysia

Abstract
In recent years, Sustainable Smart City (SSC) implementation have drawn significant attention as initiatives for enhancing urban development. Many studies have incorporated technical and non-technical characteristics to better control the growth of smart cities. However, despite considerable achievements, the direct and indirect effects of smart city characteristics on SSC have not been quantified comprehensively. Thus, the objective of this research is to identify the attributes of sustainable smart city via systematic literature review method. Only journal with Scopus index to consider as a references for this research with year interval of publication between 2012 to 2022. The findings of the thirty-two (32) attributes of SSC has been identified which this may further boosting the level of knowledge among built environment practitioner to have in-depth knowledge before it can be further adopting into relevant vision, mission, strategies or even policy maker.

Keywords: *Sustainable; Smart City; Attributes; Systematic Literature Review; Implementation*

INTRODUCTION

Cities are places where agglomeration economies are most profitable and bring cultural, economic and social benefits. However, increasing urbanization patterns are creating many problems such as inequality, pollution, aging populations and insecurity that reduce the quality of life in urban settlements (Fernandez-Anez, V., Fernández-Güell, J. M. & Giffinger, R., 2017). The concept of smart cities first emerged in the 1990s as an alternative to traditional planning methods, using new technologies (particularly his ICT) to address these issues. Smart cities are usually seen as a tool for solving urban challenges in an increasingly urbanized world. There is widespread agreement in the literature that there is not yet a uniform definition of susainable smart cities. The proliferation of smart city models, standards, and definitions has created ambiguity, making it difficult to assess how well existing smart cities meet the expectations and ideals of proponents of this paradigm (Grossi, G. & Pianezzi, D., 2017).

Smart cities are considered to be the future of national economic development (Gunjan Yadav, Sachin Kumar Mangla, Sunil Luthra, Dhiraj P. Rai, 2019; Jain, Brar, Malhotra & Rani, 2017). The concept has gained a lot of attention over the past two decades, with various researchers proposing concrete definitions to understand smart cities from their perspective (Khan, 2018). As a city with a strong technological database to connect people, share information, and build advanced transportation systems and intelligent buildings to improve people's quality of life (Gunjan Yadav et al., 2019). Bibri (2018), further emphasized by Gunjan Yadav et al. (2019) found that smart cities can be developed by applying cutting-edge communication and sensor technology to building infrastructure with smart energy systems, advanced construction technology, and advanced R&D systems.

SUSTAINABLE SMART CITY

Sustianable Smart City (SSC) development has emerged as one of the key aspects in developing the national economy and citizens' living standards (Sta, 2017). SSC are well equipped with advanced resources and technologies to improve people's living standards (Gunjan Yadav et al., 2019; Silva, Khan & Han, 2018). Developing of Sustainable Smart City (SSC) in developed countries is somewhat easier as they are endowed with advanced technologies, strong resources and effective urban planning strategies (Gunjan Yadav et al., 2019). However, the availability of existing smart cities will help them by acting as a roadmap for future development. This scenario is quite different from developing countries (Gunjan Yadav et al., 2019; Paroutis, Bennett & Heracleous, 2014). According to Gunjan Yadav et al. (2019), developing countries have already adjusted their financial commitments to achieve the base unit. In such cases, it becomes very difficult for developing countries to equip smart city development projects yet the emergence of sustainable element into it.

Developing countries more effectively aim for sustainable smart city development policies (SSC) in developed countries (Y. Zhang, M. Yutaka, M. Sasabe and S. Kasahara, 2021). Developed and developing countries will never have similar working scenarios (Gunjan Yadav et al., 2019; Vlacheas, P., Giaffreda, R., Stavroulaki, V., Kelaidonis, D., Foteinos, V., Poulios, G., 2013). It is therefore imperative that developing countries recognize the need to understand the attributes of Sustainable Smart City (SSC). This will help effectively develop the smart city agenda.

The Analogies of Sustainable Smart City (SSC)

In order to identify the attributes of SSC, it is very important to have a systematic literature review approach to examine the attributes of SSC reported by different researchers in the literature. To this end, a systematic literature review approach has been undertaken by from twenty (20) scholars which further reflected in detail in Table 1 and Table 2. This helped this research to see only articles relevant to this research work.

Table 1 outlined twenty (20) analogies of SSC. Emphasized by Y. Zhang, M et al., (2021), efficient and reliable access control in smart cities is critical for the protection of various resources for decision making and task execution. A. Kirimtat, O. Krejcar, A. Kertesz and M. F. Tasgetiren (2020); Gunjan Yadav et al. (2019); Aina (2017); and Han & Hawken (2017) agreed to conclude that SSC it’s a cities to adopt and laveraging the Information Technologies into operational and relevant process to shaped the cities into Sustainable Smart City (SSC). From an overview of the twenty (20) analogies of the SSC, further conclude that the large connections between designs, devices and the Sustainable Development Goals (SDGs) are well suited to define what the SSC envisions.

Table 1. The Analogies of Sustainable Smart City from Scopus Journal

No.	Analogies	Scholars	Year	Journal Name	Cite Scores	Scholars' Origin Country
1	Efficient and reliable access control in smart cities is critical for the protection of various resources for decision making and task execution.	Y. Zhang, M et al. (2021)	2021	IEEE Internet of Things Journal	17.1	China Japan
2	The city that is derived from the adoption and application of mobile computing systems through practical data management networks amongst all components and layers of the city itself to keep the city sustainable in future.	A. Kirimtat et al. (2020)	2020	IEEE Access	6.7	Czech Republic Hungray Turkey
3	A city that possesses strong technological database for connecting people, sharing information, advanced transport system, intelligent building to enhance the quality life of people.	Gunjan Yadav et al. (2019)	2019	Sustainable Cities and Society	14.4	India United Kingdom
4	The city identified as complex ecosystems grappling with the management of several social, economic, and environmental issues. Where city development needs to embrace cleaner production initiatives to balance the demands placed on the key sectors of health, energy, education, media, and other services.	Adapa (2018)	2018	Journal of Cleaner Production	15.8	India
5	The Smart City is very complex concept and has designed to support the future vision of smart cities which supported the new hybrid technologies and provide the value-added services to the citizens.	Ahmed & Rani (2018)	2018	Future Generation Computer Systems	18.7	United States India
6	The city considering the Internet of Things (IoT) is one of the key components of the ICT infrastructure of smart sustainable cities as an emerging urban development approach due to its great potential to advance environmental sustainability.	Bibri (2018)	2018	Sustainable Cities and Society	14.4	Norway
7	The smart city considering urban disaster and environmental protection, intelligent transportation, monitoring and evaluation of the urban resource centers as main key.	Lv et al. (2018)	2018	Future Generation Computer Systems	18.7	China
8	The emerging concept of the smart city has been acknowledged as a means of achieving sustainability by leveraging the advancements in Information and Communication Technology (ICT).	Aina (2017)	2017	The International Journal of Urban Policy and Planning	9.4	Saudi Arabia
9	The conceptual understanding of smart cities based on comprehensive and integrative approach to Smart Cities that links the three main issues identified: the key role of governance and stakeholders' involvement, the importance of displaying a comprehensive vision of Smart City projects and dimensions, and the understanding of the Smart City as a tool to tackle urban challenges.	Fernandez-Anez et al. (2017)	2017	The International Journal of Urban Policy and Planning	9.4	Spain

Table 1. The Analogies of Sustainable Smart City from Scopus Journal (Continued)

No.	Analogies	Scholars	Year	Journal Name	Cite Scores	Scholars' Origin Country
10	The “smartness” of a city seems related to its capability of providing infrastructures and services that improve the lives of its citizens where it act as a solution to problems such as aging of social infrastructure, CO2 emissions, and urbanization by considering three constitutive elements of the smart city: smart technology, smart people, and smart collaboration.	Grossi & Pianezzi (2017)	2017	The International Journal of Urban Policy and Planning	9.4	Sweeden United Kingdom
11	The Smart cities refer to the data economy, stimulation from ICTs and improved urban management from software algorithms integrated within the urban fabric where driven by technically inspired innovation, creativity and entrepreneurship.	Han & Hawken (2017)	2017	City, Culture and Society	8.1	Australia
12	Smart cities are emerging new technologies such as the Internet of Things (IoTs), e.g., RFIDs, environmental sensors, actuators, smart phones, wearable sensors, cloud computing, etc. Which these services and applications (e.g. participatory sensing provide the opportunity to collect and effectively use large scale city data for information awareness, urban planning, policy making and decision making.	Khan et al. (2017)	2017	Future Generation Computer Systems	18.7	United Kingdom Pakistan
13	The utilization of networked infrastructures to improve economic and political efficiency and enable socio, cultural and urban development.	Kummitha & Crutzen (2017)	2017	The International Journal of Urban Policy and Planning	9.4	Italy Belgium
14	Sustainable Smart City is related to the use of technology to improve urban services, whereas the second attempts for sustainable development.	Lopes & Oliveira (2017)	2017	Procedia Computer Science	3.6	Portugal
15	The emerging urban sites that promote sharing practices; exercise community-based forms of governance; and utilize local manufacturing technologies.	Niaros et al. (2017)	2017	Telematics and Informatics	13.9	Estonia Greece
16	Improving the quality of life of a city's citizen with the percentage of people living in urban areas continues to grow to be the big goal.	Palomo-Navarro & Navío-Marco (2017)	2017	Telecommunications Policy	6.2	Spain
17	Smart city is an urban additive vision for safely integrating numerous IoT and ICTs to address community benefits and advantages, including local offices information frameworks, colleges, power plants, schools, transit frame-works, hospitals, water delivery networks, and waste man-agreement networks.	Sta (2017)	2017	Future Generation Computer Systems	18.7	Tunisia

Table 1. The Analogies of Sustainable Smart City from Scopus Journal (Continued)

No.	Analogies	Scholars	Year	Journal Name	Cite Scores	Scholars' Origin Country
18	An overview some of the services that might be enabled by an urban IoT paradigm and that are of potential interest in the Smart City context because they can realize the win–win situation of increasing the quality and enhancing the services offered to the citizens while bringing an economical advantage for the city administration in terms of reduction of the operational costs.	Zanella et al. (2014)	2014	IEEE Internet of Things Journal	17.1	Italy Spain
19	The Internet of Things (IoT) is expected to substantially support sustainable development of smart cities.	Vlacheas et al. (2013)	2013	IEEE Communications Magazine	24.6	Italy Greece United Kingdom
20	Smart Cities concept by emergence the eight critical factors of smart city initiatives: management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment.	Chourabi et al. (2012)	2012	IEEE Access	6.7	Canada United States Mexico

The Attributes of Sustainable Smart City (SSC)

Various researchers have reported various attributes that facilitate the development of understanding of Sustianbale Smart City (SSC) (Gunjan Yadav et al., 2019; Fernandez-Anez et al., 2017; Kummitha & Crutzen, 2017). However, in current research work, it is important to identify enablers that promote this SSC development in developing countries. For an effective SSC attributes understanding, it is further tabulated in Table 2 below. Focusing on these thirty-two (32) attributes, on the other hand, becomes more important in the context of developing better understanding (Khan et al., 2017).

Table 2. The Attributes of Sustainable Smart City

No.	Attributes \ Scholars	A. Kirimtat et al. (2020)	Adapa (2018)	Ahmed & Rani (2018)	Aina (2017)	Bibri (2018)	Chourabi et al. (2012)	Fernandez-Anez et al. (2017)	Grossi & Pianezzi (2017)	Gunjan Yadav et al. (2019)	Han & Hawken (2017)	Khan et al. (2017)	Kummitha & Crutzen (2017)	Lopes & Oliveira (2017)	Lv et al. (2018)	Niaros et al. (2017)	Palomo-Navarro & Navío-Marco	Sta (2017)	Vlacheas et al. (2013)	Y. Zhang, M et al. (2021)	Zanella et al. (2014)	Total Times Referred
A1	Consumption of renewable energy resources Sustainable resource management	●						●	●	●				●								5
A2	Supportive environmental and entrepreneurial projects	●								●							●					3
A3	Sustainable resource management	●						●		●			●									4
A4	Immigration friendly environment	●		●						●	●				●	●						6
A5	Recycling of used resources	●			●					●	●											4
A6	Emission control system (vehicles and industries)	●			●					●		●										4
A7	Affordable housing facilities	●				●				●				●								4
A8	Development of smart buildings	●						●		●			●									4
A9	Adoption of innovative construction techniques	●							●	●		●		●								5
A10	Adequate water and power supply system	●	●							●				●								4
A11	Vision towards innovation and master planning	●								●	●	●								●		5
A12	Foreign direct investment (FDI)	●	●							●												3
A13	Project cost estimation	●				●			●	●	●			●								6
A14	Supportive government policies	●						●		●						●				●		5
A15	Planning for disaster management	●		●						●	●				●							5
A16	Enhancement of public-private partnership projects	●								●						●	●					4
A17	Education facilities	●						●	●	●				●								5
A18	Effective infrastructural facilities	●						●		●									●			4
A19	Innovative healthcare and sanitation facilities	●			●					●								●				4
A20	Availability of skilled and non-skilled workforce	●	●							●				●								4
A21	Uplifting literacy rate	●						●		●			●									4
A22	Tourist attractive projects	●				●				●				●				●				5
A23	Environmental protection	●							●	●		●		●								5

Table 2. The Attributes of Sustainable Smart City (Continued)

A24	Advanced research and development system	•								•										•	•	4
A25	Advance information and communication technology	•					•			•										•		4
A26	Smooth access to internet facilities	•					•			•										•	•	5
A27	Strong safety and security system	•								•												2
A28	Strong sensor system for city monitoring	•								•									•	•		4
A29	Solid waste management	•								•												2
A30	Intelligent parking system	•	•			•				•												4
A31	Accelerating pace of public transportation system	•								•			•					•				4
A32	Intelligent transportation system	•							•	•		•		•								5
A33	Development of pedestrian walkways and cycle paths	•		•						•	•				•							5

METHODOLOGY

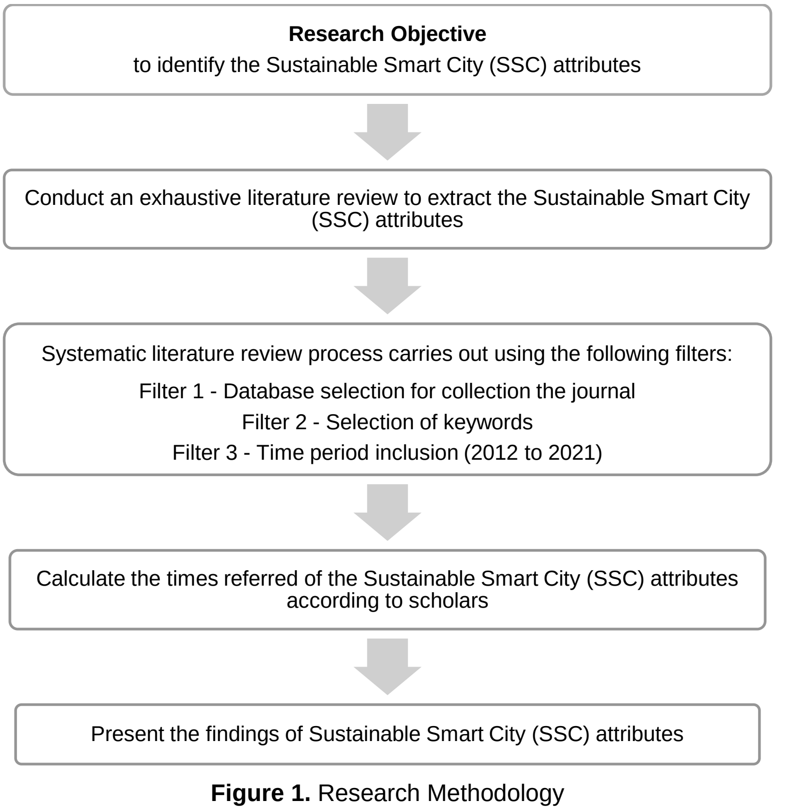

Figure 1. Research Methodology

The research methodology adopted for the present of research work is presented in Figure 1. In the initial phase, an exhaustive literature review is carried out to extract the Sustainable Smart City (SSC) attributes. Further with the systematic literature review process where there (3) filters has been set. There are:

a) Filter 1 – Database selection for collection the journal. Where in this research, the Scopus journal has been chosen.
b) Filter 2 – Selection of keyword. The keywords used are: 'sustainable city' and 'smart city'; 'sustainable smart city' and 'attributes'; and 'sustainable city' and 'smart city' and 'criteria'.
c) Filter 3 – Time period inclusion between year 2012 to 2021.

A systematic review was conducted using a combination of the keyword highlighted above. The attributes of Sustainable Smart City (SSC) has been tabulated according to scholars and number of times referred to the attributes has been tabulated accordingly. Last stage, presenting the findings on attributes of Sustainable Smart City (SSC) in the form of infographic presentation- sunburst. By referring to Figure 2, shown the numbers of Scopus journal has been used for this research. The highest numbers of journal coms from year 2017 (10 journals) and follow by 2019 (4 journals). Total 20 Scopus journal has been used for this research paper where the cite score further reflect on Table 1.

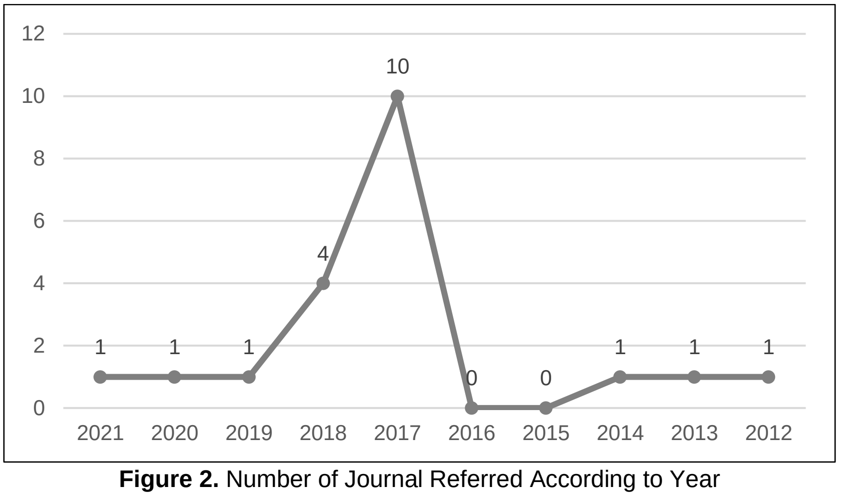

Figure 2. Number of Journal Referred According to Year

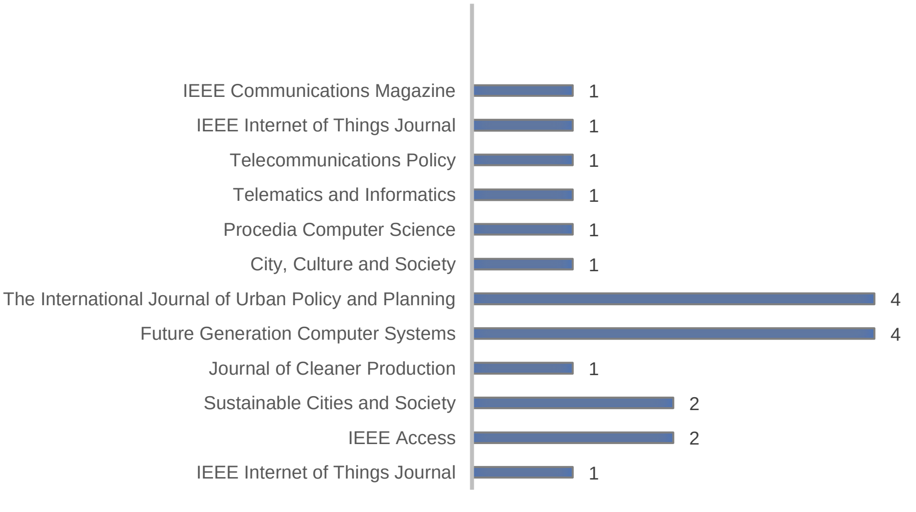

Figure 3. Number of Journal Referred According to Name of Journal

Figure 3 shown the name and numbers of journal according to name of journal. There are twelve (12) journals listed and the highest numbers of referred which are four (4) journals are The International Journal of Urban Policy and Planning and Future Generation Computer System with cite score 9.4 and 18.7 respectively. Follow by two (2) from Sustainable Cities and Society and IEEE Access with cite score 14.4 and 6.7 resepctively. The cite score for all twelve (12) journals used for this research paper are fallen between 3.6 to 24.6.

FINDINGS

Based on Table 3 and Figure 4, the ranking on thirty-two (32) attributes has been rank based on numbers of times referred and highlighted by the twenty (20) scholars. First rank are Immigration friendly environment (A4) and Project cost estimation (A13) with six (6) times referred. Second rank are Consumption of renewable energy resources Sustainable resource management (A1); (Adoption of innovative construction techniques A9); Vision towards innovation and master planning (A11); Supportive government policies (A14); Planning for disaster management (A15); Education facilities (A17); Tourist attractive projects (A22); Environmental protection (A23); Smooth access to internet facilities (A26); Intelligent transportation system (A32); Development of pedestrian walkways and cycle paths (A33) with five (5) times referred.

Table 3. The Attributes of Sustainable Smart City Ranking

Ranking	Attributes	Times Referred
1	A4	6
	A13	6
2	A1	5
	A9	5
	A11	5
	A14	5
	A15	5
	A17	5
	A22	5
	A23	5
	A26	5
	A32	5
	A33	5
3	A3	4
	A5	4
	A6	4
	A7	4
	A8	4
	A10	4
	A16	4
	A18	4
	A19	4
	A20	4
	A21	4
	A24	4
	A25	4
	A28	4
	A30	4
	A31	4

Table 3. The Attributes of Sustainable Smart City Ranking (Continued)

Ranking	Attributes	Times Referred
4	A2	3
	A12	3
5	A27	2
	A29	2

The thrird rank are Sustainable resource management (A3); Recycling of used resources (A5); Emission control system (vehicles and industries) (A6); Affordable housing facilities (A7); Development of smart buildings (A8); Adequate water and power supply system (A10); Enhancement of public-private partnership projects (A16); Effective infrastructural facilities (A18); Effective infrastructural facilities (A19); Effective infrastructural facilities (A20); Uplifting literacy rate (A21); Advanced research and development system (A24); Advance information and communication technology (A25); Strong sensor system for city monitoring (A28); Intelligent parking system (A30); Accelerating pace of public transportation system (A31) with four (4) times referred.

Follow by the fourth rank are Supportive environmental and entrepreneurial projects (A2) and Foreign direct investment (FDI) (A12) with three (3) times referred. The lowest rank are Strong safety and security system (A27) and Solid waste management (A29) with two (2) times referred by previous total twenty (20) scholars.

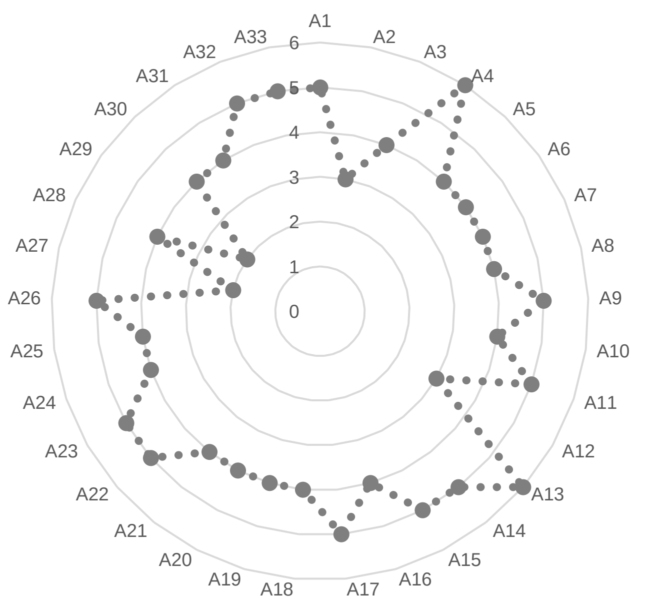

Figure 4. Spider-Web Tabulation Numbers Times Referred Attributes of Sustainable Smart City (SSC)

DISCUSSION AND CONCLUSION

A total of thirty-two (32) attributes has been highlighted in this research via the process of systematic literature review. Referring to Figure 5, the tabulation attributes of Sustainable Smart City (SSC) from the highest rank (inner sunburst) to lowest rank (outer sunburst) reflected accordingly. Among thirty-two (32) attributes, Immigration friendly environment

(A4) and Project cost estimation (A13) having the highest highlighted by the previous scholars. Taking into account the principles of smart and sustainable cities, the development of sustainable smart city sunburst attributes is inspired by the theme of smart cities, creating affordable, sustainable and intelligent, a new concept among "sustainable smart cities". Sustainable smart cities can therefore become energy self-sufficient, affordable, resilient and fully accessible. Moreover, smart citizens should benefit from these aspects and be environmentally friendly. Moreover, the current literature-based implementation of multi-objective optimization concepts covered in this research work can be implemented in current and future new construction projects and developments.

The concept of smart and sustainable cities should include some key words mentioned in the introductory section of this study. These terms include transportation, land use, environment, and their interrelationships with the Internet of Things (IoT). An ideal sustainable smart city structure must be balanced. Moreover, there is no one-size-fits-all solution that perfectly combines the aspects that make up a sustainable smart city. These aspects depend on the size of the city, accessibility to other cities, and accessibility to service centers. Therefore, the role of construction stakeholders, developers and policy makers is to bring these factors together given population size and proper functioning. Moreover, it is extremely important to provide the public with a clear and clear understanding.

The main purpose of this study was to sensitize the scientific community to the current state of smart city concepts and to demonstrate major future trends including sustainable smart cities (SSC) using IoT technologies and applications. Development (Sustainable Development Goals, SDGs) concept. The existing literature offers a range of research with a different emphasis than previous scientists around the world, with some key topics on sustainable and smart cities from Scopus Web.

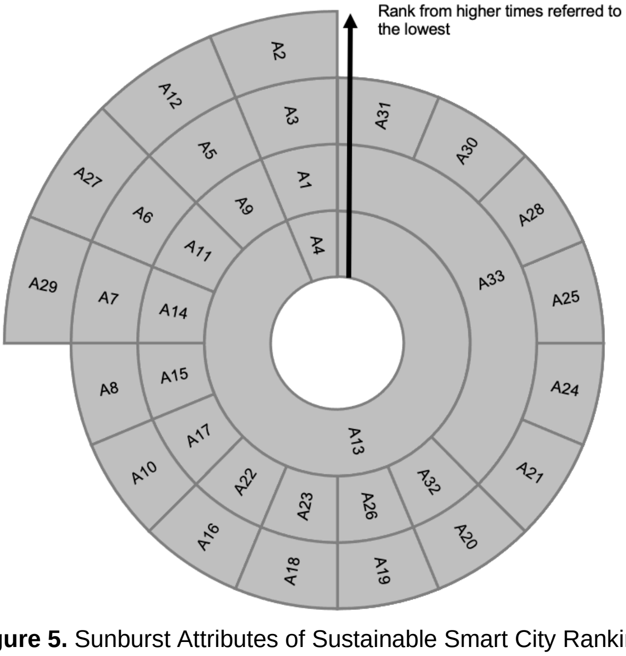

Figure 5. Sunburst Attributes of Sustainable Smart City Ranking

They concluded that there is still a lack of scientific reporting on sustainable smart cities (SSCs) based on current developments in scientific research. This seems like a good argument for future research. Using various data management technologies such as IoT, big data, cloud computing and some heuristic methods, we can consider implementing smart city key issues and methods for new construction projects and developments. In addition, real parameter optimization techniques with multiple targets are available for his SSC conceptual design. Given the high potential for forming residential areas of SSCs, SSCs have the potential to become the world's smart cities of the future. Perhaps future research can be successfully conducted considering input from experts. Believing in this research is beneficial to readers as it reveals the need to integrate sustainable smart city elements into future smart city concepts.

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DELIVER 21ST CENTURY QUANTITY SURVEYOR BIM SKILL SET: A SNAPSHOT OF ACADEMIC READINESS IN MALAYSIAN HIGHER EDUCATION INSTITUTIONS

Wong Shi Yin[1] and Wong Chee Hong[2]
[1]*Faculty of Built Environment, Tunku Abdul Rahman University College, Kuala Lumpur, Malaysia*
[2]*Practitioner and Adjunct Lecturer (MRISM, MRICS, MCIOB), Kuala Lumpur, Malaysia*

Abstract
The concept of digital construction is not new. Like many other nations, Malaysia has ventured into Industry Revolution (RI) 4.0, emphasised on digital transformation and integration to improve automation in manufacturing and communication with smart technology to assist in problem-solving and decision-making. In the context of the RI 4.0 and sustainability of built environment (BE), such an initiative confronts numerous challenging issues in management and governance, implementation policy, infrastructure, education and training, ethical and legal issues, Covid-19 pandemic etc. One of the key factors affecting the progress is lack of much needed skill sets for the implementation and adoption of the RI 4.0 technology. The objective of this research is to investigate building information modelling (BIM) curriculum readiness for quantity surveying (QS) programmes among the Malaysian higher education institutions (HEIs) on: (i) HEIs readiness in the BIM-enabled QS curriculum; (ii) the importance of BIM curriculum for QS Programmes; and (iii) solutions to enhance the BIM curriculum in HEIs, with a particular focus on how the interviewed HEIs deliver the BIM curriculum prior to and during the COVID-19 pandemic. The data collection exercise was conducted through an online interview and questionnaire survey. There were seventeen public and private interviewees selected from local HEIs. These interviewees held significant roles in delivering BIM QS curriculum. The findings shows that although the BIM uptake has been advocated by the local HEIs since early 2010s, it is noticeable that a number of the interviewed HEIs continues to face challenging issues when delivering BIM in QS programmes. The industry remains in a shortage of BIM capable graduates for the workforce.

Keywords: *BIM skill sets; BIM education; RI 4.0; Digital transformation; BIM training*

INTRODUCTION

It is a common perception that the architecture, engineering and construction (AEC) is a diverse industry and represents one of the most important sectors with a profound impact on national economic growth (Chia, Skitmore, Runeson, & Bridge, 2014). Nevertheless, the industry has a poor productivity and inefficiency in comparison to other sectors (Lee & Borrmann, 2020). One of the key factors of inefficiency is the inefficient in information management i.e., relied on two-dimensional (2D) interpretation of construction information (Lee & Borrmann, 2020). The adoption of BIM technologies can revolutionise current construction information management although the outcomes differ greatly depending on how the technologies deploy and the implementation policy within an organisation (Lee & Borrmann, 2020). From the cost management perspective, the process of quantification and cost reporting can be significantly improved by avoiding time-consuming work. Such benefits include improved quality, performance and accuracy, better visualisation, and improved information sharing (Ismail, Adnan, & Bakhary, 2019). Despite the aforementioned benefits, the adoption and implementation of BIM has been slow in the construction industry (Hossan & Nadeem, 2019).

One of the main responsibilities of QS is to ensure the costs are within the Client's budget throughout the project life cycle. Hashim, Yap, Kamarazaly, Chin, Yaakob and Loo (2021) pointed out in order to enhance and improve employability, QS graduates need to equip with basic BIM technical skills. With BIM technology, QS graduates can provide a quality service, increased efficiency of the cost and project management of a project. Concisely, the emphasis on BIM education among the QS students is crucial to form part of the QS graduates' key competencies and has significant impact on future QS's practises. However, according to Leo (2019) 25% of the graduates remain unemployed and one of the key factors is skills mismatch. This could be a setback for the HEIs where graduates do not have the prerequisite knowledge and skill sets when working in the AEC Industry.

Meanwhile Yusuf, Embi and Ali (2017) research shows that the implementation of BIM in HEIs is relatively slow. BIM skill sets and competency among the educators are low. Yusuf et al. (2017) findings revealed that one of the major issues in HEIs' education is that most of the educators within BE Faculty or Departments have not possessed the requisite BIM skill sets, lack of training and BIM qualification. On the other hand, Aziz, Yap and Zainon (2019) investigates current stage of BIM education for QS degree programme in the Royal Institution of Surveyors Malaysia (RISM) BIM Education Framework shows that 50% of the HEIs respondents fully embedded 2D and 3D quantification with BIM in the QS curriculum; 25% in Visualisation (basic 3D modelling); 29% in Planning and Scheduling (cost planning, evaluation, 4D scheduling and 5D costing) and 19% in Management (contract and professional practice in BIM integration). This indicates that HEIs has yet fully aware of the need to incorporate BIM into the BE curriculum.

Fortunately, in the past two decades global perspective, research in BIM education readiness has gained considerable attention e.g., Khosrowshahi and Arayici (2012); Abdirad and Dossick (2016); Rodriguez, Suresh, Heesom and Suresh (2017); Yusuf et al. (2017); Sadauskiene and Pupeikis (2018); Olatunji (2019) and Aziz et al. (2019). These studies reviewed BIM curriculum design in AEC and placed emphasis on individuals' HEIs implementation policy. In this research, the investigation focuses on Malaysian HEIs BIM education readiness for QS graduates in the 21st century i.e., (i) HEIs adoption of the BIM curriculum; (ii) the importance of BIM curriculum for QS Programmes; and (iii) solutions to enhance the BIM curriculum in HEIs, with a particular focus on how the HEIs deliver the BIM curriculum prior to and during the COVID-19 pandemic.

LITERATURE REVIEW

The Needs of BIM Education in QS Professional

Research conducted by Wu and Issa (2013) revealed that there is a gap between BIM adoption and the growth in recruiting BIM professionals. They suggested that advancing BIM education and recruiting BIM talents can fill the gap. Wong and Gray (2019) investigation found one of the major barriers of the BIM adoption is lack of tertiary education on BIM. High initial investment cost for training and software licensing contributes to the reluctance of BIM uptake among the survey construction organisations (Wong & Gray, 2019). To address this issue and a commitment to accelerate the BIM education and training, a MyBIM Centre i.e., a centre to provide affordable BIM Training (ABT) to the students and industry players has been set up by the Construction Industry Development Board (CIDB) (Akademi

Binaan Malaysia, 2019). The project partnered with six public universities in Malaysia to assist in a nationwide BIM education. Alongside with this initiative, private HEIs such as INTI International University / College and Tunku Abdul Rahman University College are already working in partnership with the software vendors to provide BIM education and training. However, lack of acceptance by the construction practitioners had an impact on the delay in the BIM education implementation among the Malaysian HEIs (Ibrahim, Esa, & Mustafa Kamal, 2019). Hence, it is vital to have the collective support and involvement from government, private sectors and HEIs to accelerate BIM education and uptake.

Barriers Affecting the Implementation of BIM Curriculum

BIM uptake required significant investment i.e., upfront costs for software, hardware, and the training of staff (Wong & Gray, 2019). Although this investment seems to be meaningful, it is not suitable for the HEIs as they could not make any profits from doing this. In addition, the HEIs are concerned about the cost of implementing new technologies as it has a high risk of changing the workflows and work processes (Allen Consulting Group, 2010).

Meanwhile, Ali, Mustaffa, Kear and Enegbuma (2016) developed a teaching and learning frameworks that consists of four dimensions (i.e., visualization, quantification, planning and scheduling and management) with the emphasis on the importance of improving the BIM skills of QS for both Diploma and Degree QS program in Malaysian HEIs. This implies that effective learning and strategic delivery of the BIM curriculum has been one of the challenging tasks to deliver BIM QS courses. In conjunction with the framework, Yap and Aziz (2020) found innovative and strategic teaching in BIM curriculum can have a significant impact on preparing QS graduates's BIM capability to meet the industry demand. According to the research carried out by Yusuf, Embi and Ali (2017), majority of the lecturers under the Faculty of Built Environment in the Malaysian HEIs do not have a requisite qualification or undergo any BIM training. This has an impact on getting sufficient educators to deliver BIM curriculum to the students (Memon, Rahman, Memon, & Azman, 2014).

To produce quality graduates with BIM skill sets for the construction industry, HEIs shall embed a standard curriculum into their syllabus to allow students to understand the principle of BIM technology. Although many HEIs started to offer BIM in their QS programmes, it will usually focus on general software training (Suhaida, Osman, Abdul Razak, & Shazwan, 2019). This is due to the fact that most educators still believe that BIM technology is just another version of the CAD programme that students should learn in their own time (Shelbourn, Macdonald, McCuen, & Lee, 2017).

Benefits of BIM

BIM allows a project to be designed, managed and monitored in a most efficient and effective process through better integration, collaboration and execution. It connects multidisciplinary project team members to allow data, workflows at every stage of the project to share, retrieve and continuously update and to improve the delivery process (Brydea, Broqueta, & Volm, 2012). Realising the benefit of BIM uptake, a BIM Roadmap (2014-2020) has been rolled out by the Malaysia government agency (CIDB, 2014). These benefits will be detailed in the following sections with a particular focus on the impact on QSs' practices.

Technical Benefits

The last two decades witnessed a swift change from traditional 2D CAD (computer-aided design) to the use of 3D BIM (3-dimensional geographical building information modelling) technology. This allows cost estimation and quantification performed in a simpler and more effective project life-cycle management (Arayici & Aouad, 2010). The cost data and other construction information can be stored and retrieved simultaneously in a BIM model, changes and updates can be made throughout the project life cycle (Ghaffarianhoseini, et al., 2017). The use of Common Data Environment (CDE) platform supports and enables data exchange enhanced effective project management and operational collaboration between the AEC team members. Therefore, the implementation of BIM will improve the collaboration between inter-organisational and increase productivity in the construction industry (Miettinen & Paavola, 2014).

Integration Benefits

BIM can provide an accurate quantification for building materials and components during a design stage compared to the conventional method (Irizarry, Karan, & Jalaei, 2013). In addition, BIM allows the building model to link with time, thus it provides the possibility to simulate the construction process and detect clashes (Savitri, Juliastuti, & Pramudya, 2020) during the procurement process and therefore improved buildability during the construction stage.

BIM dimensions which represent the process of linking additional dimensions of data to building models will also provide a better understanding of a construction project (McPartland, 2017). BIM has its extension of “nD” modelling which indicates different dimensions of design information required and need to be generated throughout the whole project lifecycles (Lee, et al., 2005). A 3D BIM model has more details in comparison to a 2D CAD as it involves more dimensions. According to Smith (2007), there are 8 Dimensions within a 3D BIM model, namely 3D (object model), 4D (time), 5D (cost), 6D (operation), 7D (sustainability) and 8D (safety). These “nD” models are interrelated and can have significant impact on cost and project management as discussed in the RISM Education Framework (Ali, Mustaffa, Kear, & Enegbuma, 2016).

Decision Support Benefits

BIM can accelerate the process of analysing various energy performances which allows them to avoid and reduce the environmental impacts and operational costs. When BIM has been fully utilised on visualisation at the early stage, alternative design solutions can be developed to provide different cost estimates and materials used for a project. This allows the project team rehearsing their complex procedure such as scheduling, planning, site mobilisation and manpower allocation to foresee the possible scenario that would happen (Rajendran, Seow, & Goh, 2014).

To conclude, the aforementioned benefits gear towards the awareness of BIM adoption in the construction industry among QS graduates and supporting BIM-enabled QS programmes in Malaysian HEIs.

RESEARCH METHOD AND EMPIRICAL SURVEY

The research was conducted through a detailed literature review primary on the current stage of BIM education in Malaysian HEIs and followed by an empirical survey. The empirical survey has been carried out during COVID-19 pandemic nationwide lockdown period (February 2021 to November 2021). Qualitative method has been adopted in this research to allow deeper understanding of HEIs' experience and phenomena in the context of BIM curriculum implementation, policy, strategies and challenging issues faced.

Purposive sampling, also known as judgement sampling, has been used to identify the selected set of samples whether they are qualified to become the target interviewee (Frey, 2018). This is due to specific phenomena and data related to current BIM education are needed to achieve the objectives mentioned earlier, thus the interviewees must fully understand the essence of BIM knowledge and skill sets before taking part of the survey.

A hybrid mode of empirical survey i.e., online interview and questionnaire survey has been conducted in this study. The interview questions consist of a series of open-ended questions to collect data related to the study. The targeted interviewees consist of six public HEIs and eleven Private HEIs who offer QS diploma and degree programmes accredited by the QS Accreditation Council (QSAC) and the Board of Quantity Surveying Malaysia (BQSM). They were asked to complete the survey by the attached questionnaire from the email through a link to Google Form or book a timeslot for a virtual interview session. There were eight educators responded to participate in this empirical survey.

DATA ANALYSIS

The analysis was performed and presented in four main sections i.e. (i) Demographic data of interviewees; (ii) HEIs' readiness to adopt the BIM curriculum; (iii) The importance of the BIM curriculum; and (iv) Proposed solutions to enhance BIM curriculum. For brevity, the findings will be summarised in key points with tables and figures in the following discussion.

Demographic Data

According to the findings (Table 1), there were six interviewed HEIs with less than 3 years teaching experience in BIM. In terms of BIM QS software, on average there were 4.6 academic staff teaching BIM QS from the interviewed HEIs. However, in regard to the strategies to deliver QS software in teaching and learning (TL), it was found that there were two interviewed HEIs do not have a coherent strategy when delivering TL in BIM-enabled QS software.

Table 1. HEIs' Experience to Delivery BIM Enabled QS Software

Background	Interviewee			
	A	B	C	D
Designation	Head of Programme	Programme Coordinator	Head of Built Environment	Senior Lecturer
Experience in teaching BIM Level 2	< 3 years	< 3 years	< 3 years	< 3 years
No. of Staff to teach BIM QS software	3	4	4	2
No. of BIM facilities	1	1	2	1
TL Strategies in BIM QS software	Yes	Yes	Yes	Yes

Table 1. HEIs' Experience to Delivery BIM Enabled QS Software (Continued)

Background	Interviewee			
	E	F	G	H
Designation	Assistant Professor	Associate Professor	Senior Lecturer	Senior Lecturer
Experience in teaching BIM Level 2	< 3 years	< 3 years	< 6 years	< 6 years
No. of Staff to teach BIM QS software	8	4	6	6
No. of BIM facilities	1	2	1	2
TL Strategies in BIM QS software	No at the moment	Still being deliberated	Yes	Yes

HEIs Readiness to Adopt BIM Curriculum

Findings from subjects and modules in the QS programme related to BIM show that at least one subject or module related to BIM (Table 2). This indicates that the surveyed HEIs understood the importance of the BIM skill sets to incorporate in their QS Programme.

Table 2. Subjects or Modules Related with BIM in the QS Programme

Interviewee	Comment(s)
A	BIM QS Software
B	Building Quantities III
C	Information and Communication, Digital Technology Use in Construction
D	Building Information Modelling
E	Computer-Aided Quantity Surveying
F	Cost Modelling and Measurement
G	IT Management; Integrated Project
H	BIM Application, Technical Drawings, Cubicost

Table 3. Delivery Method of BIM Curriculum Before COVID-19 Pandemic

Interviewee	Comment(s)
A	A special ***3-4 days' workshop*** will be conducted for final semester students.
B	At the moment, we only give them a few lessons to ***take off simple drawings with CostX***.
C	The theory, tutorials as well as BIM series will be ***conducted by the industry experts***.
D	We ***engage the software providers*** for the training.
E	Usually delivered by ***academic staff***. Occasionally, we ***invite industry practitioners*** to give a sharing/talk to our students.
F	***Face to face classes*** will be conducted to ensure students can understand well on the BIM subject.
G	Using ***online platforms***.
H	Using ***online learning*** by academic staff and industry invitation guests.

In regards to the delivery of BIM TL during pre-COVID-19 pandemic, two interviewees (G and H) used online platforms to deliver their TL (Table 3). Interviewee H further explained that their institution utilised online learning facilities by inviting the practitioners as special guests to share their construction experience with QS students. On the other hand, interviewees B, E and F conducted their BIM curriculum in a traditional method i.e. face-to-face physical classes to ensure their students can get immediate assistance and guidance from the lecturer and tutors throughout the TL process. Nevertheless, Interviewees A, C and D have different methods to deliver BIM curriculums for their QS students i.e. by conducting workshops, tutorials and training sessions assisted by practitioners and software vendors, while interviewees C and D indicated that engaging industry experts can provide meaningful training. For instance, the software provider will be engaged to assist the educators in guiding and tutoring students during TL sessions.

During the COVID-19 pandemic, findings from the interviewees show that majority of the interviewees were still able to deliver the BIM curriculum (Table 4). Interviewees C, E, G and H explained that their teaching has been conducted through a virtual lab and online platform. Interviewee F highlighted that student are allowed to download the BIM educational licensed software for TL purpose during the pandemic. However, other interviewed HEIs were forced to stop offering BIM curriculum to the students. Interviewees D and A revealed that many students' computers do not meet the system requirements to support BIM software and thus the BIM curriculum has been modified to suit the restrictions and needs. However, this situation will be reversed once face-to-face classroom teaching is allowed.

Table 4. Delivery Method of BIM Curriculum During COVID-19 Pandemic

Interviewee	Comment(s)
A	No. They will be given ***face-to-face training*** after the ***campus learning is resumed***.
B	Not decided yet as the subject will only be ***offered next semester***. But we plan to get the students to ***download the student licence copy*** if we are still in remote learning mode.
C	Yes, we conduct our class through a ***virtual lab***.
D	Most students ***do not have the adequate hardware*** to support BIM software. Therefore, we ***modify the curriculum*** and BIM will only be ***offered when face to face classes*** are allowed.
E	Yes, they continue to use and learn the software ***via online teaching and learning***.
F	Yes, students can ***download the software free of charge*** for their use.
G	Yes, we still conduct our daily classes using the ***online platform***.
H	Yes, they are ***still using*** the software to learn.

The Importance of BIM curriculum in QS Programme

Table 5. Major Reasons to Include BIM Curriculum into QS Programme

Interviewee	Comment(s)
A	The main reason is to ***ensure the employability*** of the graduates.
B	It is to meet the industrial demand and produce graduates with ***higher employability***. Nowadays, lots of employers are looking for QS graduates who know how to use BIM software.
C	To realise a ***smart construction environment*** by providing real-time scheduling and costing of construction projects.
D	The major aim is to ***nurture future graduates***, at the same time ***incorporating industry feedback***.
E	The ***current industry is using software heavily***, therefore, it is a must for us to get our students trained.
F	BIM software is ***increasingly being adopted by the industry*** including in Malaysia.
G	It is due to the ***digital construction effort***.
H	To give students advanced learning and gain a new skill set of BIM knowledge as BIM is important to show them ***great exploration concerning the construction industry***.

The findings revealed a consensus in perception of the importance of BIM curriculum in the QS programme. Majority of the interviewees agreed that the increasing demand of the construction industry has become one of the key factors to include the BIM curriculum in their QS Programme (Table 5). Interviewees A and B perceived that QS graduates with BIM capability are able to enhance graduates' employability. Interviewee G highlighted that the decision to include BIM curriculum could be due to part of the digital construction efforts. This idea has been reiterated by interviewees E and F i.e., the BIM adoption in construction gaining momentum and the industry more inclined to recruit QS graduates with BIM capability. Moreover, apart from implementing industry-driven BIM curriculums, interviewee D indicates that the introduction of an education framework and feedback from the industry is what they were concerned about. This clearly shows that the HEI's endeavoured to work in collaboration with the industry for the BIM curriculums. Interviewees C and H revealed that a smart construction environment i.e. real time scheduling, costing and exposure to new skill sets have been part of the major reasons to include BIM in the QS programme.

In terms of how to increase the awareness among QS students, Table 6 shows that six out of eight interviewees suggested inviting industry practitioners for guest lectures can help to increase awareness among QS students. They can provide hand-on skills and contemporary knowledge compared to the traditional class-room based TL. However, Interviewees A and C have different opinions i.e. instead of expecting students to attend the workshops or seminars conducted by the practitioners, a more proactive way is to introduce stand-alone BIM-related subjects and to incorporate them into their coursework and assessment strategy. This inevitably makes TL in BIM become important and to encourage their students to investigate further.

Table 6. Suggestions to Increase the Awareness Among QS Students

Interviewee	Comment(s)
A	The proactive way would be to ***incorporate BIM elements into the coursework and assessment strategy***. Students who have been exposed to BIM software during their training would appreciate the importance of BIM in their career advancement.
B	Encourage students to ***attend more BIM-related workshops or seminars.***
C	We may increase the awareness of students by ***introducing stand-alone BIM courses*** in institutions of higher learning.
D	Students may experience the ***exposure through industry practitioners***, and through ***intensifying research on BIM awareness and challenges***.
E	HEIs may ***invite industry players*** for a ***sharing session***.
F	Give the students ***proper and sufficient exposure*** to the capability and potential of BIM.
G	HEIs should either encourage their educators or engage the experts from the industry to share their ***practical experience and knowledge***.
H	To ***share examples to students*** on how BIM brings benefits to the construction industry and related parties.

In the context of the importance of support and incentives to promote BIM QS curriculums (Table 7), findings show that the support from the government agencies is crucial. Interviewees B, C and E advocated that subsidy shall be provided by the government agencies to the HEIs to reduce financial burden of software licensing. On the other hand, Interviewees D and F highlighted examples of the agencies' efforts such as the BIM Centre runs by CIDB, and a BIM research centre monitored by Jabatan Kerja Raya (JKR) Sarawak. This demonstrates the government's initiatives to share the responsibilities of promoting digital construction in collaboration with the HEIs. Besides, Interviewees A and H revealed that BIM guidelines and the BIM management requirements for G5 contractors (project value exceed RM3 million) and above to promote BIM in construction. It has a significant impact on promoting good practice and streamlining current BIM implementation in the construction industry. Interviewee G also emphasised the importance of having support from the government because they are the policy maker and promoter of influential BIM adoption in the construction industry.

Table 7. Importance of Supports and Incentives from Government Agencies

Interviewee	Comment(s)
A	The government initiative is crucial. PWD can impose ***mandatory requirements on the BIM management approach*** to all mega or large government projects undertaken by G5 and above contractors.
B	Yes. Some of the BIM relative software are quite ***expensive for their licence fee***. This might become a hurdle for HEIs to purchase and integrate with the syllabus.
C	Yes. The government may provide support by ***subsidising the implementation cost of BIM*** in institutions of higher learning.
D	Yes. ***JKR Sarawak*** is completing a ***research centre*** that will focus on digital construction, where BIM will be a major component in future projects.
E	Yes. ***Providing subsidies in BIM software*** adopted in HEIs may be a good idea.
F	Yes. CIDB is running a ***BIM Centre*** that allows students to visit.
G	Of course. The support from the government shall be able to ***encourage and increase the awareness*** among the public toward the BIM curriculum.
H	Yes. The government ***implemented BIM projects*** and ***set guidelines*** to promote BIM in construction.

There is a common perception of the BIM curriculums in HEIs becoming important in the next three years (Table 8). Demand for BIM capable QS graduates will be increased and as a consequence BIM education in HEIs will become more demanding in the next three years. Interviewee G emphasised that the industry would focus more on the coordination and management of BIM. Interviewees A and E also highlighted that the BIM curriculum will become a common subject in all HEIs. Interviewee A further elaborates that the level of demand and how significant this will be will depend on external factors such as the government's initiatives.

Table 8. Future of BIM Curriculums in HEIs in The Next Three Years

Interviewee	Comment(s)
A	To ensure HEIs stay competitive and relevant to the industry would have to ***introduce the basic knowledge and competency in BIM QS Software***. Whether there is a significant demand for graduates with these capabilities is ***mostly dependent on many other external factors***, i.e., a government initiative.
B	Since more and more construction firms are using BIM software, the ***demand for graduates with BIM capabilities*** will ***surge***.
C	There will be a ***higher demand for BIM-skilled academics*** to teach BIM curriculum in institutions.
D	Depends on location. In Borneo, it may ***take slightly longer***, but BIM is ***irrefutably the future***.
E	It will become a ***common subject*** in all HEIs.
F	There will be a significant increase in the ***demand for students with knowledge about BIM***.
G	It will be focusing more on ***BIM coordination and management***.
H	BIM will be ***demanding,*** and future graduates will have a ***big opportunity for their careers***.

In terms of the BIM curriculums in HEIs in the next five years, findings show that there is a general agreement that the demand for BIM capable QS students will be significantly higher than currently perceived (Table 9). Four of the interviewees indicate that the industry will be more inclined to recruit QS graduates with BIM capability than those without BIM skill sets. Along the line, in order to keep abreast of latest BIM developments, interviewee C revealed that the collaboration between HEIs and practitioners are essential. Afterall, interviewees E, G and H opined that in the future QS graduates "must" be fully prepared and equipped with BIM technologies.

Table 9. Future of BIM Curriculums in HEIs in The Next Five Years

Interviewee	Comment(s)
A	In the long run, BIM would be a ***highly sought-after competency***.
B	The demand for graduates with ***BIM capabilities*** will continue to ***surge*** and BQSM might even impose BIM related software to be set as one of the ***compulsory core subjects*** in QS courses.
C	The need for ***collaboration*** between BIM-skilled academics and industry experts will ***become higher***.
D	Graduates with significant ***BIM knowledge and skills*** will be an ***advantage*** to any companies or institutions seeking to expand their operations globally.
E	All local/private graduates ***must be equipped*** and know how to use ***BIM software***.
F	That should be the ***trend in the future***.
G	All the QS graduates should be ***equipped with BIM technologies*** now.
H	Graduates will be ***fully prepared and equipped with BIM technologies*** and understand the whole process of BIM.

Solutions to Enhance the BIM Curriculum

Responses from the survey show that 50% of the interviewees agreed that current BIM education approach is good enough and able to accommodate the demand of the market (Table 10). Interviewees A, B, G and H agreed that the current BIM education approaches are adequate and able to satisfy the constructions' needs and expectations. This has been further explained by how the syllabus developed and delivered to the students. However, Interviewees C and E argued that HEIs have yet to be ready to accommodate the needs of the construction industry due to the lack of experienced BIM educators and hindered by the high software licence fees. Interviewee F indicates that there is a challenge on this matter as different HEIs have their own pace to develop and enhance their BIM education. Furthermore, interviewee D indicates that current BIM curriculums still room for improvement.

Table 10. Current Status of BIM Education Approach

Interviewee	Comment(s)
A	BIM is still at the ***infancy stage in Malaysia*** which I think the BIM Educational Framework introduced by BQSM is adequate for the current industry's needs.
B	Yes. HEIs have ***done a great job*** in nurturing BIM capable QS graduates.
C	No. There is still a ***lack of BIM-skilled academics*** to incorporate BIM in their teaching. There is still a need to introduce BIM standalone modules or courses.
D	Yes, but with still ***room for improvements***. Additionally, collaboration with the industry is a must.
E	There are still ***not many HEIs using or teaching*** BIM software due to high license fees.
F	It depends on the ***individual institution's strategy and approach*** to ensure that students can meet such demands and expectations.
G	Yes. The skill sets of QS graduates shall be ***able to meet the requirements of market demands***.
H	Yes. The ***course structure*** has been designed to meet the market demand.

Current approach and strategies in the BIM curriculum implementation are varied. According to the findings (Table 11), interviewees A, C and G revealed that regular revisions and updates are necessary to ensure their students are able to learn the latest BIM skill sets. Interviewee G indicates that the programme structure has been reviewed to include the BIM elements into the syllabus. Similar opinions were found in Interviewees B and D responses. The HEIs always encourage their lecturers to be consistently involved in BIM related workshops and seminars or to work in collaboration with the practitioners to ensure they are on the right track to deliver up-to-date BIM skill sets to the students. This finding has been reinforced and supported by the Interviewee F, where hands-on sessions delivered by the lecturers and practitioners in the BIM subjects are crucial.

Table 11. Current Structural Approach of HEIs

Interviewee	Comment(s)
A	The ***revision of our programme structure and syllabus*** has taken into account the BIM elements spelt out in the BIM Educational Framework (by BQSM).
B	***Lecturers*** need to equip themselves with BIM capabilities by attending ***training, seminars and workshops*** which are BIM related. Besides, ***HEIs*** need to keep ***connected with industry experts*** like the ones who know the needs of the construction industry. Additionally, the ***purchasing of BIM software*** needs to be updated and renewed from time to time. As for ***students***, their awareness and readiness can be enhanced by ***attending BIM-related workshops, seminars and integrating BIM*** into our syllabus.
C	Our university has Introduced a ***BIM-focused degree programme***. We deliver about four BIM-related courses to our students.
D	We constantly ***engage industry professionals*** to enhance our teaching and learning. We always have ***collaborations with BQSM, CIDB, JKR, PAM and other regulatory bodies*** that are regularly conducted via a variety of platforms to keep our curriculum on track.
E	**Practises and guidelines**
F	A ***good introduction*** to the concept of BIM and some ***hands-on sessions*** on using the BIM software is required when delivering BIM knowledge to the students.
G	The HEI has reviewed the programme structures ***to include the BIM curriculum***.
H	The current approach is based on the ***niche of the curriculum*** which BIM is the ***strength and new skills*** as a great opportunity to be learned.

Table 12. Short-Term and Medium-Term Strategies and Approaches

Interviewee	Comment(s)
A	As a private education provider which is mostly market-driven, we must always ***be vigilant*** and ever ***ready to attune*** ourselves to the industry's needs. However, we have to strike a balance ***not to overlook other competencies*** which form the fundamental knowledge of quantity surveying practice. Specifically, we emphasise the Level 1 competency - knowledge and understanding and Level 2 competency - application of BIM QS software (basic/elementary operation of software).
B	For short term strategies, HEIs need to ***plan for space and facilities*** for the incorporation of BIM into programmes. For medium-term strategies, HEIs can ***collaborate with professional bodies or industries*** that know the demands and needs of the construction industry. This collaboration will be useful as a platform for sharing ideas and skills.
C	It is advisable to ***increase the availability of BIM-trained staff***.
D	As discussed just now, our university has Introduced a ***BIM-focused degree programme***, whereby we have about four BIM-related courses for our students to ***prepare themselves*** before joining the construction industry.
E	We shall always check on the ***MQA requirements***. Besides, the ***sharing by industry players*** and ***demand from industry*** are the key factors to be taken into account.
F	HEI should plan it well. They shall make sure that the relevant staff members have gone through ***certified training*** for the BIM software to be used, ***attended the training*** on the concepts of BIM, and ***formulate suitable coursework*** for the software to ensure a positive learning experience for students.
G	HEI should focus on a ***bigger picture of digital construction***.
H	Adopting BIM into the QS programme is a great start as QSs, especially consultants, give lots of ***contributions*** to the construction industry. Need to ***polish the course*** following the current demand.

In terms of short- and medium-term strategies and approaches to ensure HEIs readiness in delivering BIM curriculum in the QS programme, Table 12 shows interviewees A, B, E and H agreed that the contribution of the construction experts is mandatory for short- and medium-term strategies and approaches. This is because sharing ideas and skills from the experts provide a more specific direction for the educators to plan their teaching materials. Besides, interviewee H highlighted that one of the tasks that need to be done by the HEIs is to "polish" their programme structure for QS students. This idea can be supported by the opinions shared by Interviewee A. The HEIs shall not only focus on the industry's needs but other possibilities that can enhance the BIM Level 1 (knowledge and understanding) and Level 2 (usage of BIM software). Interviewees C, D, E, F and G indicate that the HEIs are in an important position where they shall always validate the formulation of programme structure and qualifications of their lecturers and tutors. For instance, Interviewee F suggested that the educators shall have gone through the certified training for BIM software and always attended the training on the concepts of BIM. Interviewee G explained further that the HEIs shall have the foresight to vision a bigger picture of digital construction.

In regard to important resources needed to enhance and implement BIM education, findings show that (Table 13) there is a common perception among the interviewees that having experienced and trained educators and academic staff are vital. Interviewees A and F further explained that the educators shall ensure they are familiar with BIM software, knowledge, and skill sets to deliver TL in BIM. Interviewee D further explained these educators shall be able to deliver BIM knowledge and skill sets and know-how to deliver praxis-oriented learning. Other than that, interviewees B, C, E and H highlight that the resources are relatively important in enhancing TL in BIM education. These resources including BIM infrastructures i.e. BIM software, BIM lab and BIM centre. Interviewee G indicates that the technology, people, and process are equally important in the context of enhancing the implementation of BIM education.

Table13. Important Resources to Enhance and Implement BIM Education

Interviewee	Comment(s)
A	An ***experienced trainer*** with a certified BIM software qualification.
B	***Well-equipped staff*** and ***availability of BIM-related software and computers***.
C	People and Technology i.e. ***Trained staff*** and ***availability of resources***.
D	Getting the ***right people***, not only with academic research capabilities but also with the ***proper know-how to deliver praxis-oriented learning*** meaningfully that fulfils the intricate demands of project management.
E	The ***software*** and ***trainers***.
F	The staff shall be ***familiar with BIM skill sets, BIM lab and the software***.
G	Technologies, people and the process are the critical factors. There is ***no one superior to another***.
H	The important thing is the ***BIM tools*** and ***industry expertise***. Understand the whole process of real BIM and implement it in a real situation. Exploring real practice and technologies is the main key.

CONCLUSION

HEIs' Readiness to Adopt BIM Curriculum into QS Programme

From the findings and analysis, it can be concluded that all the interviewed HEIs were implementing BIM curriculum in their QS Programme. Majority of them were able to continue to deliver the BIM curriculum through online platforms to the students. Some HEIs even started to develop their BIM curriculum using online platforms prior to the pandemic lockdown which shows that these interviewed HEIs already established more efficient ways to deliver the BIM curriculum. The findings also show that HEIs engage the experts from the construction industry to have seminars, workshops or talks to share their construction experience with the QS students. This indicates that effective delivery of the BIM QS programme required strategic and innovative approaches through industry collaboration (i.e. workshop, open digital platform, project-based learning etc). This is in line with finding from Aziz et al. (2019).

Discussion on The Importance of Adopting BIM Curriculum into QS Programme

A number of benefits of BIM have been analysed and stated in this research. Besides, the findings indicate that the main reason for HEIs to include BIM curriculum is to ensure the employability of the QS graduates. This is due to the increasingly high demand from the construction industry to recruit BIM capable graduates. The statement is supported by the forecast of BIM curriculum status in the next three and five years. Furthermore, the findings also show that sharing sessions conducted by practitioners are vital to provide students with proper and sufficient exposure to increase their awareness of BIM technology. This is vital given the increasingly global adoption of the digital technology particular in the context of IR 4.0 (Hussain, Husain, Roslan, Fadzil, & Ani, 2019).

Discussion on The Solution to Enhance BIM Curriculum in HEIs in Malaysia

As stated in the analysed data, majority of interviewees agreed that they are well prepared to nurture BIM capable QS graduates for the industry. This is mainly due to their syllabus designed and planned based on the industry requirements and the BIM education framework recommended by BQSM. However, minority of the interviewees argued that current HEIs lack trained educators and financial support, which had an impact on the HEIs in delivering BIM education. According to the findings, QS graduates shall at least possess reasonable BIM skill sets and be able to improve their employability Such findings in line with the research conducted by Hashim et al (2021). The collaboration and support from government agencies are vital to promote the BIM curriculum in HEIs in Malaysia.

Recommendations for Future Research

This research is related to the readiness of HEIs in Malaysia towards BIM education in QS curriculum. As it is focusing on the HEI’s perspective on BIM education and implementation, future research will be focused on practitioners’ perceptions in the context of how industry responds to the HEIs QS graduate with BIM capability in the job market. It is anticipated that the findings will provide valuable feedback for the HEIs’ QS programmes to deliver the prerequisite BIM skill sets for QS graduates.

SUMMARY

This research focused on the readiness of BIM education for the QS programme in HEIs. A discussion on the research objectives has been carried out to ensure the research objectives can be achieved. The research findings show that the Malaysian HEIs currently working toward to provide sufficient and qualified BIM capable QS for the construction industry. The interviewed HEIs currently working in collaboration with the industry players to deliver their BIM curriculum with innovative approaches. This study serves as a useful and valuable reference for both educators and practitioners in relation to the readiness of HEIs to nurture qualified QS graduates with sufficient BIM knowledge and skill sets. The future research in this context will be focused on the practitioners' perceptions to identify the needs and the success of the BIM curriculum of the QS graduates in the construction industry.

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DETERMINING THE CURRENT PRACTICES IN BUILDING MAINTENANCE MANAGEMENT FOR PUBLIC UNIVERSITY BUILDINGS IN MALAYSIA

Prescilla Palis[1], Mohd. Saidin Misnan[2] and Sylvia Gala Mong[3]
[1]*University of Technology Sarawak, Sibu, Sarawak, Malaysia*
[2]*Universiti Teknologi Malaysia, Skudai, Johor, Malaysia*
[3]*Universiti Teknologi MARA Cawangan Sarawak, Kota Samarahan, Sarawak, Malaysia*

Abstract
As the primary purpose of a university is to generate high-quality graduates, university buildings that are regarded as valuable assets and resources have a significant role in this process. Therefore, building maintenance management is crucial to extend the lifecycle of university buildings, besides ensuring that all university operations continue to function optimally. Despite the prior investigation in this research field, maintenance of university building appears to be a trivial factor. As such, this present study looked into the practices of building maintenance management in five Malaysian public universities. Data gathered from 10 building maintenance experts via interview were analysed via single- and cross-case analyses. The study outcomes revealed that the university maintenance department deployed the following practices; prioritise maintenance, planned maintenance, preventive maintenance, and corrective maintenance.

Keywords: *Current Practices; Building Maintenance Management; Public University Buildings; Malaysia*

INTRODUCTION

The core function of a university is to educate and train students to become graduates and experts in multiple areas that contribute to the progress of a country in attaining high-income status (Olanrewaju & Abdul-Aziz, 2015). Apart from generating intellects, universities mould the attitude and working culture that dictate how a country flourishes in all aspects. Essentially, universities have a significant role in driving the economy of a country, as well as preparing a workforce that is innovative to compete at the global scale (Olanrewaju & Abdul-Aziz, 2015).

As Malaysian universities are a critical factor that steers innovation towards becoming a high-income country, the growth of this tertiary education system has been given much emphasis. As a result, the last decade witnessed higher enrolment of students, research publications, patent registrations, and institutional quality in Malaysian universities (Olanrewaju & Abdul-Aziz, 2015).

Universities are an emblem that promotes educational activities, such as teaching and learning, as well as research work publications. As these activities demand exceptional amenities, functional facilities, and an environment that is conducive; the building condition must be maintained to promote educational values and offer comfort to the users. Hence, the maintenance work quality of university buildings, which are viewed as asset and not liability, reflects the value of the buildings as regarded by the universities (Lateef, Khamidi & Idrus, 2010; Olanrewaju & Abdul-Aziz, 2015).

The lifecycle of a university building begins from construction, operation, and to demolition phases. The building operation phase, which involves a range of academic activities such as workshops, classrooms, and laboratories; demands endless maintenance activities due to damages that occur over time (Lateef et al., 2010; Olanrewaju & Abdul-Aziz, 2015). Hence, appropriate maintenance must be considered by the university management to ascertain the functionality of the buildings.

Unfortunately, the management of some universities dismisses the significance of building maintenance to extend the building lifecycle. When building defects are ignored, those facilities may need to be demolished due to damages beyond repair and new buildings would be erected. Although constructing a new building offers higher education quality and better academic facilities, the priority should be maintaining the existing building to serve its purpose – provide an educational setting that is conducive for learning to take place (Lateef, Idrus, & Faris, 2011). Demolition is, on the other hand, an economical or technical aspect (Lateef et al., 2010; Zulkarnain, Zawawi, Rahman & Mustafa, 2011; Olanrewaju & Abdul-Aziz, 2015) that incurs more cost than maintaining a building that already exists.

Multiple defects detected with regular building maintenance facilitates in minimising maintenance costs (Peng Au-Yong, Shah Ali & Ahmad, 2014; Salim, Salleh & Zahari, 2016), whereas neglecting the damages in building increases maintenance cost (Lateef et al., 2011). Damages on buildings increase over time due to multiple factors, including natural events and extreme weathers, that first affect the exterior of the building and followed by interior defects in long run – ultimately defeating the function of the building and jeopardising the safety of the users (Zulkarnain et al., 2011). As depicted by Zulkarnain et al. (2011), damages found in buildings during inspections must be resolved to ensure the safety and utility of the building, as well as the comfort enjoyed by users when using the building.

In comparison to building construction and demolition, Sightlines (2014) and Lateef et al. (2011) asserted that university buildings are linked with two waves – construction and maintenance. In the initial wave; construction, the high space demand that reflects the growing number of graduates matches neither the university budget nor the existing space in those half century buildings. This leads to exorbitant management costs and waste of resources. Meanwhile, most public universities in Malaysia have transitioned to self-funding mode (Lateef et al., 2011); where maintenance and repair costs are a burden. As a result, building management is often dismissed.

Maintenance of university buildings adequately executed on continuous basis is significant, as building damages accelerate over time. Apart from minimising the cost of building maintenance, appropriate maintenance practices ascertain optimum building performance. Well-managed and well-maintained university buildings offer support to the academic institutions in meeting their goals and become a valuable national asset. Hence, the objective of this study is to determine the present practices in building maintenance management in public university buildings across Malaysia.

PUBLIC UNIVERSITY BUILDING MAINTENANCE

Today, universities and other institutions of higher learning use a variety of methods to keep their facilities in good repair. Classrooms, labs, staff housing, and student hostels are among the structures. Different maintenance procedures are used depending on the age of the university, which ranges from more than 50 years to less than a year. This is related to the maintenance capacity of the university (Albrice, 2013; Au-Yong, Ali and Chua, 2016).

Maintenance programmes are always aimed at extending the life of the structure for as long as possible because building replacement is not only costly but also time consuming, potentially interfering with the institution's operations. Maintenance is carried out on university buildings to extend their service life by delaying the pace of deterioration, decay, and failure (Idrus et al., 2009; Lateef et al., 2011). The building's maintenance tasks range from cleaning work to fundamental activities such as roof, window, and door replacement, as well as electrical wiring and energy management (Idrus et al., 2009; Lateef et al., 2011). However, for the purposed this study, the researcher will only focus on the current building maintenance practices employed by the public universities in Malaysia.

CURRENT PRACTICES FOR THE MAINTENANCE OF PUBLIC UNIVERSITY BUILDINGS

Studies have revealed that public universities worldwide deploy certain practices for maintenance of their buildings. Upon assessing the building maintenance practices in Malaysian universities, Idrus, Khamidi, and Lateef (2009) identified that most of these tertiary-level institutions executed planned, corrective, predictive, and preventive maintenance of the buildings or combination of these.

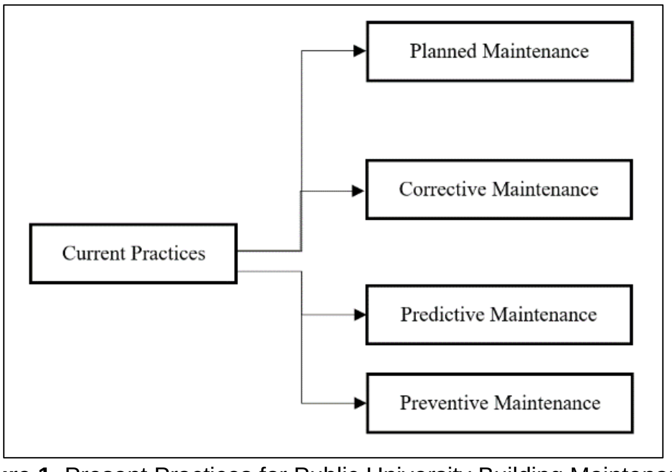

Figure 1. Present Practices for Public University Building Maintenance

Planned Maintenance

Murthy, Atrens, and Eccleston (2002) studied the methods and theories that make up the framework for strategic planning to execute maintenance. They developed a framework for a plan by linking the functions of support to be line with corporate strategies with other services. The study deployed an analytical methodology to develop a systemic method in order to build the framework. The study outcomes revealed that planned maintenance was successful due to the extent of involvement that the major stakeholders and the top manager dedicate towards a project. A building system needs updated records or documents about its repair and maintenance activities. Inadequate papers on repair and maintenance translates into delayed repair and maintenance process due to limited information that permits the maintenance operation (Akcamete, Akinci, & Garrett, 2010). Some benefits of having timely maintenance and updated documents are reduced downtime and evasion of a significant cost incurred during massive repairs. Besides, planned maintenance extends the lifespan of equipment and facilities (Akcamete et al., 2010). Regular service to equipment increases lifespan and reduces risk for costly repairs. Planned maintenance also enhances safety in a facility (Akcamete et al., 2010).

Corrective Maintenance

Corrective maintenance entails initiating maintenance when the building has failed and is aimed at restoring the building to its original condition. This approach is awfully expensive and results in low user satisfaction (Idrus et al., 2009; Lateef et al., 2011). Corrective maintenance conducted based on the condition of the building is referred to the as traditional type of maintenance. This type of maintenance, according to Idrus et al. (2009), contributes to several maintenance backlogs and does not provide value to the stakeholders of those buildings.

Corrective maintenance is mainly reactive as opposed to being proactive and systematic (Idrus et al., 2009). Preference for corrective building maintenance, which is common among university building maintenance managers, was attributed to the outsourcing of maintenance services (Lateef et al., 2011). Upon investigating the use of corrective maintenance practices for university buildings, the findings reported by Lateef et al. (2010) are in line with outcomes discovered by Idrus et al. (2009) that most institutions of higher learning deploy corrective maintenance programs. While important, physical inspection encourages poor service delivery amid the costly maintenance. Lateef et al. (2010) indicated that corrective maintenance is failure based.

Predictive Maintenance

Yam, Tse, Li, and Tu (2001) and Ferrarese and Piazza (2012) claimed that predictive maintenance denotes techniques of maintenance for identifying the condition of the building system and the state of equipment that are in use to estimate on time suitable for executing a maintenance practice. According to Carvalho and Lopes (2015), predictive maintenance saves more cost when compared to preventative maintenance. This type of maintenance allows the proper allocation of a convenient date to carry out corrective maintenance, thus reducing chance of failure by the equipment and other systems installed in a building (Carvalho & Lopes, 2015).

In particular, predictive maintenance focuses on gathering specific information about the conditions of the equipment to identify precisely which equipment or building part needs servicing more than the other (Yam et al., 2001; Ferrarese & Piazza, 2012; Carvalho & Lopes, 2015). As a result, structures and machines benefit from the maintenance thus elongated lifespan. For example, Carnero (2006) studied on setting up programs for predictive maintenance. Predictive maintenance not only offers a safe way, but also improves the quality and availability of the industrial plants. Carnero (2006) added that the process of setting up a program depends on strategic decision making. Hence, many organisations lack the measures to analyse that enable the setup, control, and management in predictive maintenance.

Preventive Maintenance

Albrice (2013) and Au-Yong, Ali and Chua (2016) referred preventive maintenance to the practice of maintaining the general conditions of buildings before the lifespan or before the failure of the facility systems. In this type of maintenance, the daily activities involve redecoration on the exterior part of the house, internal decoration, general repairs, as well as checking and replacing faulty electrical and plumbing systems. Through preventive maintenance, one can effectively retain old facilities with the least destruction. As preventive maintenance prevents failure of structures and systems, it helps in maintaining the status of the decorative finishes on the buildings.

The primary goal of preventative maintenance is to retain the structures and equipment to remain functional until the date of the planned maintenance (Forster & Kayan, 2009; Flores-Colen & De Brito, 2010; Carvalho & Lopes, 2015). Some primary activities include overhaul of equipment and systems, lubrication of moving parts in a machine, and replacement of worn parts within structures (Forster & Kayan, 2009; Flores-Colen & De Brito, 2010; Carvalho & Lopes, 2015). This kind of service increases lifespan and efficiency in work, thus lowering the cost of maintenance.

RESEARCH METHODOLOGY

Research is a systematic process in which data are collected, analysed, and interpreted to improve the understanding of an interest or a concern. Data and methodology are likely to depend on each other as such the correlation should be established between the research methodology and the nature of the gathered data to solve the research problem (Creswell, 2013). The objective of this study is to identify the current practices in building maintenance management for public university buildings. Therefore, after outlining the research questions and reviewing the relevant literature, this section specifies the methods used for data collection in line with the research objectives.

Research Design

Research design or strategies of inquiry are the strategies and the practices for research that traverse the steps from expansive hypothesis to certain strategies for collecting data, addressing research questions or testing hypotheses (Creswell, 2013). The three common categories of research design are quantitative, qualitative, and mixed methods. Turning to this study, the qualitative research approach was adopted.

According to Neuman (2014), the emphasis of a qualitative study is on the quality and profundity of data while not on the extent of the data. As thick and detailed data were collected in this study, the qualitative design suits the most. The scholarly literature depicts that the design of a study has a crucial role in the whole process of the study since it outlines the deeper framework for the collection of data as well as its formulation, as required in any other scholarly research.

The qualitative research approach narrates and describes the general experience of people being studied before making any conclusive remark. Application of the qualitative method for data collection enables researchers to investigate the best ways to execute building maintenance management practices in universities into deeper details.

The other explanation for selecting the qualitative approach in this study is as illustrated by Flick (2014) and Neuman (2014); qualitative research focuses on the general explanations and meanings generated by the individuals being studied. Getting to understand an individual involves deep investigations on their beliefs and giving reflections on their general beliefs (Flick, 2014; Neuman, 2014). With that in mind, the researcher considered it practical to investigate the best ways of building maintenance management practices by interviewing staff involved in such practices.

Research Method

This study adopted the case study methodology. The method of case study denotes the collection of data only from those relevant, instead a fraction of merely assumed representatives from the whole population. Outcomes retrieved from this type of study presents only the information from the cases involved during a specific point in time when the study is conducted, thus dismissing generalisability of the outcomes with other contexts (Yin, 2013; 2017).

Although this approach does not consume much time, its drawback relates to the investigation of a single situation among the cases selected. However, specific cases can be used to project what is happening in the entire population (Yin, 2013; 2017). The case study method is the most suitable approach in this study primarily because it directly assessed the best ways of building maintenance management practices deployed in five public universities.

Research Setting and Participants

This section describes the sampling techniques applied in this study. A case study was performed on five selected public universities to identify the practices deployed for building maintenance management, as well as to identify the main factors that affected the building maintenance cost. The selected universities for this study were given pseudonyms; (C1) to (C5), to retain confidentiality.

It is indeed necessary to capture opinions from experts regarding the current practices in building maintenance management for public university buildings. It is based on such expert opinions that best practices for effective building maintenance management are outlined in this study. The study sample comprised of the highest authorities from the five selected universities and are experts in the field of building maintenance management. The ten university maintenance department authorities were chosen, with two experts from each university. The participants were selected by using the purposive sampling method and the experts who volunteered to take part in this investigation were included in the data collection. Purposive sampling was used to explore the feature or process of interest to the researcher. This method allowed for the focus to be put on what the experts felt and to explore the reasons (Neuman, 2014; Crossman, 2017).

Data Collection Method

Interview sessions were conducted with the high authorities safeguarding the buildings in the five mentioned universities to gather data for this study. The interview sessions were scheduled according to the convenience and availability of the concerned authorities at the universities. It is believed that the environment of the universities determines the comfort in the process of teaching and learning, as well as for conducting research work (Yin, 2013; Fellows & Liu, 2015).

Therefore, the researcher decided to interview the highest authorities in the universities who gradually became part of the building, its maintenance, and the infrastructure. The interview gathered details concerning aspects of building maintenance, challenges of maintenance, infrastructure of laboratories, hostels, and classrooms, role of administration in maintaining the building, defects identified, and practices applied to resolve the issues. For the purpose of data collection, an interview expert was employed. Essentially, interviews allow for face-to-face discussion among the selected university participants regarding building maintenance practices (Corbetta et al., 2015).

Additionally, the interview process allows for an exploration of the complex decision-making process involving staff in implementing building maintenance activities. Capturing the vast perceptions from staff about building maintenance facilitates in determining the effective implementation of building maintenance strategies. Therefore, conducting the interview sessions on a one-to-one scale equipped the researcher with detailed information related to the study. Interviews also allow one to take notice of body language and non-verbal feedback, in addition to the information stated formally.

Data Analysis

Data analysis is another major part of any qualitative study. In this study, after the interview, all the recorded interview was transcribed. The transcribing process was performed by using verbatim techniques that embedded body language, pause, and facial expression of the participants. Next, the transcript was analysed manually, whereby the data were coded into several categories. Several themes emerged based on the general argument in the literature and interpretation of words from the participants. Williamson, Given and Scifleet (2017) pointed out that prior theories from pilot case, review of the literature, and convergent interviews can all be linked to a given case being studied by doing what is referred to as data collection and analysis. In respect to the mentioned transcripts, making summaries of the important dimensions is equally strategic while analysing qualitative data.

RESULTS

Five case studies were performed in this study to identify the present practices in building maintenance management for public university buildings. Apparently, four practices were identified based on the ranking that the selected public universities had adopted to maintain their buildings, as illustrated in Table 1. The details are explained in the next section.

Table 1. Recommended/Acceptable Physical Water Quality Criteria

Unit of Analysis	C1	C2	C3	C4	C5
Present Maintenance Practices	1. Planned	1. Preventive	1. Prioritise	1. Planned	1. Planned
	2. Preventive	2. Planned	2. Planned	2. Preventive	2. Preventive
	3. Prioritise	3. Prioritise	3. Preventive	3. Prioritise	3. Prioritise
	4. Corrective	4. Corrective	4. Corrective	4. Corrective	4. Corrective

Planned Maintenance

Under planned maintenance, the results from the interviews showed that the maintenance activities were divided into in-house and outsource approaches. For example, maintenance activities, such as repair and renovation work, were carried out by contractors based on the magnitude of the job. In this case, the five selected universities adopted the price agreement framework for different categories of contractors. For example, the price agreement for electrical maintenance differed from the requirements for civil or mechanical maintenance. The contracts, which were usually awarded for large maintenance activities, depended on the number of activities and units to be executed in that year. All repair and renovation work, which was quoted based on specific category, was paid, and included in the annual building management expenditure. Extract from the interview transcript, the participants stated that:

"Under planned maintenance, simple or minor maintenance was performed by our in-house staff while major works mostly related to electrical and mechanical, especially heating, ventilation and air conditioning (HVAC) system we outsourced it to the best contractors based on their good records for the effective results and cost."

In addition to that, the participants also stated:

"Maintenance works under divided into two main category which is major and minor works. Normally, minor works done by in-house maintenance staff, for example, replaced light bulbs, minor carpentry works, and minor painting works. Meanwhile, major works, for example, air-conditioning replacement, wall painting for the academic buildings, administration buildings and hostels, outsourced to the hired contractors. This gives more advantage on cost and quality of maintenance."

Maintenance contracts were fixed in such a way that once they were sealed, only minor changes could be made related to cost. That is, when a set of maintenance activities have been priced and agreement between the contractor and the university has been entered, the two parties have no influence on the cost factor as outlined in the contract. Therefore, these contracts would expire at the end of the year and were open to suitable bidders for another financial year.

Although the period of contracts was not uniform across the universities, some institutions considered maintaining a particular contractor as they displayed outstanding performance. Departmental executives played a significant role in selecting the appropriate contractor based on the outlined procedure and the contract objectives. For example, the mechanical executive was responsible for the vetting process for all mechanical maintenance contracts.

When the interviewer inquired about the procedure that was used to collect, assess, and respond to complains raised by students or a staff member, all the participants claimed that they adopted a common reporting sequence for all units. The first stage was collection of complaints, where those with concerns aired them to the respective wardens. The wardens or sometimes the technicians in-charge received the complains and produced a ticket to track the problem. Next, the ticket would be forwarded to the maintenance department. The departmental head would then assess the issue and consider if it could be handled locally or a contractor should be contacted.

In cases where problem was noted within the framework and jurisdiction of an existing contract, the contractor was solely responsible for the restoration of the functional aspects related to the reported case. However, when it was not within any stipulated contract, then the administrators would move to the next level and consider the internal capacity to resolve the problem. When technicians from the units could not address the issue based on its complexity, then the services would be contracted externally. The difference among heating, ventilation, and air conditioning (HVAC), electrical, mechanical, and civil maintenance in the selected sample was the nature of outsourcing. The electrical and civil units were partially outsourced since simple repairs were carried out by the department technicians. However, for mechanical issues, the entire maintenance role was the responsibility of the contracted party. Followed with the following extract, the participants stated that:

> *"Before the problem occurs, building users have to report to the maintenance department, so that they are able to detect and correct the problems."*

Preventive Maintenance

Evidently, preventive measures were part of the strategies used to sustain efficiency associated with building maintenance for the five public universities. The reported maintenance practices were geared towards enhancing the functionality of the buildings. Thus, the department included the services of wardens to foster preventive measures. The wardens and technicians performed regular inspections where necessary to improve preventive maintenance.

University buildings are classified based on the following functions: accommodation units, administrative offices, workshops, hostels or student residence, staff accommodation, support units, social buildings, laboratories, and classes. The maintenance activities are categorised into two groups; minor and major jobs. Under major jobs, the university faces electrical, civil, and mechanical challenges, which when not properly addressed, could affect the efficiency of service delivery to students and university staff. Therefore, the maintenance department of the respected universities executed routine repair work and inspections for each form of building maintenance. Based on the findings, the electrical maintenance process included daily inspections and statutory corrective measures. Notably, the inspections were meant to enhance performance and electricity uptime (time period) in all units. The interviews also indicated that the universities did ensure that preventive maintenance was carried out according to the schedule to enhance performance and reduce risks. Extract from an interview with the participants:

"preventive maintenance work carried out is in accordance with the planned program or planning plan, based on maintenance policies, periods of premises and periodic inspection."

Moreover,

"Preventive maintenance designed to avoid the need for more expensive maintenance works. For example, to ensure building users feel at ease and safe, it is must to always monitor the condition of the building before the occurrence of any damage which may cause injury to the building users."

In addition,

"The preventive maintenance is a periodic activity that is implemented within a certain period of time to ensure that every component of the university buildings is in a good and optimal condition. For example, conducting regular checking to ensure that no serious damage occurs in the future."

Prioritise Maintenance

The participants gave their responses regarding how complains or maintenance issues were managed. Apparently, the nature of the complaint or issue defined the response approach. In most cases, the issues were addressed based on the level of urgency. While some reported cases were addressed by the departments within 24 hours, others were identified by the administrators and included in the annual programs. Such activities include major changes and renovations that require an extended period of time to accomplish. Priority is given to problems that may lead to critical implication for the profitability of the universities when considered as a business entity. This can be seen based on the extract below:

"We prioritise our work based on the urgency of the repair work, the consequent. For example, if not doing the works immediately, it will be affected building users, or affecting other components of the buildings or not, if so, we will do it first."

Activities that disrupt administrative work, issues endangering or complicating the lives of students and staff members, and those that could halt regular lecture session are classified as first-level priority. Second-level priority includes intermediate urgency challenges, such as maintenance of assets, malfunctioning equipment, and occurrences that interfere with learning but are characterised by minimal risk. The participant mentioned that:

"Prioritization works refer to conducting maintenance activities, that affect the safety, security, and comforts of the building users such as administrative buildings before its time or before a work order arises. An activity is given importance over the others. For example, when there is a leakage in the pipes or cables, the first priority of repairing work should be given before it affects the other components."

Third-level priority entails routine maintenance process and regular work program for the department. The participants also giving an example of situations that fall under emergency priority and high priority as follows:

"Emergency priority includes life-threatening and safety issues, fire alarms, gas leaks or smell of gas, total power loss, loss of water to the entire building or overflowing plumbing. Meanwhile, high priority includes minor leakage in buildings, power loss at certain buildings, or loss of lighting at night and, prioritize maintenance concentrate more on to administrative buildings, hostels, academic buildings and laboratories."

Corrective Maintenance

The selected public universities for this case study integrated their old buildings with new ones. As the universities are expanding, it is the norm of the management department to consider the use of new buildings. Completion of new buildings usually leads to some changes, such as relocation of functions. In this case, the old buildings were renovated and integrated into the system as part of their building infrastructure. This is a common practice in both main and satellite campuses.

Since the universities are large and the number of buildings is many, the maintenance departments in these universities had adopted a system that allowed people with any complain relating to electricity, civil, and mechanical problems to inform the authority for a corrective action to be undertaken. However, as there was no direct access to the department; those seeking to raise a concern would need to contact the wardens for specific buildings based on category. For example, students can only report issues with faulty electricity to the hostel warden and not directly to the head of maintenance. This can be seen based on an extract from the interview below:

"For example, when the air-conditioning at the administrative buildings or classroom not functioning well, repair works conducted based on a complaint made by the student or staff during that time."

Additionally, the building maintenance practiced in the selected public universities adhered to the objective of reducing the cost of wear and tear. In this case, the sub-department in-charge was given the responsibility to conduct regular corrective intervention in order to restore and preserve the desired quality and functionality.

In most cases, the corrective activities were carried out based on a routine that was repeated over a specific period. Some major activities include keeping the buildings clean through regular painting, repair of entrances, and other refurbishments. The regular complains this unit received were cases of leaking pipes, clogging, insufficient water due to poor circulation system, as well as safety concerns regarding entrance to the hostel, main gates, offices, and other lockable areas. The example given by participants as below:

"If the walls in the lecture room have serious cracking, and disrupt teaching and learning session, then we will take immediate action by repairing the walls, to ensure that the lecture rooms were safe to conduct teaching and learning session."

CONCLUSION

In conclusion, the public universities in Malaysia assessed in this case study had a robust building maintenance framework. The strategies employed were geared towards accommodating the recent changes in construction and design. Referring to the study outcomes, four practices were implemented by the five studied universities, namely planned maintenance, preventive maintenance, prioritise maintenance, and corrective maintenance. All the five case studies unravelled a significant view pertaining to their practices in building maintenance. Hence, the objectives of this study are met by capturing data via face-to-face interview with the selected participants.

This study findings may assist universities in Malaysia to enhance their reputation in maintenance services, while simultaneously serve as a promotional tool in attracting future students from both local and international levels. The public universities in Malaysia are capable in providing more conducive educational environment and in maintaining their building in a comprehensive manner. Apart from that, the universities may benefit from their continuous effort at improving their buildings and maintenance services. Perhaps, additional measures are required to resolve issues faced by the university in light of building maintenance. Essentially, this study contributes towards generating a more conducive learning environment for our future generation.

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VERBAL COMMUNICATION BETWEEN CONTRACTORS AND FOREIGN WORKERS

Kai Chen Goh[1], Nadzirah Zainordin[2] and Sui Lai Khoo[2]
[1]Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Malaysia
[2]School of Architecture & Built Environment, Faculty of Engineering, Technology and Built Environment, UCSI University, Kuala Lumpur, Malaysia

Abstract
The challenge of communication among foreign workers is not new in the construction industry. In construction sites, verbal communication is frequently used. Languages, dialogues, and directions are examples of verbal communication techniques. This article aims to determine the effects of and solutions to communication problems on construction sites. Project cost overruns, disagreement, project delays, and safety and health hazards are all negative consequences of poor communication. To deal with the problem, alternatives such as organising language classes, using a translating device, and using a translator in constructions have been devised. This study was conducted in Batu Pahat, Johor. Contractors, developers, and foreign employees were all involved. These respondents were chosen because they are the most important parties participating in the building site communication process. Triangulation design for mixed technique is the method used. The mixed method approach was chosen because it may combine the strengths and weaknesses of quantitative and qualitative methodologies. Both a survey and an interview are carried out. Contractors, site supervisors, and project managers were given questionnaires, and foreign workers were interviewed. The results demonstrate that there is no evidence of adopting any alternatives to overcome communication problems, but respondents have recommended another option: the use of body language. In conclusion, the research findings indicate that aside from decreasing worker productivity, there are several negative consequences of a communication failure that may lead to construction failure.

Keywords: *Alternatives; Communication problem; Construction; Effects; Foreign workers*

INTRODUCTION

Beginning in the 1980s, foreign workers flocked to Malaysia, where they quickly established themselves as the country's primary labour supply in a wide range of industries, including construction. As a result, there were significant differences in language, ethics, skills, and a variety of other areas. Language is inextricably linked to the act of communicating (Vysotki et al., 2021). Malaysia's immigration situation has gotten even more difficult as a result of a diverse group of foreigners flocking to the country as a result of the country's geographical location, which is surrounded by other countries. Every year, nearly one million construction workers are required, with the vast majority of them coming from other countries (Moyce & Schenker, 2018). That the problem has existed for a long time and is becoming significantly more problematic as the use of foreign employees' increases is demonstrated by the fact that Construction will suffer catastrophic consequences as a result of this problem, including constructions that are different from what clients expected or poor-quality work, at some point in the future or sooner. Beginning in the 1980s, foreign workers flocked to Malaysia, where they quickly established themselves as the country's primary labour supply in a wide range of industries, including construction. As a result, there were significant differences in language, ethics, skills, and a variety of other areas. Language is inextricably linked to the act of communicating (Vysotki et al., 2021). Malaysia's immigration situation has gotten even more difficult because of a diverse group of foreigners flocking to the country as a result of the country's geographical location, which is surrounded by other countries. Every year, nearly one million construction workers are required, with most of them coming from other countries (Moyce & Schenker, 2018). That the problem has existed for a long time and is becoming significantly more problematic as the use of foreign employees' increases is demonstrated by the fact that Construction will suffer catastrophic consequences as a result of this problem, including constructions that are different from what clients expected or poor-quality work, at some point in the future or sooner.

LITERATURE REVIEW

Communication hurdles have existed in the construction sector for a long time and have yet to be resolved. To address the issue, this study will describe what communication is and how it has evolved in the construction industry. The process of communicating information and understanding from one person to another is known as communication (Abuse, 2020). In order to communicate effectively, both sides must have a common understanding. Throughout the communication process, only a few items are required (Winn, 2020) Communication is a cycle in which two persons, the sender and receiver, are involved. The medium and the message or information transmitted are in the middle. The sender is a person who tries to inform or explain his or her ideas to others. The recipient is the person to whom the message was sent. The senders in this study will primarily be contractors and site supervisors, whereas the receivers will be site foreign workers. Nonverbal and verbal communication can be used in this situation.

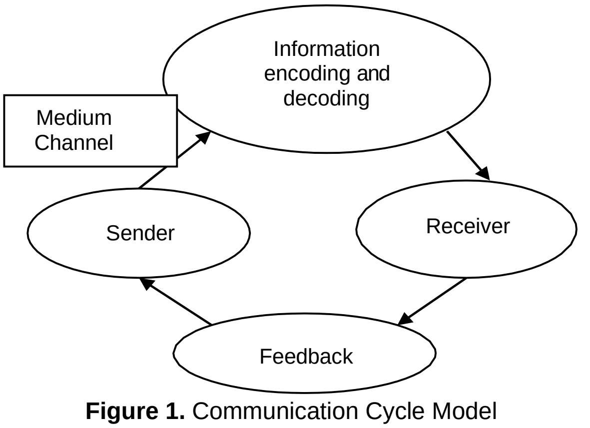

Figure 1. Communication Cycle Model

Negative Effects Caused by Communication Problem

Safety and Health Issues

According to Winge et al. (2019), the biggest cause of construction accidents is a lack of communication. According to reports, foreign workers are rarely exposed to safety practises. If the number of different languages spoken on construction sites continues to rise, this will be difficult to achieve. Foreign workers are having trouble comprehending work-related instructions, and there is no safety training available in their native languages (Yanar et al., 2018). If foreign workers can communicate in the local language, they can considerably reduce the number of accidents and risks. They'll be able to translate warning signs, equipment manuals, and hazardous material labels (Yanar et al., 2018).

Project Cost Overrun

Communication issues are one of the reasons behind project cost overruns (Vu et al., 2020). Construction sites are densely populated with data. Various types of data are required to support ongoing activity and decision-making. To adapt to changes, site supervisors and foreign workers must respond quickly. This includes changing the order of things based on client or on-site decisions. Interaction at building sites must be efficient to reduce downtime and waste.

Conflict on Construction Sites

According to the research Tsai et al. (2018) the true causes of conflicts would be unsuccessful communication processes. Main challenge of communication among the constructors or site supervisors lies in the project activities (Oswald et al., 2019). In one construction projects, foreign workers will work for the longest hours among all parties involved. A small incident will trigger a conflict between each other. The benefits of strong personal relationships include improved communication and reduced conflicts. In the middle of team conflicts, the most important may have been communication.

Project Delay

According to Umar (2018), communication problem caused project delays. Construction sites consist various type of works. This is further agreed by Tam et al. (2020), stated that communication barriers caused foreign workers to make mistake during on-going construction project. The mistake needs to be repair. Contractors must pay extra cost and time to rebuild. Foreign workers are not intended to make such fault. The main root cause of this problem is the message delivered by the supervisors or others did not reach them and this is one of the major communication barriers in construction sites.

Alternatives to Overcome Communication Problem

Translating Device

Translating device is a device which can translate verbal and text messages from one language to another (Valitherm, 2014). This device can be very useful for site supervisors and foreign workers. Instructions can turn into different languages after inserted into the device. Many site supervisors even contractors do not realize or even know about this type of device. It can shorten the time to decode and encode the information. The size of the device is small and very convenient for site supervisors. It is also good to translate words in the safety manual to foreign languages.

Language Training Class

According to Construction Industry Development Board (CIDB), there are no language class organized for both. Research by Valitherm (2014) shows that both sides want each other to learn their respective language. It is not possible for site supervisors to learn all kind of languages and it will be very time consuming. Besides that, the language taught in the class will be 4 different compared to daily conversation in construction sites. Whereas most of the foreign workers will work only.

Translator

Translator will act as a “bridge” to connect foreign workers and site supervisors. Usually, translator at site will be a foreign worker who are experienced and understand local languages (Yildiz, Dikmen, Birgonul, Ercoskun & Alten, 2014). According to the research by Valitherm (2014), foreign workers have more experience in Malaysia construction industry are more fluent in Malay language compared to workers with lesser experience. The finding of the research shows that, workers with more than 5 years can speak Malay language fluently. Valitherm stated that, currently there is no sign of translator job in construction sites.

Conflict Management

It is better to prepare for conflict than to prevent conflict. The first step of conflict management is to understand the root problem of conflict (Einarsen et al., 2018). Site supervisors must communicate with foreign workers to find out conflicts. Site supervisors consult parties in conflict face-to-face to gain their trust. Einarsen et al. (2018) stated that site supervisors with good communication skill can solve the conflict easier as they already build up a friendly relationship with foreign workers A research by Anyon et al. (2018) shows that morning meetings also reduce conflict in construction sites. The understanding of an individual behaviors is an important issue for site supervisors and project manager to manage conflict (Anyon et al., 2018).

RESEARCH METHODOLOGY

Depending on the nature of the research, several methods will be used to undertake it. To acquire reliable and relevant data for scientific evaluation, the best options have been pursued. The research process is a well-organized series of interconnected steps. Each level is linked to the next. This research will begin with an empirical study based on a literature review, followed by two research approaches: qualitative and quantitative. Following the research methodology, questionnaires will be used to conduct two methods: survey and interview. Finally, the data gathered from respondents will be analysed using various methodologies.

The quantitative method, qualitative method, and mixed technique are the three basic types of research approaches (John et al., 2019). The pragmatic approach is also known as the mix technique. The above-mentioned three research methodologies will be used throughout the study. The unique feature of triangulation design is that both qualitative and quantitative data are collected simultaneously and given equal weight. The goal of this strategy is to combine the strengths and weaknesses of quantitative and qualitative methodologies (John et al., 2019).

The outcomes of several ways are gathered and compared. Through the interpretation of the researcher, a fresh conclusion was reached. The triangulated technique was employed to meet the research's two main aims. Table 1 illustrates how qualitative and quantitative methods aid in the collection of data.

Table 1. Summary of Triangulation Method

Study Objective	Research Tools
1. To study the effect of communication problems in construction site	Questionnaires Section B Interview Literature Review
2. To identify ways to overcome communication problem in construction sites	Questionnaires Section B Literature Review

FINDINGS AND DISCUSSIONS

For the questionnaire, data was obtained from 137 respondents. There are 46 responses to the survey, accounting for 33.6 percent of the total. Five foreign workers participated in the interview session: two Bangladeshis, two Indonesians, and one Chinese from China. Due to the fact of language barriers among the respondents, there are limited numbers of interview respondents. Tables 2 and 3 show the background information provided by respondents from the interviews and questionnaires.

Table 2. Summary of Interview Respondents' Background

Respondents	Nationality	Construction Site Found	Experience (Years)
Respondent 1	Bangladeshi	Parit Raja	2
Respondent 2	Bangladeshi	Near "Kolej Perwira"	2
Respondent 3	Chinese (from China)	Kawasan Perindustrian Sri Gading	1
Respondent 4	Indonesian	Near "Kolej Perwira"	6
Respondent 5	Indonesian	Parit Raja	4

Table 3. Summary of Questionnaire Respondents' Background

	Frequency	Percentage (%)
1. Type of Company		
i. Contractor	37	80
ii. Developer	9	20
2. Experience of Company		
i. 1-3 year(s)	3	7
ii. 4-6 years	4	9
iii. 7-9 years	19	41
iv. More than 10 years	20	43
3. Projects Completed		
i. Less than 10	2	4
ii. More than 10, less than 30	23	50
iii. More than 30, less than 50	18	39
iv. More than 50	3	7
4. Position of Respondents in the company		
i. Site Supervisor	9	20
ii. Site Manager	3	6
iii. Project Manager	8	17
iv. Office Executives	5	11
v. Not Stated	21	46

Effects of Communication Problems in Construction

Learning Local Languages

Bahasa Malaysia is the local language (BM). Based on the results of a survey, this is proved. BM was chosen by all respondents as the primary language used on construction sites. As a result, knowing the local language will be critical in reducing miscommunication between the site supervisor and international personnel. In comparison to other foreign workers, those from Indonesia have a higher level of BM fluency. They will be less affected by the communication difficulty.

Construction Progress

Based on all the answers from 5 respondents, communication problem has no effect on construction progress. This result is different from the research result by Sanni-Anibire et al. (2020). In Sanni-Anibire's study, it stated that communication barriers caused foreign workers to make mistake during on-going construction project. Example like foreign workers who misplaced tiles and over excavate. The mistake needs to be repair. Contractors must pay extra cost and time to rebuild.

Workers' Performance

The result from the study is similar with research by Yue et al. (2019), communication did affect the performance of workers. One of the reasons provided by respondents are Qualitative Data Collection Quantitative Data Collection Qualitative Data Analysis Quantitative Data Analysis Qualitative Result Quantitative Result Comparison Interpretation 6 difficult in learning process when they are new to construction sites. The other reason included communication problem led to construction fraud. Site supervisor failed to deliver information to foreign workers will cause them to have mistaken while completing tasks.

Conflicts

Miscommunication between contractor and foreign workers in term of salary and pay is the main reason why conflict happened. The communication system between foreign workers and contractors must be effective to reduce misunderstanding about the job's reward and privilege they should have. Conflict between supervisor and foreign workers are lesser. This is due to site supervisor are representative from their employer which is contractor or developer.

Who and How to Solve Conflicts?

The result of the research shows that most of the conflicts will be settle by site supervisors. Site supervisors take full responsibility to what happened in construction sites. Respondents depend on site supervisor to solve conflict through discussion and explanation. This is the similar as the research by Goh & Goh et al. (2019), site supervisor must deliver the information precisely to each party involved in construction operations.

Understanding of Instruction

Majority of respondent have no problem to understand instruction from site supervisor except respondent 2 for interview session. The experience of respondent 2 only have 2 years of experience working in construction industry. Respondent 2 also explain himself that he is not fluent with local language. The effect from not understanding of instruction will further lead to construction mistakes.

Effect Toward Cost of Project

According to the respondents, communication problem caused construction mistake and wastage which lead to additional cost to project. The mistake made need extra cost and time to repair. Thus, sometime delay the project also. Example like misplaced of tiles and mistake in constructing the design of building. It takes almost double of time and cost to repair construction mistakes. Thus, increasing the cost in term of human power and material cost. According to research by Goh & Goh et al. (2019), wastage also happened due to miscommunication in between management and operational group. It is related with ways of handling and procedure of working. Example like reuse of formwork materials and logistic problem.

Safety and Health Issues

According to the responses from 5 respondents, there is no information about health and safety are told to foreign workers. One of the most important issues is they are no safety equipment prepare for them. According to Nath et al. (2020), the accident rate of not wearing safety devices is much higher compared to workers who prepared with safety equipment. The rules and regulation in Malaysia stated that employer must provide basic safety equipment. In fact, in construction site there are still many foreign workers who didn’t get the basic safety equipment they needed.

Stress

According to data collected, communication did add stress to majority of the respondents. Construction industry was a stressful industry because the working hours are not consistent, and it takes a long time before a project can be complete.

Accident

Research by Nath et al. (2020), shows that workers had communication problem have higher rate of accident compared to others. The result shown there are only around 20% of foreign workers and 40% of employees had accidents due to miscommunication.

Table 4. Summary of Communication Problems in Construction Sites

Aspect	R1	R2	R3	R4	R5
Learning Local Language	• Through friend and experience	• Self- learning and friends	• Know mandarin • No communication problem faced	• Experience	• Experience
Construction Progress	• No	• No	• No	• No	• No
Workers' Performance	• Difficult in Learning Process	• Slow down productivity	• No effect	• Mistakes Technical & Design problem	• No effect
Conflicts	• Usually happen between foreign workers • Sometimes happen if salary pay are lesser than promise	• When project are in rush • Conflict happen after mistake is made	• No conflict between site supervisor and foreign workers • Between different nationality of foreign workers	• Conflict when made mistake	• Related to money (pay, salary) • Communication process between contractor and foreign workers are slow and not effective
Who and How to solve conflicts	• Site supervisor • Discuss • Settle themselves	• Site supervisor • Discuss • Ignore	• Settle themselves	• Site supervisor • Send another representative • Pass information to contractor	• Site supervisor • Pass information to contractor
Understanding of Instruction from site supervisor	• No problem	• Sometimes do not understand	• No problem	• No problem	• No problem
Effect toward Cost of Project	• Cost for repair	• Wastage	• No effect	• Cost for repair	• Cost for repair
Information about Safety and Health issues	• No	• No	• No	• No	• No
Stress	• Yes	• Yes	• Yes	• Yes, already get used to it	• Yes
Accident	• No	• No	• No	• Yes	• No

Ways to Overcome Communication Problem in Construction Site

According on the literature review, numerous options have been offered. Four of the suggested possibilities are discussed below. According on the information gathered, no contractors employ these alternatives. The following are the reasons why respondents aren't using the devices. In fact, the responders had various suggestions for resolving the communication issue.

Translating Device

All the reasons why contractors do not utilise a translating device are listed in Table 5. With a mean of 3.83 and an average index range of in agreement, contractors believe site managers can serve as translators. The reason for this is that site supervisors operate as a "middleman" between the contractor and the foreign labour. Contractors can directly provide orders to site supervisors, and site supervisors are accountable for delivering the information (Grill & Nielsen, 2019).

Table 5. Analysis Factors Why Contractors Do Not Use Translating Device

Ranking	Factors Why Contractors Do Not Use Translating Device	Mean	Average Index
1.	Site supervisors act as the “translating device”	3.83	Agree
2.	Translating device will add additional cost to the company	3.72	Agree
3.	Translating device are troublesome for supervisors to carry around	3.26	Neither Agree Nor Disagree
4.	Not all languages are included in translating device	3.17	Neither Agree Nor Disagree
5.	Translating device will not improve the communication in construction sites	3.15	Neither Agree Nor Disagree
6.	The company did not aware of the existence of translating device	2.39	Disagree

The building company is unaware of the existence of a translating device, which is one of the factors with the lowest mean. For this reason, the average index is classified as disagree. Most contractors are aware of the device's presence. Contractors may easily obtain knowledge in this technological age via the Internet and other forms of media. CIDB also played an important role in keeping local contractors up to date on technological advancements in the worldwide construction sector.

The translating device is the second most important component, as it will incur additional costs for the organisation. A translating device like Sigmo, which costs $50, is an example. Contractors who hire a significant number of site supervisors view this as an additional cost that reduces the project's profit margin.

Language Training Class

Table 6. Analysis Factors Why Contractors Do Not Provide Language Training Class

Ranking	Factors Why Contractors Do Not Provide Language Training Class	Mean	Average Index
1.	Language training class will take a very long time before foreign workers can go into work	3.59	Agree
2.	There are no teacher available to teach in foreign languages	3.37	Neither Agree Nor Disagree
3.	Foreign workers are temporary workers, not worth to put extra cost on them	3.28	Neither Agree Nor Disagree
4.	Language training class will not improve communication in construction sites	3.17	Neither Agree Nor Disagree
5.	Site supervisors do not want to learn foreign languages	3.13	Neither Agree Nor Disagree

All the reasons why contractors do not conduct language training classes are included in Table 6. The main reason is that language training classes will take a long time before foreign workers can start to work, with a mean of 3.59, according to the respondents' Average Index of Agree. This is because most immigrant workers are uneducated. If they decide to take classes, they must begin at the beginning. It took months to complete a language training course. As a result, they will have to wait longer before they can contribute to the growth of a company.

The second most important aspect is inextricably linked to the first. There are very few foreign teachers that open their classrooms to teach in their native tongue. For Bangladeshis and Nepalese, there is no trace of a foreign language class. Many language classes are offered in major languages such as Japanese, English, and Mandarin.

Respondents categorised the remaining three factors as neither agree nor disagree. This might be defined as the respondents' lack of clarity or ambiguity. Contractors and developers haven't been given access to information about these programmes. Language instruction had not been provided by local authorities such as JKR and CIDB.

Translator

All the reasons why contractors do not have translator positions are listed in Table 7. The component of site supervisor duty as translator has the highest mean of 4.09. The job of the site supervisor is to act as a liaison between the contractor and the foreign workers. The site supervisor is responsible for translating information from higher management levels into language that foreign personnel can understand (Oswald et al., 2019). In construction sites, the site supervisor is known as the translator.

Experienced foreign workers who can also act as translators is the second most important factor. Foreign workers, for example, respondent 2 for qualitative data analysis, occasionally come to grasp and learn local languages through daily activities.

Table 7. Analysis Factors Why Contractors Do Not Have Translator Post in Construction Site

Ranking	Factors Why Contractors Do Not Have Translator Post in Construction Site	Mean	Average Index
1.	Site supervisors are as good as translator	4.09	Agree
2.	Foreign workers with more experience function as translator	3.80	Agree
3.	Time costing if translator intervene communication cycle	3.41	Neither Agree Nor Disagree
4.	Translator will not improve the communication in construction sites	3.13	Neither Agree Nor Disagree
5.	Translator will transmit wrong information to foreign workers	3.11	Neither Agree Nor Disagree

The third consideration is the expense of time if a translator is involved in the communication process. The communication cycle on construction sites will be affected by the translator. The translator serves as a conduit for information to be passed from the site supervisor to the international workers. Because of varied interpretations of words, confusing input, and disturbance from the environment, the odds of receiving false information increase.

Some respondents believe that using a translator on construction sites will not increase communication. One of the reasons is that they have never tried or even heard of a translator in the construction sector. Another component, with a mean of 3.11, indicates respondents' skepticism about translators' abilities. Respondents believe that translators will give incorrect information to foreign workers, particularly when it comes to construction words. The hired translator may not be familiar with the building industry. When they try to translate certain terms into multiple languages, it can be confusing.

Conflict Management

Table 8 summarises the reasons why contractors lack conflict management. With a mean of 4.43, the top factor is site supervisors, who are responsible for resolving disagreements on construction sites. The full responsibility for resolving disagreement is placed on site supervisors. Site supervisors are extremely effective at resolving disagreement during face-to-face negotiations. As a result, the contractor is forced to rely entirely on on-site contractors. The second problem is that hurdles to communication exist between the site supervisor and the foreign personnel. Most contractors opt to overlook communication issues on building sites.

The second problem is that hurdles to communication exist between the site supervisor and the foreign personnel. Most contractors opt to overlook communication issues on building sites. It makes no difference to them if the project remains on schedule. Even site supervisors have difficulty communicating with foreign workers, so why should they upgrade the communication system? Finally, communication failures result in fraud in construction projects and incur additional costs to rectify the error. Conflict resolution may involve individuals other than the site supervisor, such as the project manager and coordinator. It is preferable to avoid conflict than to resolve it once it occurs.

Table 8. Analysis Factors Why Contractors Do Not Have Conflict Management

Ranking	Factors Why Contractors Do Not Have Conflict Management	Mean	Average Index
1.	Site supervisors are responsible to solve conflicts in construction sites	4.43	Agree
2.	Communication barriers in between site supervisor and foreign workers also create conflict	4.00	Agree
3.	Supervisors are not specially trained to solve conflicts in construction sites	3.32	Neither Agree Nor Disagree
4.	A report is made to evaluate the communication problem for every conflict is troublesome	3.11	Neither Agree Nor Disagree

Recommendation – Body Language

Body language is a type of non-verbal communication that includes expressions, gestures, and others. One advantage of employing body language is that it enables communication with those who do not speak your language. According to Abbar & Shaheed (2021), body language is a universal language that is "installed" in us from birth. Non-verbal communication can be used to communicate information in a variety of environments. For instance, on building sites, which are rife with noise pollution. Body language also saves time because it conveys messages more quickly than spoken communication.

CONCLUSION

In conclusion, communication problems impair the performance of foreign workers by reducing their productivity. Due to the language barrier, new international staff are far more difficult to train. Additionally, conflict on construction sites is exacerbated by communication breakdowns. Safety and health concerns are also associated with communication difficulties.

Additionally, the working atmosphere was extremely stressful for foreign workers due to communication breakdowns. Communication breakdowns also contribute to construction site accidents. Thus, a translating gadget is one that can translate from one language to another. The primary reason contractors do not utilise translating devices is that the site supervisor serves as the "translating device" on the construction site, followed by a desire to avoid increasing the company's costs. Language training classes also assist in resolving the communication issue. The final possibility suggested is dispute resolution. The reason contractors lack conflict management is that they believe the site supervisor is sufficient to resolve conflicts on building sites. There is a recommendation from respondents that non-verbal communication be used to resolve communication issues on the building site using body language such as simple hand signals.

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THE POTENTIAL OF SMART WEARABLE TECHNOLOGY IN MALAYSIAN CONSTRUCTION HEALTH & SAFETY

Faraziera Mohd Raslim[1], Koo Jia Ern[1] and Hamizah Liyana Tajul Ariffin[2]
[1]*School of Housing, Building and Planning, Universiti Sains Malaysia, Gelugor, 11800 Pulau Pinang, MALAYSIA*
[2]*Department of Quantity Surveying, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia, Skudai, 81310 Johor, MALAYSIA*

Abstract
The advent of smart wearable has been widely utilized for personal health and motion monitoring, there are a wide range of industrial wearable available in current market which can be used to enhance the environmental health and safety on construction worksite. However, the adoption rate and studies in Malaysian construction industry is comparatively low as compared to foreign countries where a lot of successful use cases and pilot programs were conducted to encourage the wearable usage. Therefore, the objective of this paper is to investigate what are the challenges faced by local construction practitioners and to explore what are the critical success factors (CSF) to implement wearable technology in Malaysian construction industry. In this study, a total of 115 Malaysian contractor firms registered under CIDB Grade 4 to Grade 7 in territory of Kuala Lumpur, Selangor, Penang, Johor Bahru have participated. Descriptive statistical analysis was used to analyse the data collected. Type of smart wearable were grouped into smart PPE, smart wrist-worn devices, clip-on wearable devices, and exoskeleton. The top three most significant challenges found in this research are cost of implementation, shortage of skilled personnel & aging of workforce and lack of awareness & understanding on wearable. Whilst the top three most vital CSFs are top level management support and leadership, corporate financial resources and corporate culture towards innovation and workplace safety.

Keywords: *Wearable; Safety and Health; Critical Success Factors; Challenges*

INTRODUCTION

Generally, the smart wearable has been widely applied across industries such as healthcare, manufacturing, business, mining, aerospace studies, athletics and public safety. However, the construction sector has only at its nascent stage to partake in the possibilities of wearable to enhance safety and efficiency (Awolusi et al., 2018). While wearable is increasingly being used to improve health and well-being or even due to the current COVID-19 outbreak, technology applications in construction sector to monitor occupational safety and health risk factors are getting more important. According to a study by Pasco et al. (2020), the construction workers have a relative risk of 5 times greater than normal adults in other occupations that aged between 18 to 64 years to diagnose and hospitalize due to COVID-19. For instances, by wearing smart bands, social distancing can be exercise more effectively as it will alert them through sensors when they exceed the safety distance to contact with each other. In the long run, utilizing the smart wearable will help the workers stay update and alert on the existing situations of the surrounding such as dangerous material or heavy machinery (Sauve, 2020).

Recently, due to the uncovered potentials of smart wearable in different sector other than healthcare, researches documented on the application of wearable technology in construction industry and their future vision in integrating sensors with PPE are getting common (Blecha et al., 2018; Edirisinghe, 2019). Moreover, due to the accelerating growth of tech-savvy generation and consumer's purchasing power, countries under Asia Pacific (APAC) have expected to potentially develop into the most attractive regional market for wearable technology after North America and Europe (Data Bridge Research Market, 2020). However, Malaysia, as one of the countries under APAC has not significantly capable to compete with other countries under APAC such as Thailand and China. This can be supported by the global comparison statistics on user penetration of wearable by Statista (2020), where it shows that Malaysia is ranked at 37^{th} and the user penetration rate in Malaysia is relatively lower at only 4.4%.

LITERATURE REVIEW

Internet of Thing (IoT) Application in Construction Industry

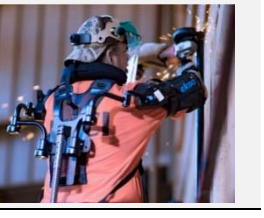
Although construction industry is not the pioneer in Internet of Things (IoT) adoption, a recent statistic showed that this emerging innovative technology will play a vital part in improve employee safety, reduce construction cost, facilitate waste management, aiding match properties to tenants (Digiteum, 2020). The current applications of IoT in construction industry worldwide includes Unmanned Aerial Vehicles (UAV), Monitoring sensor, Wearable technology, Construction site robot, 3D printing, Information sharing platform and more (Qing, 2019). There are few ways where the construction companies could leverage the application of IoT technology which includes real-time site monitoring, effective project management, construction site safety, fleet management and machine control (Mazhandu, 2020). As data has become a critical commodity in any business, by applying IoT into construction, the regular objects are now able to generate meaningful data relevant to users and further integrate with conventional construction process through deployment of various autonomous application, which results in increase sustainability and efficiency of projects and entire industry (Atzori et al., 2010). In general, security, on-site safety, productivity and maintenance tend to be the key drivers of IoT adoption in the construction sectors.

Wearable Technology and Internet of Thing (IoT)

Unlike traditional portable devices such as cell phones, wearable technology seeks device miniaturization to work unobtrusively. Being the most pervasive application of IoT to date, wearable devices are significantly potential to meet the vision of IoT (The Commission of The European Communities, 2016). Generally, when the wearable devices are used on workplace, these devices will connect to a wireless mesh infrastructure through an IoT network that connect to computer device for monitoring and data analytics. This mechanism enables the sending off of messages, warnings, and alarms beside location monitoring (Earnest et al., 2019). To simplify, the idea of wireless body worn communication linked the IoT with wearable technology as IoT is built upon availability of networked objects such as sensor, actuators, RFID tags; whilst the wearable technology will help in connect the human with those networks (Gribel, 2018). Nowadays, the wearable are equipped with multiple sensor types from the sensor network rather than a single type of sensor in a device (Melanie, 2012). Wearable devices are equipped with sensors which can track, monitor, and diagnose an user through different integrating different types of sensing not only from motion or physical, physiological, biochemical (Patel et al., 2012), but also from the user's environments (Lee et al., 2016). Therefore, a sensor network system is vital platform to connect and communicate user with environment and also between the environments (Ben Arbia et al., 2015).

Adoption of wearable in Malaysia Construction Industry

Table 1. Types of Smart Wearable in Construction Industry

Types	Description	Image
Smart Hard Hat	A rigid protective helmet that embedded with sensors which can track and monitor user's perspiration, respiration and EEG to access the level of fatigue and health status of an individual (Panchal, 2019).	
Smart Safety Vest	An intelligent safety jacket stretches past the traditional safety vest and has GPS mapping, sensors and allowed short-range communication (Ann, Aguilar & Edmondson, 2020.	
Smart Glass	A head mounted displays that overlay a visual virtual image on top of the physical world vision, which is the Augmented Reality (AR) Technology (Riddell, 2020).	
Smart Safety Boots	Smart safety work boots can 1) detect pressure 2) measure fatigue level 3) track worker's location, 4) monitor worker's activities and safety on site and send alarm during emergencies and, 5) prevent accidents through communication within heavy equipment (Kumar et al., 2018).	
Smart Wrist-Worn Devices	A wrist-wearable device (wristband or smart watch) that equipped with motion sensors is one of the most common application for measuring activities distance and conditions of movement by wearers from time to time (Kumar et al., 2018).	
Clip-on Wearable Devices	Clip-on wearable can be attached to belts, vests and shirts. It can also be clip-on the upper arm or chest to detect a range of poisonous gases, avoiding unnecessary hazardous exposure and potentially saved a lot of lives on site (Agaskar, 2016).	
Exoskeleton	The exoskeletons or namely 'exosuits' or 'bionic suits' are metal frameworks that fitted with pneumatic muscles to increase the wearer's strength by providing muscular and skeletal support for workers resulting lifted objects feels lighter or even weightless, thus avoid risk of injuries for workers and improve compliance (Thilmany, 2020; Folk, 2020).	

To date, there are very limited researches on the usage of wearable technology in Malaysian Construction. According to Riahi Sfar et al. (2018), the readiness of local construction organizations towards the implementation of IoT is revealed to be very low as only 34.3% construction organizations conduct data collection from sensors and 28.9 % through RFID tag. It revealed that the usage of wearable in construction is likely to be low as sensors and RFID is the most fundamental element in wearable technology. It is supported by Mahmud et al. (2018) where among all the IoT applications used in construction site, the smartwatch was placed at lowest rank in terms of usage by construction practitioners while the most common application of IoT is social media, email and websites. There are many more types of smart wearable that have not being used in Malaysia construction industry as shown in Table 1.

Challenges to Implement Smart Wearable in Construction Industry

Proving of Return on Investment (ROI)

Although most of the construction companies have been exploring and seen the potential of wearable technology to improve construction safety and health (H&S), most of them expected to see successful cases and proof of ROI within 3 to 5 years (Kline, 2018). Similarly, Jiang et al. (2017) had mentioned that the high investment cost has posed barriers for its wide adoption among the industries.

Cost of Implementation

The price of implementing IoT devices is usually expensive starting with all the cost of software, network infrastructure to cost for operation and maintenance that are necessary to ensure the device’s interoperability which eventually constraint organization from implementing IoT (Mahmud et al., 2018; Luthra et al., 2018).

Organization Size

According to study by Manuel (2019), the limit spread of smart devices not only restricted to cost, but also the risk that smaller company might need to take as they have no past experience in implementing technology at workplace. Therefore, smaller construction company might not be able to bear this technology risk as this is a permanent investment that may lead to financial loss.

Limited Market Size

Another barrier that limits the widespread adoption of wearable technology in construction industry will be the market share and size. By looking at the market, it offers an understanding of the wearable technology outlook in all industries and reveal signs of the future development (Aroganam et al., 2019).

Organization Culture, Acceptance and Trust

Organizational culture influences the way people set professional priorities in the workplace, affects the way people think actively and subconsciously, and eventually determines how people execute activities and use capital to accomplish them (Lok & Crawford, 2004). According to the co-founder and CEO of SolePower highlighted that the culture within an organization such as construction workers, supervisors and safety managers is very critical in setting up the technology adoption as it will affect the engagement of employee buy-in (French, 2016).

Lack of Awareness and Understanding on wearable

A study from Habibipour et al. (2019) has also highlighted that another social challenges that might affect the adoption of wearable technology is the lack of understanding and information such as its applications and operation of the wearable devices due to its complexity.

Shortage of Skilled Personnel and Aging of Workforce

According to Troy (2019), younger workers are more eager to explore, adopt and leverage new technology's ability in making them more productive and efficient. However, according to International Labor Organization, construction sector obtained less interest from younger generations as a career option and incurred a shortage of skilled personnel to implement innovative technology has constraint the widespread adoption of wearable technology (Lu & Fox, 2001).

Privacy and Ethic Issue

Through the exponential growth in wearable devices embedded with multiple sensors, many types of personal data such as worker's location and physiological information will be produced (Silva et al., 2015). Although research has found that construction workers are being more efficient by using wearable devices as they realize they are being monitored, the wearable technology has raised huge privacy and ethical implications (Goodwin, 2014).

Industry Standards and Regulatory Compliance Issues

The compliancy to product regulations in industry is one of the major constraints faced in the effort of bringing advanced wearable into the market and then into the construction jobsite. In most cases, standards which the industry can depend and refer to ensure health and safety requirements can be said non-existed due to the stakeholders involved in design and development stage of wearable are all from different disciplines and background (e.g. medical devices, clothing industries) (The Commission of The European Communities, 2016).

Poor Network Access and Connectivity

The combination of smart sensors and equipment devices with connectivity solutions and storage of data in wearable technology has enabled enhancement of safety and health protection in PPE of construction worker (Adjiski et al., 2019). This is because one of the key aspects in wearable devices will be the connectivity which includes Wi-Fi, Bluetooth, Zigbee or Mobile networks in order to support large amount of IoT connectivity (Perera et al., 2014).

Data Inaccuracy and Uncertainty

In construction, inaccurate information produced by wearable technologies during the construction process may cause accidents, damage and losses to assets and lives on site. According to a recent national survey, accuracy was selected as the key feature in wearable and exceeded 50% of consumers would consider purchasing one if the accuracy is trusted (Valencell, 2016).

Poor Usability

Previous studies have determined the usability related issue in wearable is due to the complex interfaces and functionalities which are not user-friendly to older worker (Tedesco et al., 2017).

Hardware and Sensor Durability

As construction works often conducted in a tough environment conditions, it is very essential to ensure the wearable devices is lightweight, long battery span and highly resistance to damage to ensure the life of construction workers will not be harmed (J. Lee et al., 2016).

Big Data Issue

It is hard to manage, store and process the raw data through real-time collection as the high bandwidth and large storage requirement have created an issue for the implementation of wearable in construction sector. In other way round, it can be said that organization might most likely to face difficulties to access and extract data in a meaningful approaches that required to perform certain function and lead to significant improvements in an organization (Gamil et al., 2020).

Network Security

It is apparent that cybercrime poses a real challenge to the construction industry by embracing IoT appliances as any compromise of data could lead to a delay or halt in the project (Marwedel & Engel, 2016).

Critical Success Factors to implement Smart Wearable in Construction

Top Level Management Support and Leadership

In the process of successful implementation, top management support is vital to assign and also shall be convinced to provide sufficient resources such as financial, time and proper training for workers to a new technology (Borhani, 2016).

Corporate Culture Towards Innovation and Workplace Safety

According to Welch et al. (2015), the culture of a construction company significantly influences the decision making of the organization, as well as employee's attitude and perception toward implementation of safety innovations.

User Intention on Wearable's Ease-of use and Performance

Understanding the determinants that can affect employees' intention to utilize wearable technology is one of the critical success factors that need to be address as it can assist top level management in company to execute strategies in encouraging adoption of technologies and improving the innovation implementation procedure (Sargent et al., 2012).

Professional Development & Training Program

Organizations that provide facilitate condition such as provision of training and support will bring positive influence on worker's use of innovation (Talukder, 2012).

Technology Awareness

Education is the core concept for technology awareness where there is a need for continuous education to young and old professionals throughout the industry in order for them to share common understanding of the wearable technology (Silverio-Fernandez et al., 2019).

Corporate Financial Resources

According to Verdantix Ltd. (2018), the financial capacity of a corporate to pay for wearable system such a cost of hardware and sensors, system and data analysis can be another factor affecting their ability to prioritize the EHS management into workplace.

Interoperability

Due to the heterogeneous characteristics of construction sector, different type of construction projects or activities will require different equipment to operate. To uphold a migration from conventional construction to a new paradigm which considers the IoT technology or wearable devices, the interoperability between new and existing equipment must be consider (Silverio-Fernandez et al., 2019).

Governmental Support

According to Rajendran et al. (2020), the government is responsible to enforce better occupational safety and health (OSH) related regulations and legislations by making smart PPE mandatory for workers that involved in high-risk industry such as construction and mining. Besides that, it is critical for the government to participate actively in conducting sponsored workshop or training to nurture the awareness and knowledge of smart wearable adoption for construction site.

Standardized Regulatory Framework

Standardization plays a crucial role in manufacturer to reassure that their wearable products are compliant with the regulatory requirements whilst enhance construction workers' trust in new technological approaches (The Commission of The European Communities, 2016).

RESEARCH METHODOLOGY

This research used probability sampling method, to determine the sampling size for this research, formulas as shown as below will be used.

$$\boldsymbol{n} = \frac{\boldsymbol{m}}{\boldsymbol{1} + \frac{\boldsymbol{m} - \boldsymbol{1}}{\boldsymbol{N}}}$$

Where n = sample size of limited population
m= sample size of unlimited population
N= sample size of available population

According to the formula above, ‘n’ is the final sample size that will be referred, ‘N’ is the sample size of all Grade 4 to Grade 7 Contractors registered under CIDB (refers to contractor which are allowed to tender for projects worth not less than RM 1,000,000) in Territory of Kuala Lumpur, Selangor, Johor and Penang (15,028 firms), whilst ‘m’, the sample size of unlimited population that has to be calculated using the equation below:

After the ‘m’ is obtained and ‘N’ which is 15,028 contractor firms that is predetermined, ‘n’, which is the exact sample size of limited population required for this research study and can be calculated using the earlier equation as follow:

$$\boldsymbol{n} = \frac{\mathbf{385}}{\mathbf{1} + \frac{\mathbf{385 - 1}}{\mathbf{15,028}}} = \mathbf{375.41} \approx \mathbf{376}$$

In this study, these are the two formula that are referred to determine the sample size. As the population size of registered Grade 4 to Grade 7 Contractors under CIDB in the four states, ‘N’ is 15,028, therefore the sample size for this study, ‘n’ is 376. A set of questionnaires were then distributed to the sample size to obtain the data required for the study. A total of 115 Malaysian contractor firms registered under CIDB Grade 4 to Grade 7 in territory of Kuala Lumpur, Selangor, Penang, Johor Bahru have participated. The questionnaire included three sections which are Respondents background, challenges to implement smart wearable, and Critical Success Factor in implementation of Smart Wearable. In order to give a structural result, the 5-point Likert scale which range from scale 1 to 5 will be chosen as the method to access and quantify the respondents’ opinions.

RESULTS AND DISCUSSION

Ranking of Challenges for Smart Wearable Implementation

Table 2 shows the result of challenges for smart wearable implementation in Malaysia which cost of implementation, shortage of skilled personnel and aging of workforce, and lack of awareness and understanding on wearable are found to be the primary barriers to implement wearable technology in the Malaysian construction industry. This result is in line with the findings from past local research on general IoT adoption.

Throughout the literature, a total of 15 challenges are identified and the findings shows that majority of the Malaysian construction practitioners strongly opined that the implementation cost of wearable which falls under the economic category is the main barrier in pushing the adoption of wearable in the construction industry out of all the challenges proposed. It is then followed by shortage of skilled personnel and aging of workforce as second most agreed challenges which faced by our country and impedes the assimilation of smart wearable into construction. Also, the outcome for challenge of lack of awareness and understanding on wearable by Malaysian construction practitioners was foreordained as the researcher has encountered multiple inquiries by the respondents to explain more regarding the wearable before participating in the questionnaire. Therefore, the finding and process of collecting responses have shown that the Malaysian construction practitioners certainly do not exhibit adequate understanding on this technology especially in the construction industry.

Table 2. Ranking of Challenges for Smart Wearable Implementation

Variables	N	Mean	Rank
Cost of Implementation	115	4.23	1
Shortage of Skilled Personnel and Aging of Workforce	115	4.19	2
Lack of Awareness and Understanding on wearable	115	3.98	3
Industry Standards and Regulatory Compliance issues	115	3.90	4
Hardware and Sensor Durability	115	3.79	5
Poor Network Access and Connectivity	115	3.74	6
Limited Market Size	115	3.70	7
Organization Culture, Acceptance and Trust	115	3.62	8
Network Security	115	3.59	9
Data Inaccuracy and Uncertainty	115	3.58	10
Poor Usability	115	3.57	11
Proving of ROI	115	3.47	12
Big Data Issue	115	3.42	13
Organization Size	115	3.41	14
Privacy and Ethic Issue	115	3.33	15

Based on the finding, it is found that privacy and ethic issue is the least agreed barrier for wearable adoption among the Malaysian construction practitioners, which means that they are less concern and aware on the privacy risk that might incurred when using wearable and it is certainly not the main challenges which has caused the slow adoption of wearable in Malaysian construction. The finding contradicts phenomena in foreign countries as there were a number of studies which showed that the construction workers are very concerned over their own privacy, and they do not favour the feeling of being monitored by their superior. Therefore, it has caused them to feel less motivated to apply them in daily work on site.

Ranking of Critical Success Factors for Smart wearable Implementation

Table 3. Ranking of Challenges for Smart Wearable Implementation

Variables	N	Mean	Rank
Top level management support and leadership	115	4.50	1
Corporate Financial Resources	115	4.33	2
Corporate culture towards innovation and workplace safety	115	4.15	3
Governmental Support	115	4.14	4
Technology Awareness	115	4.00	5
Standardised Regulatory Framework	115	3.99	6
Professional Development & Training Program	115	3.96	7
User intention on wearable ease of use and performance	115	3.90	8
Interoperability	115	3.79	9
Average Mean	***4.08- ‘Important’***		

Based on Table 3, top level management support and leadership found to be the most important factors in ensuring the successful implementation of wearable technology in Malaysian construction industry with the mean ranking of 4.50 which represents ‘highly important’. More than half of the respondents, which is 55.7% voted this critical success factor (CSF) as strongly important whilst none of the respondents opined that this factor is unimportant in the process of successful adoption of wearable. It is supported by numerous past studies from Sargent et al. (2012) and Abrahamse & Lotriet (2012) that support from top level management and having the lead person inside an organization will help in determining the successful or failure of emerging technology's transfer or adoption.

Corporate financial resource is ranked second as key factors to successful implementation of wearable technology in Malaysian construction industry with the mean of '4.33='Important', where 39.1% of the respondents voted 'important' and 48.7% of them voted 'highly important'. Therefore, it is found that Malaysian construction practitioners viewed the financial capability of the company as an element which might greatly influence the success or failure of wearable adoption. Finding from Verdantix Ltd (2018) further supported this CSF whereby having strong and even 'unlimited' financial resources is extremely essential as besides the cost of products and system itself, there a lot more carrying charge to successfully implement the wearable technology such as cost for training or educational programs.

Corporate culture towards innovation and workplace safety (M=4.15= 'Important') is ranked as third out of the nine Critical Success Factor (CSF) which will greatly influence the successful adoption of wearable in Malaysian construction. Out of the 115 respondents, 50.4% of the respondents have opined that it is important and 33% of them thought it is a 'highly important' factor to ensure the successful adoption of wearable. It is aligned with research by Silverio-Fernandez et al. (2019) whereby the corporate culture towards innovation is the key aspect for successful adoption as construction company with culture that does not seize possibilities in innovative technology will most probably make a lot of careful consideration prior implementation.

On the level of important, governmental support is ranked at fourth among all the CSF with the average mean of 4.14='Important'. Majority of the respondents (44.3%) perceived this factor as 'highly important' whilst only 3.5% of the respondents voted as 'unimportant'. The finding shows that Malaysian construction practitioners suggested that Malaysia government plays an indeed crucial role to support and encourage the introduction of wearable technology in construction workplace. Past local studies by Rajendran et al. (2020) and MCMC (2020) **recommended that local government can help in several ways such as 1) Enforcement of better OSH regulations to make smart PPE mandatory to be equip on site 2) Conduct free workshop or training on wearable to construction workers 3) Increase IoT Grants to construction sector.** Also, there are some oversea studies from western countries such as The Commission of The European Communities (2016) and Martin & Leurent (2017) suggest that if the government is willing to conduct more pilot program for wearable technology, either in construction industry or across industries such as logistics, the growing of successful use-case of industrial wearable will uninvitedly attract adopters from construction industry.

Next, Technology awareness as one of the CSF of wearable adoption in construction workplace received an average mean of 4.00= 'Important' and ranked as the fifth important factor for successful implementation of wearable in Malaysian construction industry. This statement is supported by Borhani (2016) where one of the respondents mentioned that they are fully unconscious about the current available options for industrial wearable as they normally use smartwatches for general health monitor only, which proven that a high level of technology awareness is crucial step for the succesful adoption of any innovative technologies.

According to the finding, standardized regulatory framework is ranked at sixth with the average mean of 3.99=‘Important’ which is slightly higher than Professional development and training program (M=3.96=‘Important’) that ranked seventh. There are about 42.6% of the respondents thought it is ‘important’ and 29.6% of them voted ‘highly important’. The comparatively lower ranking of this CSF shows that the Malaysian construction practitioners do not perceive this factor to have great influence on the successfulness of wearable adoption in construction worksite as compared to the other CSF.

Professional development & training program is ranked at seven with a mean of 3.96= ‘Important’. This statement only received 6.1% of ‘unimportant’ votes, 17.4% of neutral vote, 51.3% of ‘important’ and 25.2% of ‘highly important’. It shows that Malaysian construction practitioners viewed professional training program on wearable technology less effective as compared to other CSF ranked above this. However, Silverio-Fernandez et al. (2019) and Borhani (2016) argued that to successfully apply new technology, provision of comprehensive training and support to familiarize with innovative technology could help in fostering a suitable environment to encourage and ease the integration process.

In the point of view by the Malaysian construction practitioners, user intention on wearable’s ease of use and performance is ranked at eighth which is comparatively less important as a critical factor for successful implementation of wearable with a mean of 3.90= ‘Important’. There is a small amount of them (6.1%) opined that it is unimportant, 20.9% unsure about it, 50.4% of them treated it as important while about a quarter (22.6%) of them opined that it is strongly important. Previous study by Talukder (2012) argued that the long-term successful implementation of technology is highly reliant of the worker’s acceptance and expectations upon the function of new technology.

Lastly, it is found that Interoperability ranked as the least important CSF by the Malaysian construction practitioners with the average mean of only 3.79=‘Important’, whereby only 36.5% of respondents voted ‘important’ and 23.5% of the total respondents reacted ‘highly important’. It is speculated to be caused by respondents do not fully understand the term ‘interoperability’ as there is over one third of the respondents (35.7%) reacted ‘neither important nor unimportant’ on this factor. However, past local research from Badarudin et al. (2018) and Suresh et al. (2014) opined that assuring the interoperability and connectivity of technologies is critical to generate a collaborative medium for IoT solution and for the successful launch of IoT in Malaysia.

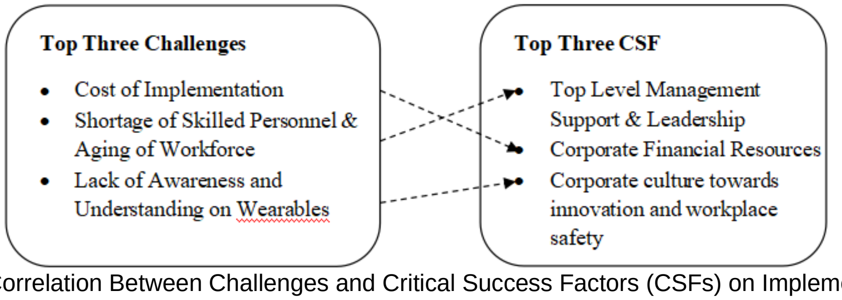


Figure 2. Correlation Between Challenges and Critical Success Factors (CSFs) on Implementation of Smart Wearable in Malaysian Construction Industry

Throughout the study, the researcher also discovered the correlation between the top three challenges and top three CSFs which can be presented in the Figure 2. It is found that the determined CSF can be used to address the challenges faced by the Malaysian construction industry in implementing smart wearable.

CONCLUSION

According to the finding, Malaysian construction practitioners opined top level management and leadership as the most vital factor in order to ensure the successful implementation of wearable in the local construction industry. It is then followed by corporate financial resources and corporate culture towards innovation and workplace safety as the top three most rated CSFs. While the Malaysian construction practitioners consider device interoperability to be the least critical out of the nine variables in ensuring the successful implementation of smart wearable. Based on the finding, it is found that these top three highly important factors are all related to the organizational level in terms of the management, financial and culture. Therefore, the researcher has concluded that organization's factor is highly influencing towards the successfulness of smart wearable implementation in the construction industry. Also, additional CSFs that are suggested by the respondents are 1) Demand and affordability of market and end user, 2) Investment must have return of profit and give benefits back to the users, so that contractors will start to follow and 3) Teamwork and resources. All of these additional CSFs are proved to be valid and supported by some literatures, while some of them are related to the challenges that need to be addressed by the Malaysian construction industry such as market demand and proving of return of investment.

It is recommended that future research study could conduct a comprehensive study on the level of awareness regarding wearable technology within Malaysian construction practitioners. Such research initiatives could help to raise the society awareness and to encourage more local construction companies to consider on the adoption for the sake of construction health and safety. The researcher can generate creative approach to understand the Malaysian construction practitioners' perceptions on the wearable technology and at the same time instilled and convinced them on the benefits that can be exploit using wearable. Moreover, it is suggested that the researcher to explore the possible strategies to be taken to increase the adoption of wearable in Malaysian construction industry and to overcome the barriers mentioned in this research. The CSFs investigated in this study can also form part of a broad strategic framework for the application of smart wearable in local construction projects. In terms of target respondents, future research could also involve wider respondents from all grades, states and even developer companies.

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IDENTIFYING CONSTRUCTION SUPERVISOR COMPETENCIES FOR EFFECTIVE SITE SAFETY IN SARAWAK

Magdalen Petrus, Ting Siew Lung and Esther Wong Siaw Wei
Quantity Surveying Department, School of Built Environment, University of Technology Sarawak (UTS), Sarawak, Malaysia

Abstract
Essentially, the competencies of construction sites supervisor are regarded as important elements for improving and ensuring the health and safety culture by reducing the number of injuries. This research intended to review past researchers that had been conducted in the health and safety area of research, to identify the necessary site supervisor's competency for effective safety performance in Sarawak construction industry. Primary data was collected quantitatively via self-administered questionnaires to meet the research's desired aims. Total 225 response from professional's team including G5 and G6 contractor obtained in this research. Self-administered questionnaire was distributed to them since they have more experience in the implemented method of safety regulations through handling large projects. Collected data was analyse using Microsoft Excel and represented in figures, which are based on the respondent frequency and Relative Important Index (RII). To be compendious, there are 17 supervisor competencies that were ranked by the RII. Based on the results, the most important construction supervisor competencies for effective site safety in Sarawak, Malaysia is to have an organizing efficient safety communication, job planning and delivering, lesson learned from accidents, adapting safety and health materials into simple language should be taken into account together with other competencies variables such as safety plan implementation, providing training by using natural language, and knowledge of distributing daily work tasks. The results shows the top seven most recommended competencies that may help the front-line construction supervisor to improve their knowledge, and the ability to determine all future occupational dangers and hazards in Sarawak's ongoing building project.

Keywords: *Competencies; Construction industry; Supervisor; Sampling method; Safety*

INTRODUCTION

Nowadays, construction industries are critical because of their charismatic rare, and limited essence (Fang et al., 2015; Mohseni et al., 2015). This is owing to its high accident rate, which results in significant loss of life and property. Construction supervisor plays an important role in the workplace because they can have direct contact with site workers and upper management. Therefore, upper-level management like supervisors or foremen often represents the responsibility for bringing positive impact on construction site protection even that is a complex and multifaceted job on the ultimate site protection. It is because construction supervisor or foreman preparation contributes to increasing efficiency and safety on the job site as disputed by top managers and safety managers (Lingard et al., 2012). According to the previous research, there are very limited research about front-line supervisors' competencies for effective site safety (Hardison et al., 2014). Conchie et al. (2013) suggested that more researches are required to improve the supervisor's necessary competency skills in how to ensure effective site safety. This paper aims to identify the necessary site supervisor's competency for effective safety performance in the Sarawak construction industry. The research process and findings are explained in this paper.

LITERATURE REVIEW

Operational Definition

Construction site supervisors are the critical person who has responsibilities to ensure the site's overall safety (Hardison et al., 2014). Supervisors' reactive and positive actions have a clear and immediate effect on workers' attitudes (Fang et al., 2015). Therefore, they should have a clear mindset to share the same objectives and goals with the workers to prevent misunderstanding and ensure a safe environment on-site indirectly. This research had strongly agreed that the site supervisor is the key person to bring good results on effective site safety performance.

Competency can be explained as the scope to complete the exercise or the skill to perform well in the workplace. Simply, competencies were defined as characteristics, abilities, or knowledge that are applied through work (Lindberg & Rantatalo, 2015). The competencies of construction supervisors had focused on in this research (Hardison et al., 2014). This research will show that supervisor competency is a technique or skill that should be required for high achievement about construction health and safety climate.

Construction Site Supervisor's Competencies for Effective Site Safety in Sarawak

Managing workplace safety issues is a challenging and complicated task. Multiple factors affect the ultimate site protection. Usually, top management will assign the responsibilities to the supervisor for construction site protection (Swuste et al., 2012). However, the competencies applied by construction supervisors to improve successful site safety practices had become a significant factor in the construction industry's overall impact. Based on the previous researchers, there are Seventeen (17) numbers of variables that can be identified as a competencies of construction site supervisors. All the competencies of the construction site supervisors identified are listed in the Table 1 below.

Table 1. Competencies of Supervisors for Successful Safety Management at Construction Site

No.	Supervisor's Competencies for Effective Site Safety	Source
1.	Organizing efficient safety communication	Burke et al. (2011); Chan et al. (2016); Ling et al. (2013); Tutt et al. (2011); Hare et al. (2012); Okorie (2018)
2.	Organizing specific leader-member exchange	Burke et al. (2011); Walumbwa et al. (2011); Chan et al. (2016); Yikun Su (2019); Shen et al. (2017), Liang & Zhang (2019); Al-Atwi (2016)
3.	Knowledge of distributes daily work tasks	Ling et al. (2013); Tutt et al. (2011); Swuste et al. (2012); Lingard H. Z. (2019); Hardison et al. (2014)
4.	Known contributing of excellent team techniques	Swuste et al. (2012); Chan et al. (2016); Chen et al. (2013)
5.	Determine worker stress levels	Lingard (2011); Hardison et al. (2014); Guo & Yiu (2016); Fang et al. (2015); Han et al. (2014)
6.	Leading employee responsibilities	Hardison et al. (2014); Chmiel et al. (2017); Basak et al. (2019); Jeschke et al. (2017)
7.	Conflict and attitude management	Conchie et al. (2011); Hardison et al. (2014); Guo & Yiu (2016)
8.	Job planning and delivering	Hardison et al. (2014); Smith et al. (2015); Odesola (2019); Herbert C. Biggs (2012); Lingard et al. (2012); KOSHA (2013)

Table 1. Competencies of Supervisors for Successful Safety Management at Construction Site (Continued)

No.	Supervisor's Competencies for Effective Site Safety	Source
9.	Racial discrimination toward workers	Wong & Lin (2014); Chan et al. (2016); Flynn (2014)
10.	Diversification of cultural and spiritual	Loosemore et al. (2011); Tutt et al. (2011); Ling et al. (2013); Chan et al. (2016); Wong & Lin (2014)
11.	Lesson learned from accidents	Guo & Yiu (2016); Wachter & Yorio (2014); Chan et al. (2016); Cheng et al. (2012); Jiang et al. (2015); Mohammadi (2018)
12.	Safety plan implementation	Chmiel et al. (2017); Hardison et al. (2014); Huang et al. (2018); Basak et al. (2019)
13.	Understanding of OSHA policies/concepts	OSHA (2011) OSHA 30-hour; Hardison et al. (2014); Roelofs (2012); American Society of Safety Engineers (2013)
14.	Provide training by using natural language	Ling et al. (2013); Tutt et al. (2011); Flynn (2014); Wong & Lin (2014); ASSE (2015); Chan et al. (2016); Ling et al. (2013)
15.	Provide opportunities for employees' career advancement and development	Flynn et al. (2013); Chan et al. (2016); Catholic Diocese of HK Diocesan Pastoral Centre for Workers (Kowloon) and HKWHC (Hong Kong Workers' Health Centre) (2011); Wong & Lin (2014); Hardison et al. (2014)
16.	Understand workers' health problems	Chan et al. (2016); Flynn et al. (2013); Roelofs et al. (2011); Hardison et al. (2014); Mohammadi (2018)
17.	Adapt safety and health materials into simple language	Jiang et al. (2015); Catholic Diocese of HK Diocesan Pastoral Centre for Workers (Kowloon) and HKWHC (Hong Kong Workers' Health Centre) (2011); Chan et al. (2016); Hardison et al. (2014); Feng (2013); Wong & Lin (2014); Pinto et al. (2011); Chi et al. (2013); Frazier et al. (2013)

RESEARCH METHODOLOGY

The present research adopted the quantitative technique. In the past, quantitative strategies were appropriate when variables, measurements, analysis, and statistical processes are available (Hardison et al., 2014). Through the questionnaire distributed to the respondents, the supervisor's competencies for successful site safety in the Sarawak construction sector can be determined. The respondents are those who are actively involved in top management or who work in the building sector as professionals. This method was adopted because the researchers will be able to identify the construction supervisor competencies for effective site safety in Sarawak based on the ranking of 5point – Likert scale by the professionals. Number 5 symbolizes very high contribution whereas Number 1 symbolizes very low contribution.

The respondents for this research were G5 and G6 contractors including the other professional teams in Sarawak, Malaysia. The sampling method adopted was purposive sampling method because the present study required information from interviewees with unique characteristics (Pajo, 2018). The respondents who have experience handling large projects and involved with longer project period were selected. According to Sekaran and Bougie (2016), purposive sampling method is a good choice to collect information from the persons who possess the necessary information. The ranking of various variables were evaluated using Microsoft Excel and represented in figures, which are based on the respondent frequency and Relative Important Index (RII). According to Jarkas & Bitar (2012), "the rank of each group was established by quantifying the average value of the importance indices for all factors within; the higher the average value, the stronger the effect of the group”. The following formula was used to calculate the RII (Lung, 2018):

$$RII = \left(\frac{\Sigma w}{A \ x \ N}\right)^{nt}$$

Where:

RII = Relative Importance Index
W = Weighting given to each supervisor competencies for effective site safety by the respondent (scale range 1 to 5)
A = Highest weight (5)
N = Total number of respondent

The RII ranges from 0 to 1. Higher RII symbolizes the most reliable construction supervisor competencies for effective site safety in Sarawak, Malaysia.

RESULTS AND DISCUSSIONS

Number of Respondent

There were 77 numbers of respondent that responded to the questionnaire for this study. There are both 21 Engineers and Architects, 15 Quantity Surveyors and 18 Project Managers, 1 of each Designer and Intern among 77 respondents.

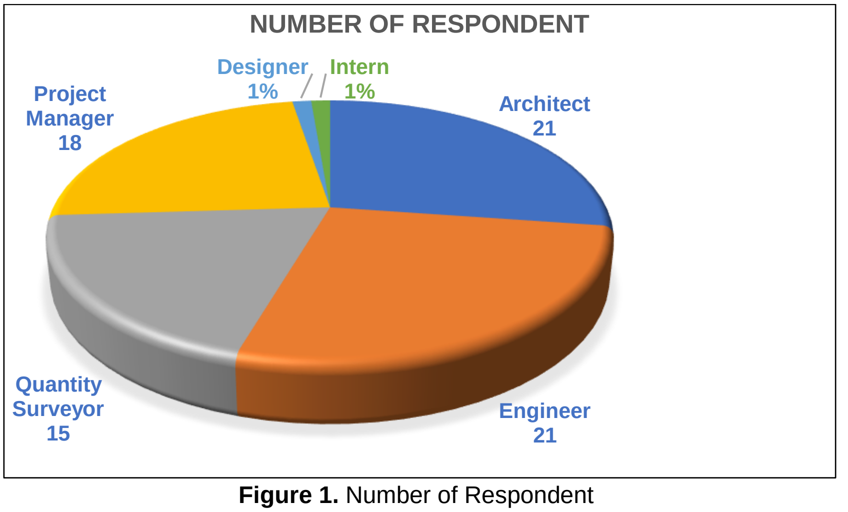

Figure 1. Number of Respondent

Working Experience

Based on terms of the working experiences among them, a lot of respondents had less than 5 year’s working experience with 39 percent. This set of responders reflects the bulk of project team members with construction project expertise in the construction sector.

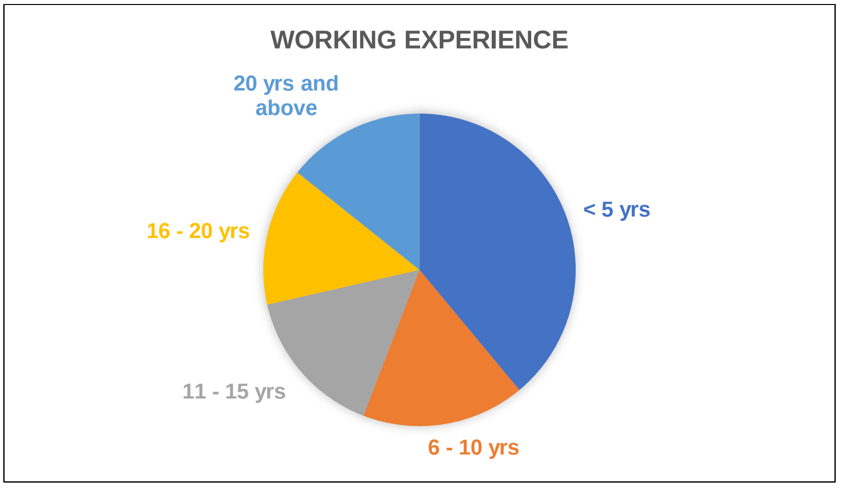

Figure 2. Working Experience

Overview of Supervisor's Competencies Findings

Table 2. Summary of All Variables

Variables	Mean	S.D	Rank
Organizing efficient safety communication.	4.30	0.844	1
Job planning and delivering.	4.23	1.122	2
Lesson learned from accidents.	3.97	1.111	3
Adapt safety and health materials into simple language.	3.92	1.010	4
Safety plan implementation.	3.76	1.099	5
Provide training by using natural language.	3.68	1.186	6
Knowledge of distributes daily work tasks.	3.66	1.154	7

DISCUSSION

Giving the Mean and rankings, the results are self-explanatory According to the findings, the major influence of supervisors' competencies for effective site safety in the construction sector is agreed upon by the current study respondents. The principal results included organizing efficient safety communication, job planning, and delivery skills, lessons learned from accidents, adapting safety and health materials into simple language, safety plan implementation, providing training by using natural language, and knowledge of distributing daily work tasks. The seven (7) described key variables have also received good marks in prior studies.

From the results, it shows that the most important construction supervisor competencies for effective site safety in Sarawak, Malaysia is to have an organizing efficient safety communication. This is because the Sarawak building sector involves parties of diverse races and cultures, which creates communication problems among them. Similar to the previous study conducted in Nigeria, it also had shown that efficient safety communication will improve workers' safety performance to continuously develop work processes and keep accident risks at the construction site to a minimum (Okorie, 2018). Since language limitations between supervisors and foreign workers might lead to misconceptions, open communication between construction site supervisors and workers should be encouraged.

The respondents also agreed that construction team members that job planning and delivering are one of the important competencies for effective site safety. Task planning and delivery skills should be addressed adequately by all parties involved, to make sure the efficiency of site supervisors' safety performance (Hardison et al., 2014).

The competencies "lesson learned from accidents" was the third important competencies in the current survey that should be learned by the construction site supervisors. Effective site safety has a strong interrelationship with the first-aid rate and the safety behaviors of all construction site members (Guo & Yiu, 2015).

Besides that, the construction site supervisors are expected to generate simple language safety materials including security precautions in connection with contingencies, safety procedures, and regulations. Since these selected competencies are famous and useable in previous research and also agree by the most respondent in the Sarawak construction industry, thus "adopt safety and health materials into simple language" play a significant role in determining the capability, quality, and safety standards at work (Chi et al., 2013).

Furthermore, the respondents agreed that it is not enough to have a safety plan only but also required to follow up on the plan daily to assess the health and safety strategy of each employee to ensure that the necessary adjustments have been made and are being executed appropriately.

According to the respondents, provide training by using natural language also can be considered as one of supervisor’s competencies. When construction site supervisors required specific competencies to provide safety courses, employees' comprehension improves, and they can dedicate their complete attention to the material without getting to consciously translate it into their first language especially in Sarawak because there are diverse language and culture can be found in Sarawak.

"Knowledge of distributes daily work tasks" was placed seventh as an agreed important competency in the Sarawak construction industry. Establishing an adequate strategy for the workers will enable construction site supervisors to easily handle a full group's vitality. The supervisor's leadership abilities are essential in implementing pre-employment preparation briefings and work risk monitoring, which is crucial to avoid serious injuries caused by irregular or non-routine labour (Ling et al., 2013).

The results of the present research can provide guidelines to the construction supervisor in Sarawak to become mere competent in providing effective site safety in Sarawak. When the competencies are highlighted, site safety will be more effective, and the progress and management of construction project will be more competent enough. Furthermore, similar research can be conducted by academicians to study the perspective view of construction players towards the competencies for effective site safety in others state such as Sabah and Western Malaysia.

LIMITATION OF THE PRESENT STUDY

Although the current study met the aims, it had several limits. The forms therein may be misinterpreted by the responders. As a result, forms should be designed in a basic and direct manner to avoid wordiness, making it appear easier and clearer for respondents to answer. Finally, because this is a quantitative study, the obtained data are analysed statistically, which may limit the respondent's ability to provide their viewpoint because they cannot be given a clear explanation face to face.

CONCLUSION AND RECOMMENDATION

Questionnaire distributions were conducted to allow the professional team including G5 and G6 contractor to rate different construction supervisor competencies for effective site safety in Sarawak in term of their importance in enhancing the site safety based on 5-point Likert scale. The responses of the survey were analysed using RII method. The design alternatives for each component were ranked based on RII. Based on the results, organizing an efficient safety communication was identified as the most important competencies followed by job planning and delivering and lesson learned from accidents. The present study is the first in Sarawak to study the construction supervisor competencies for effective site safety in Sarawak. Organizing an efficient safety communication should be one factor to be considered by the construction supervisor to promote effective site safety. Through this study, it is anticipated to create awareness among the construction supervisor to consider the most important competencies that are available to suit the situation at the construction site. Job planning and delivering, lessons learned from accidents, adapting safety and health materials into simple language should be taken into account together with other competencies variables such as safety plan implementation, providing training by using natural language, and knowledge of distributing daily work tasks so that all the construction supervisors are not only competent but capable in maintaining the efficiency and effectiveness of site safety.

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RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE IN THE MALAYSIAN CONSTRUCTION INDUSTRY

Yoke-Lian Lew, Yang-Jie Ong and Jeffrey-Boon-Hui Yap
Department of Surveying, Lee Kong Chian Faculty of Engineering & Science, University Tunku Abdul Rahman, Sungai Long Campus, Jalan Sungai Long, Bandar Sungai Long, Cheras, 43000 Kajang, Selangor, Malaysia

Abstract
Over the past years, rapid growth of construction industry and deficient devotion of construction practitioners to construction and demolition (C&D) waste management has increased the overall amount of C&D waste, resulted in becoming one of the single largest waste streams in Malaysia. This research aims to provide an overview of the current practices of recycling C&D waste by Malaysian construction practitioners. This research has adopted quantitative research method in which a total of 800 questionnaires were distributed to construction practitioners within Klang Valley, Malaysia. The overall response rate in this research was 21.38%, a total of 171 responses collected. The respondents come from three different types of companies, which are contractor, consultant and developer. The level of awareness of the practices of recycling C&D waste was identified, which 80% of the respondents are well aware of the practices of recycling C&D waste. This research has also identified eight benefits, and 9 barriers of recycling C&D waste as faced by the Malaysian construction practitioners. The five most important benefits of recycling C&D waste identified included: (1) sustainability, (2) lesser negative environmental impacts, (3) natural resources savings, (4) reduction in public health and social issues, and (5) reduction in landfill spaces. Meanwhile, the five most agreed barriers of recycling C&D waste revealed: (1) high cost of recycling, (2) lack of government policy and regulation, (3) technological barriers, (4) lack of market recycled products, and (5) lack of incentives. This research seeks to alert the Malaysian construction practitioners on the problem of C&D waste and wished to motivate and encourage the practice of recycling C&D waste in the construction industry.

Keywords: *Construction and demolition; Construction waste; Recycling*

INTRODUCTION

The problem of construction and demolition (C&D) waste is a global phenomenon. A major portion of the total solid waste production in the world comes from C&D waste (Rao, Jha and Misra, 2007). With the increasing number of projects constructed in developing countries, it is no doubt that the generation of C&D waste would be snowballed. These projects could range from complex to simple buildings such as airports, factories, skyscrapers, residential and so on. Reducing C&D waste is one of the key environmental issues in the construction industry. It is challenging to give a precise amount or quantity of C&D waste produced. In Thailand, it was assessed that around 4.2 million tons of C&D waste were generated in 2014 (Thongkamsuk, Sudasna and Tondee, 2017). Hence, it could lead to various negative impacts to the environment as well as health problems (Begum et al., 2009). C&D waste includes demolished concrete, woods, bricks, masonries, glasses, pipes, and soil, creates a substantial element of the total waste (Coventry, 1999). Hence, reducing C&D waste has become one of the key environmental issues in the construction industry. Over the past years, rapid growth of the industry together with deficient devotion to C&D waste in Malaysia have contributed to a pressing desire for additional research on the C&D waste (Begum et al., 2007).

Based on previous studies, researchers only focus on the factors of waste generation in Malaysian construction industry, approaches in developing an integrated management of C&D waste, methods to minimize waste, and the readiness of contractors to pay for C&D waste management (Ikau, Joseph and Tawie, 2016; Begum et al., 2007; Esa, Halog and Rigamonti, 2017; Begum et al., 2009). Ikau, Joseph and Tawie (2016) studied and found out that there are several factors leading to construction wastes generation in Malaysia. Esa, Halog and Rigamonti (2017) carried out a research on the key principles and strategies in developing an integrated management of C&D waste and found out that the process of managing C&D waste should start in the early stage of a project, consequently the amount of waste could be reduced. It can be said that there is a lack of study in the level of awareness of construction practitioners in recycling of C&D waste, as well as the benefits and barriers of recycling C&D waste.

The identification of level of awareness of recycling C&D waste is able to portray the current alertness of Malaysian construction practitioners on the practice of recycling C&D waste. Meanwhile, identifying the benefits in recycling C&D waste would increase the motivational level of construction practitioners in implementing the recycling practice of C&D waste. Nevertheless, identification of the barriers in recycling C&D waste would help the construction practitioners in gaining additional knowledge towards this issue, especially contractors, which they can take proactive steps to better prepare themselves to avoid costly and unnecessary measures. Thus, it is important for this research to focus on the above-mentioned issues of recycling C&D waste in the Malaysian construction industry.

LITERATURE REVIEW

The construction industry portrayed a major role in generation of waste. C&D waste can be defined as waste generated in the process of construction, renovation, reconstruction, demolition of old buildings, and expansion of roads or structures (Statistics Canada, 2000). According to Baxter, Srisaeng and Wild (2018), C&D waste would be produced from land clearing work, excavation work, as well as repairing works, and these waste materials can be any non-hazardous solid waste such as concrete, wood, metals, plastic, pipes, cardboard, soil, debris, and many more. However, those wastes are frequently dumped without any consideration, triggering various kind of trouble such as air pollution, ground water contamination, and associated health and social risks. The increasing amounts of C&D waste has also caused problems such as scarcity of land used for landfilling and the ever-increasing building costs. Meanwhile in China, C&D waste was estimated to be 30% to 40% of the total municipal waste, and the recycling and reusing rate of C&D waste in China is not more than 5% (Huang et al., 2018).

Malaysia is observing a swift growth of its urban centres, thus the generation of C&D waste is increasing uniformly with the new development in the area. In a recent study, it was discovered that 70% of contractors did not exercise waste separation unless instructed by specific private contract requirements (Begum et al., 2009). Large amount of C&D waste was produced with the increasing demand for major commercial buildings, infrastructure projects, and housing developments. The construction activities produce considerable amount of waste in a construction site such as the worker's shelters, as well as supplementary facilities on site. Dumping the wastes in landfills is the common practice in Malaysia. Hence, most C&D waste are subsequently disposed or dumped to the landfill.

The practice of recycling C&D waste is able to provide several environmental benefits, which includes lesser negative environmental impacts; reduction in public health & social issues; natural resources savings; purchase savings; reduction of landfill spaces; waste disposal savings; sustainability; and increase job opportunity. According to Jin et al. (2017), one of the environmental benefits from recycling and reusing of C&D wastes is that the greenhouse gas emission could be reduced. Besides, recycling C&D waste could also reduce public health & social issues such as soil and ground water contamination that may possibly affect the population within the area (Begum et al., 2006). Some contractors that seek to avoid the high tipping fees of landfilling may choose to dispose the C&D waste illegally, causing water and air pollution by dumping it into rivers or choose to eliminate them by open burning (Narcis, Ray and Hosein, 2019; and Jin et al., 2017).

Many products today are made with recycled materials. In fact, recycling C&D waste is able to provide an alternative source of building materials to be used by construction practitioners in a project, leading to conserving of natural resources and a reduced demand for new resources (Behera et al., 2007; Yuan and Shen, 2011; and Narcis, Ray and Hosein, 2019). Recycling C&D waste can preserve finite natural resources (Tam, Kotrayothar and Loo, 2009). Purchase savings can also be achieved as a result of recycling C&D waste as money will be saved reusing and recycling waste materials instead of purchasing them.

Recycling of C&D waste is able to reduce the needs for sending C&D waste to landfills. Thus, decreasing the needs for constructing large landfill spaces that were planned to accommodate the waste generated from construction and demolition projects (Jin et al., 2017). Moreover, the costs for disposing waste may be reduced by the practice of recycling and reusing of C&D waste (Narcis, Ray and Hosein, 2019; and Tam, Kotrayothar and Loo, 2009). According to research conducted by Narcis, Ray and Hosein (2019), the practice of recycling C&D waste has the potential to promote sustainability. The recycling of C&D waste is able to save energy in terms of manufacturing and production of construction materials (Jin et al. 2017). In addition, recycling of C&D waste requires a large amount of labour forces. The process of recycling can be considered as much more labour-intensive as compared to solid waste management (Leblanc, 2019). The implementation of recycling of C&D waste could create new job opportunities (Omarenviro, 2017).

Meanwhile, implementing the practice of recycling C&D waste is a challenging process in the Malaysian construction industry. There were several barriers identified which most construction practitioner, especially contractors, faced in recycling of C&D waste.

Landfill has always been the first option applied by construction practitioners in various countries to dispose C&D waste. According to the survey conducted by Zou, Hardy and Yang (2015), it was found that the landfilling is the cheapest alternative to recycling. The low price of landfilling is encouraging contractors to choose to landfill rather than recycling the C&D waste. Moreover, the cost of recycling could exceed the cost of purchasing new construction materials.

The government of a country play a vital role in driving the practice of recycling. The absence of government-backed policies and regulations in favour of C&D waste management are one of the main causes of preventing countries to have an effective system of C&D waste management (Ghoddousi et al., 2015). Government policies or regulations to mandate the recycling of C&D waste is important as it could motivate construction practitioners, ensuring a higher rate of recycling of C&D waste. It is not easy for contractors or demolition personnel to avoid or reduce waste when it can be disposed inexpensively.

Another reason that construction practitioners chose not to recycle C&D waste is due to the low cost of virgin construction materials. Furthermore, due to the requirements of construction materials to meet certain criteria, it is easier for construction practitioners to choose virgin new construction materials rather than going through the hectic process of having recycled products that is certified to be used as an alternative. Meanwhile, the lack of supply and demand for recycled C&D materials prohibits the growth of recycling C&D waste (Zou, Hardy & Yang, 2015). It is difficult for recycled products to have a place in the current construction industry since the market for virgin new construction materials are strong, and most importantly it is cheaper than recycled products.

In addition, contamination often occurs and may hinder the recycling process. The current recycling process on a construction site is to use an on-site crusher and grinder to make C&D waste into debris for recycling purposes, yet some C&D waste which may contain hazardous substances are very difficult to separate them thus requiring a better technology to process them (Warren, Chong & Kim, 2007). Furthermore, lack of space is also a significant barrier in implementing recycling of C&D waste. Usually, the space for sorting C&D waste would not be taken into consideration by contractors. C&D waste that has been complied in a disposal bin is often contaminated due to the lack of space for separation of C&D waste (Zou, Hardy & Yang, 2015). Hence, these barriers are the main obstacles that demotivates Malaysian construction practitioners in practicing recycling of C&D waste.

RESEARCH METHODOLOGY

Quantitative research was adopted in this research instead of qualitative research. Since all construction practitioners in the industry faced the issue of recycling of C&D waste. Therefore, the sample population shall consist of construction practitioners from all types of construction companies. In this research, only major construction players such as contractor, consultant, and developers were selected as the targeted population instead of the minority which consisted of suppliers and manufacturers. The targeted population shall only be limited in Klang Valley, Malaysia, as statistics shown that it has the most construction practitioners in Malaysia (CIDB, 2020). Databases and information from CIDB, Real Estate & Housing Developers' Association (REDHA) Malaysia, and the Board of Quantity Surveyors Malaysia (BQSM) were referred. All contacts information were compiled in an Excel file, and random numbers were generated in order to pick the respondents randomly from the list using random sampling method. However, the targeted population is still too large to be included. Thus, in order to find out the bare minimum sample size for this research, Cochran's formula of calculating sample size was implemented, as it is suitable to be applied when the population is too large (Glenn, 2009; Cochran, 1977). Hence, the minimum sample size was 384, when critical value of the normal distribution at 95% confidence level is 1.96; the estimated sample proportion to be 0.5; and the margin of error to be 5%. In order to achieve the minimum sample size, a total of 800 questionnaires were distributed to the selected respondents through simple random sampling method. The questionnaire was designed to obtain the necessary information that could satisfy and achieve the research objectives.

The questionnaire is designed into several sections: section A, section B, section C and section D. Section A was the first part of the questionnaire, and it was involved with the collection of the respondents' personal information. Meanwhile, section B involved collecting data for the first research objective, which is to investigate the level of awareness of construction practitioners in recycling of C&D waste in the Malaysian construction industry. Section C aim to collect responses regarding the second objectives of the research, which is the benefits of recycling C&D waste. Meanwhile, section D seeks the respondents' opinion on the barriers of recycling C&D waste. A pre-test of questionnaire was conducted to test the workability and appropriateness of the questionnaire.

RESULT AND DISCUSSION

A total of 800 questionnaires were distributed through simple random sampling method, and a total of 171 responses were collected. The overall response rate was 21.38%, which is in line with the opinions of Dulami et al. (2003) and Akintoye (2000) who suggested the response rate for Malaysian construction practitioners is around 20% to 30%. The detail of the response rate is as shown in the Table 1.

Table 1. Response Rate

Types of Company	Questionnaire		Response Rate (%)
	Distributed (Nos.)	Collected (Nos.)	
Contractor	270	61	22.59
Consultant	265	53	20.00
Developer	265	57	21.51
Total	800	171	21.38

Meanwhile, Table 2 summarized the respondents' demographic details according to the types of company that they are currently working with. In terms of working experience across the three types of company, majority of the respondents (75 out of 171) are less than 2 years of working experience. Whereby 33 of them are contractors, 24 are consultants, and 18 are developers. In addition, most of the respondents are positioned as executive level (74 out of 171), which 37 from contractors, 16 from consultants, and 21 from developers. It can also be concluded that majority of the respondents from contractor and developer are positioned as executive, while majority of consultant are positioned as a quantity surveyor.

Table 2. Respondents' Demographic Profile Comparison Based on Respondents' Type of Company

Profile	Descriptions	Types of Company			Total	Frequency (%)
		Contractor	Consultant	Developer		
Working experience	≤ 2 years	33	24	18	75	43.90
	> 2 – ≤ 5 years	13	15	10	38	22.20
	> 5 – ≤ 10 years	11	9	17	37	21.60
	> 10 years	4	5	12	21	12.30
Position in company	Executive	37	16	21	74	43.30
	Senior Executive	13	8	8	29	17.00
	Engineer	1	4	5	10	5.80
	Quantity Surveyor	2	19	6	28	16.40
	Assistant Manager	0	0	1	1	0.60
	Manager	4	2	7	13	7.60
	Senior Manager	3	1	4	8	4.70
	Upper Management	0	3	5	8	4.70

Reliability of Results

Table 3 summarized the result of the Cronbach's Alpha Reliability test. According to Gliem and Gliem (2003), the acceptable range of alpha values should be more than 0.70. Based on Table 3, the alpha values for both the benefits and barriers of recycling C&D waste are more than 0.70. Hence, the data collected were reliable and ready to be used for this research.

Table 3. Cronbach's Alpha Value for Benefits & Barriers of Recycling C&D Waste

Category of Variables	Number of Items	Cronbach's Alpha
Benefits of Recycling C&D Waste	8	0.897
Barriers of Recycling C&D Waste	9	0.877

Level of Awareness on Recycling C&D Waste

The author anticipated the respondents' answers in this section to find out the level of awareness on recycling of C&D waste in the Malaysian construction industry. In order to observe the level of awareness of the Malaysian construction practitioners in the practice of recycling C&D waste, the respondents were asked to answer four questions in this section. 80% of the respondents have answered yes in the first question, this proved that the level of awareness of the practice of recycling C&D waste is above average. In addition, the response from the second and third questions further determine the respondents' awareness and knowledge on the costs related to the practice of recycling C&D waste. Whereas, the last question in this section was to observe the implementation of the practice of recycling C&D waste from the companies in Klang Valley, Malaysia. Table 4 summarised the result of the data collection from the 171 respondents.

Table 4. Level of Awareness on Recycling C&D Waste

Level of Awareness on Recycling C&D Waste	Response				Total
	Yes		No		
	Count	%	Count	%	
I am aware about the practice of recycling C&D waste, and I have the knowledge about it.	137	80.10	34	19.90	171
I have the knowledge about the cost of recycling C&D waste.	75	43.90	96	56.10	171
I have the knowledge about the cost of disposing C&D waste in landfills.	78	45.60	93	54.40	171
The company that I currently work with is practicing recycling of C&D waste.	67	39.20	104	60.80	171

Based on Table 4, 80.10% of the respondents acknowledged that they were aware and have knowledge about the practice of recycling C&D waste. However, majority of the respondents do not know the cost involved in recycling C&D waste (56.10%) and the cost of disposing C&D waste in landfills (54.40%). In addition, 60.80% of the respondents' current company do not practice recycling of C&D waste. In order to get a detail analysis on the respondents' level of awareness on recycling C&D waste, the following table has summarised the respondents' response in terms of the types of company on the level of awareness on recycling C&D waste.

Benefits of Recycling C&D Waste

Table 5 summarised the result of the Mean Ranking analysis for benefits on recycling C&D waste. The respondents were asked to rate from 1 to 5 on the level of importance of benefits of recycling C&D waste, whereby 1 represented not important; 3 as neutral; and 5 represented very important. All benefits shown in Table 5 has a mean value more than 3.00. It can be concluded that the respondents agreed that all the benefits listed were important benefits of recycling C&D waste. The top five overall ranking for the benefits of recycling C&D was sustainability ($\bar{x} = 4.37$, $\sigma = 0.840$); lesser negative environmental impacts ($\bar{x} = 4.23$, $\sigma = 0.910$); natural resources savings ($\bar{x} = 4.11$, $\sigma = 0.895$); reduction in public health & social issues ($\bar{x} = 3.99$, $\sigma = 0.891$); reduction in landfill spaces ($\bar{x} = 3.98$, $\sigma = 1.073$).

The respondents agreed that sustainability is the most important benefit of recycling C&D waste. Recycling C&D waste ensures that the finite natural resources are used in a more efficient and effective way. Meanwhile, lesser negative environmental impacts were ranked as the second most important benefits. When the practice of recycling C&D waste is implemented, the odds of extreme climate change, soil and ground water contamination, and associated environmental problems could be reduced. Moreover, the third most important benefit of recycling C&D waste was natural resources savings as recycling C&D waste could lead to conserving natural resources.

Table 5. Mean Ranking on Level of Importance of Benefits of Recycling C&D Waste

Benefits of Recycling C&D Waste	Overall (N = 171)			Types of Company: Contractor (N = 61)			Consultant (N = 53)			Developer (N = 57)		
	$\bar{x}$	SD	Rank	$\bar{x}$	SD	Rank	$\bar{x}$	SD	Rank	$\bar{x}$	SD	Rank
Sustainability	4.37	0.840	1	4.26	0.835	1	4.45	0.774	2	4.42	0.905	1
Lesser negative environmental impacts	4.23	0.910	2	4.03	0.930	2	4.45	0.722	1	4.25	1.005	2
Natural resources savings	4.11	0.895	3	3.97	0.983	3	4.17	0.753	3	4.19	0.915	3
Reduction in public health & social issues	3.99	0.891	4	3.84	0.934	4	4.02	0.796	4	4.14	0.915	4
Reduction in landfill spaces	3.98	1.073	5	3.79	1.018	6	4.02	0.990	5	4.14	1.187	5
Waste disposal savings	3.84	1.054	6	3.80	1.014	5	3.87	1.001	6	3.86	1.156	7
Purchase savings	3.62	1.058	7	3.62	1.035	7	3.55	0.932	7	3.68	1.198	8
Increase Job Opportunity	3.53	1.199	8	3.36	1.125	8	3.34	1.239	8	3.89	1.175	6

Note: $\bar{x}$ denotes mean; SD denotes standard deviation, σ; N denotes number of samples

Barriers of Recycling C&D Waste

Table 6 summarised the result of the Mean Ranking analysis for the barriers on recycling C&D waste. The respondents were asked to rate from 1 to 5 on the level of agreement on barriers of recycling C&D waste, whereby 1 represented strongly disagree; 3 represented neutral; and 5 represented strongly agree. All barriers shown in Table 6 has a mean value more than 3.00. It can be concluded that the respondents agreed that all the barriers were significant barriers of recycling C&D waste. The top five overall ranking for the barriers of recycling C&D was high cost of recycling ($\bar{x} = 4.12$, $\sigma = 0.959$); lack of government policy & regulation ($\bar{x} = 4.12$, $\sigma = 1.024$); technological barriers ($\bar{x} = 4.11$, $\sigma = 1.012$); lack of market recycled products ($\bar{x} = 4.07$, $\sigma = 0.998$); lack of incentives ($\bar{x} = 4.07$, $\sigma = 1.009$).

Overall, the respondents agreed that high cost of recycling is the top barrier of recycling C&D waste. Construction practitioners would not choose to recycle C&D waste when there is a lack of an economically viable solution for it. Meanwhile, lack of government policy and regulation was ranked as the overall second most agreed barrier of recycling C&D waste. All three types of company agreed that the government play a significant role in accelerating the practice of recycling C&D waste as the absence of government-backed policies and regulations in C&D waste management are one of the main causes of preventing countries in practicing recycling C&D waste. Furthermore, technological barriers were ranked as the third overall barriers of recycling C&D waste. The current recycling technologies are facing challenges in converting C&D waste into useful products.

Table 6. Mean Ranking on Barriers of Recycling C&D Waste

Benefits of Recycling C&D Waste	Overall (N = 171)			Types of Company								
				Contractor (N = 61)			Consultant (N = 53)			Developer (N = 57)		
	x̄	SD	Rank	x̄	SD	Rank	x̄	SD	Rank	x̄	SD	Rank
High cost of recycling	4.12	0.959	1	3.97	0.948	4	4.15	0.818	4	4.26	1.078	1
Lack of government policy & regulation	4.12	1.024	2	4.08	1.038	1	4.21	0.988	2	4.09	1.057	5
Technological barriers	4.11	1.012	3	4.03	1.032	2	4.04	0.919	6	4.25	1.074	2
Lack of market recycled products	4.07	0.998	4	3.92	0.954	6	4.19	0.962	3	4.12	1.070	4
Lack of incentives	4.07	1.009	5	3.97	0.983	5	4.26	0.984	1	4.00	1.052	7
Lack of knowledge & awareness	4.05	1.078	6	4.00	1.065	3	4.15	0.988	5	4.00	1.180	8
Low cost of virgin construction materials	3.84	1.092	7	3.56	1.088	8	3.91	1.061	7	4.09	1.074	6
Low cost of landfilling	3.82	1.141	8	3.49	1.105	9	3.83	1.033	8	4.16	1.192	3
Lack of space	3.54	1.144	9	3.59	1.086	7	3.57	1.118	9	3.47	1.241	9

Note: x̄ denotes mean; SD denotes standard deviation, σ; N denotes number of samples

CONCLUSION

This research aimed to study the practice of recycling C&D waste in the Malaysian construction industry. The level of awareness of Malaysian construction practitioners in Klang Valley was observed, and eight benefits as well as nine barriers of recycling C&D waste were identified. Opinions from 171 construction practitioners from contractor, consultant and developer in Klang Valley, Malaysia, indicated their views through the questionnaire on the practice of recycling C&D waste, which included their level of awareness on recycling C&D waste, opinion on the level of importance for the eight benefits of recycling C&D waste, and the level of agreement on the nine barriers of recycling C&D waste. Eventually, three specific research objectives were achieved upon the completion of this research and summarised in the following.

As a result, 80.10% of the construction practitioners were aware on the practice of recycling C&D waste. 56.10% of the construction practitioners did not have the knowledge about the cost of recycling. Similarly, 54.40% of the construction practitioners also did not know the cost of disposing C&D waste in landfills. Lastly, 60.80% of the construction practitioners responded that they did not practice recycling C&D waste recycling in their current company. The results indicated that the level of awareness of recycling C&D waste were adequate, however, majority of the construction practitioners were not equipped with the knowledge of the related costs in the practice of recycling C&D waste. Besides, the level of implementing the practice of recycling C&D waste was low among the construction practitioners in Klang Valley, Malaysia. Meanwhile, all eight benefits of recycling C&D waste were rated as important benefits of recycling C&D waste. The top five benefits of recycling C&D waste were ranked as follows: (B7) sustainability was ranked as the top benefits, followed by (B1) lesser negative environmental impacts, (B3) natural resources savings, (B2) reduction in public health and social issues, and (B5) reduction in landfill spaces. Furthermore, all nine barriers were rated more than the mean value of 3.00, thus it was identified and confirmed that these barriers are important barriers of recycling C&D waste. The top five barriers of recycling C&D waste as ranked by the 171 construction practitioners was as follows: (C2) high cost of recycling as the top barriers, followed by (C4) lack of government policy and regulation, (C8) technological barriers, (C7) lack of market recycled products, and (C5) lack of incentives.

Although there are more barriers than the benefits that were identified in this research, it should not hinder the motion of implementing recycling C&D waste in the Malaysian construction industry. Construction practitioners and the government play an important part in solving these barriers so that the industry could be motivated towards the practice of recycling C&D waste. Therefore, the government and construction companies in Malaysia should implement more training, incentives, and policies or legislations on C&D waste management so that the construction practitioners' level of awareness and level of implementation of recycling C&D waste could be further improved.

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SUSTAINABILITY CRITERIA FOR AFFORDABLE HOUSINGS IN KLANG VALLEY MALAYSIA

Lai Li Xuan, Wong Phui Fung and Felicia Yong Yan Yan
Department of Surveying, Lee Kong Chian Faculty of Engineering and Science, Universiti Tunku Abdul Rahman (UTAR), Sungai Long Campus, 43000 Kajang, Selangor, Malaysia

Abstract
Housing affordability and sustainability is a global concern around the world including Malaysia. Sustainable development is a multifaceted process integrating environmental protection with economic, social, and cultural development. Yet, most affordable housing policies in developing countries failed to address the three sustainability pillars. The affordable housing scheme, PR1MA, could not meet homebuyers' needs, resulting in a low take-up rate. Meanwhile, the Malaysian government has recommended including innovative technologies and sustainability features in Malaysian social housing to improve inhabitants' living quality. Hence, this research aims to analyse the sustainability criteria for affordable housing based on the homebuyers' perspective. The criteria contributing to sustainability in affordable housing were categorised into the environment, economic, social and technological criteria A questionnaire was designed and distributed to B40 and M40 homebuyers in the Klang Valley. The data obtained were analysed using Arithmetic Mean, Mann-Whitney U Test and Kruskal-Wallis Test to identify the differences between each demographic group on sustainability criteria. This study concluded economic sustainability is essential in sustainable, affordable housing development from the homebuyers' perspective. Results also revealed that homebuyers with different demographic backgrounds have different preferences on sustainability criteria when purchasing affordable housings. The findings could guide future affordable housing policies to meet homebuyers' requirements to address property overhang and affordability issues. The research complies to the United Nations Sustainable Development Goal 11 to ensure citizens' access to adequate and affordable housing in sustainable cities and communities.

Keywords: *Affordability; Affordable Housing; Sustainable Affordable Housing; Sustainability; Sustainability Criteria*

INTRODUCTION

Malaysia's urbanisation rate has risen gradually from 72.53% in 2012 to 75.37% in 2016, resulting in a scarcity of housing development in urban areas (Soon and Tan, 2019). The continuous urbanisation has boosted demand for housing, causing housing prices to rise and impacting housing affordability. Residential property market in Malaysia is deemed "seriously unaffordable" to most Malaysians (BERNAMA, 2019). The median Malaysian annual household income is RM 61,392 (DOSM, 2020), while the median housing price is RM 300,000 (NAPIC, 2021). Based on the Median Multiple approach, housing priced below RM 185,000 is considered affordable in Malaysian communities. However, finding a house with the aforementioned median house price is difficult.

Under the latest National Housing Policy (2018-2025), the Ministry of Housing and Local Government (MHLG) has planned to construct one million affordable housing units for the lower (B40) to middle-income group nations (M40) (MHLG, 2019). This housing policy focuses on affordability and quality of housings. In other words, affordable housing should not only low in price, but should also provide an acceptable standard of living to the homebuyers or occupants. In Malaysia, the government has taken initiative in affordable housing provision, such as the "Perumahan Rakyat 1Malaysia" (PR1MA), "Program Bantuan

Rumah" (PBR), "Perumahan Penjawat Awam Malaysia" (PPAM), and "Rumah Mampu Milik Wilayah Persekutuan" (RUMAWIP). to meet the rising demand. However, the liveability and sustainability of these houses have been neglected. Most of them could not enhance one's living quality, and worst, deteriorated into an indecent place for families (Tan, 2013). Besides, one of the affordable housing schemes, PR1MA, had a low take-up rate due to the unattractive housing attributes, and applicants were having difficulty acquiring bank loan facilities. Consequently, RM 172 million was paid as compensation for cancellation of PRIMA projects (Yunus, 2020). Furthermore, Olanrewaju and Idrus (2019) claimed that the current housing crisis in Malaysia results from deficient housing policies in Malaysia, which were ineffective in accommodating homebuyers' needs. In consequence, the affordable housing shortage continues to grow while homeownership continues to decline due to the mismatch of supply and demand in the property market.

More affordable housing policies will left unoccupied and unsold if this problem remains unattended, simultaneously exacerbating the prevalent housing overhang problem. In light of this, extensive studies have been conducted on the homebuyers' preferences, mainly on regular residential housing and limited on affordable housing. Soon and Tan (2019) investigated the homebuyers' preferences and their affordable housing price range and housing type in relation to their income. Ismail et al. (2020) revealed that affordable housing prices, location, and structural design were significant concerns among middle-income groups in Malaysia. Similarly, Zainon et al. (2017) found that affordable housing prices are the priority of the middle-income groups in Klang Valley, Malaysia. Afiqah et al. (2020) discovered that price and locality are important factors for the occupants of affordable housing "Rumah Selangorku". Meanwhile, with an increased awareness of sustainability, empirical research has developed sustainable indicators for residential housing. Myeda et al. (2016) surveyed that the homebuyers in Klang Valley, Malaysia prioritised housing near the public amenities, better soundproof, and a larger green landscape area, which could enhance occupants' wellbeing and satisfaction. Whereas, homebuyers in Pakistan appreciate housing with energy-saving features (Khan et al., 2020). Similarly, in Australia, energy-efficient housing and a safe and clean neighbourhood were the main concerns of homebuyers. In conclusion, past empirical studies dedicated to homebuyers' preferences on normal residential housing, affordable housing, or sustainable housing separately. However, homebuyers' preferences on affordable housing were not investigated broadly by only considering the financial and social criteria while overlooking the environmental issues. UN-HABITAT (2012) agreed that affordable housing is often assessed via a cost basis, whereas environmental and social issues are usually addressed separately or neglected. Ignoring any aspect of sustainability results in more problems and less stable housing.

Housing that is planned and built sustainably will not only be more accessible to low incomers, but also meet their social and cultural needs and benefit their physical and mental health, the economy as well as the natural and built environment. Sustainable houses also last longer, making them a prudent investment for the government and other stakeholders (UN-HABITAT, 2012). The benefits of sustainable development and its global adoption have successfully spurred Malaysia's housing development. Ministry of Housing and Local Government (MHLG) has recommended the inclusion of innovative technologies and sustainability features in Malaysian social housing to improve inhabitants' quality of life (MHLG, 2019). Several sustainability criteria for affordable housings were established in the previous studies, yet they were primarily from the opinions of project developers, government or project practitioners (Mulliner et al., 2013; Gan et al., 2017; Chan and Adabre, 2019), and there is little knowledge from the perspective of homebuyers, specifically the Bottom 40% (B40) and Middle 40% (M40) homebuyers, in which they are ultimately the purchasers and end-users of these affordable housings. Hence, this research intends to analyse the sustainability criteria for affordable housings from the B40 and M40 homebuyer's viewpoint. In addition, relatively limited studies on affordable housing have included technological sustainability. To achieve the aim of this study, the criteria for affordable housing on the environmental, economic, social and technological sustainability were identified and the ranking of criteria in choosing sustainable affordable housings among house purchasers from different social demographics background were evaluated.

LITERATURE REVIEW

Sustainability Criteria for Affordable Housing

In Malaysia, housing affordability is measured via a median multiple approach. A house is considered affordable if the median price is three times or less than the median household's annual income (Khazanah Research Institute, 2019). However, a low-priced house located in a remote place with high transportation costs is not genuinely affordable. Besides, the quality of housing development is also critical to support sustainable living among the nations (Khazanah Research Institute, 2019). Hence, the traditional definition of affordability, which is more concerned with housing price affordability, has to shift to a more expansive perspective by considering other elements, such as sustainability and other economic issues. Sustainable development is defined as an endeavour to meet the current generations' needs without jeopardising future generations' ability to meet their own (WCED, 1987). A prominent strategy of adopting sustainability is the triple bottom line, namely economic, environment and social sustainability (Gan et al., 2017; UN-HABITAT, 2012). Also, MHLG (2011) indicated that a new millennium has confronted the housing sectors with constructing more affordable and adequate housing for the public. Innovative construction materials and more sustainable design are thus required to achieve the goal efficiently and effectively. Hence, in this study, the sustainability criteria for affordable housing are classified into environmental, economic, social, and technological criteria, as depicted in Figure 1.

With the concern on climate change and environmental degradation, to be environmentally sustainable in affordable housing development is the solution to minimise its negative consequences towards the built environment. Protection of natural resources such as land, vegetation, water and landscape are necessary as it impacts humans' physical, economical and social wellbeing (Basrah et al., 2021). In response, affordable housing should be designed with energy and water efficiency features (e.g. appliances with higher Energy Star Ratings, motion sensors, dual flush toilets or low flow water fittings), rainwater harvesting system, larger green areas, adequate density and proper waste management system to conserve the scarce natural resources, as these designs will contribute to a housing's environmental performance.

According to the research on the Malaysian housing market, housing price is the most influencing factor (Zainon et al., 2017; Olanrewaju et al., 2018), followed by the mortgage accessibility (Baqutaya et al., 2016). Meanwhile, the primary agenda of affordable housing schemes is to improve housing availability and affordability among low to middle-income nations (Gan et al., 2017). Hence, the economic criteria are housing price or rental affordability, interest rate, availability of mortgage and subsidy, as well as the resale value. It shall not solely focus on the initial housing cost but also the recurrent housing occupation costs.

In terms of the social criteria, household satisfaction and housing quality are critical factors for liveable and adequate housing. According to Tan (2013), the public transportation coverage in Malaysia is still not comprehensive, and traffic congestion remains a significant problem. Hence, Basrah et al. (2021) asserted that providing alternate transportation modes, a decent transit route, and a good traffic circulation pattern are among the most critical factors to emphasise in sustainable affordable housings. Housings with good accessibility to amenities will bring convenience to the households while minimising dependency on transportation. Besides, housing is an individual's primary need. Thus, it should provide a safe and comfortable environment to the occupants, i.e. indoor air quality, thermal comfort, visual and acoustic comfort, and a decent neighbourhood to improve social ties and establish a sense of belongingness. Meanwhile, households' needs and housing preferences might change in their different stages of life. Housing should have high adaptability to accommodate such changing requirements and ensure housing is easily modified for people with limited mobility.

Additionally, innovation in construction methodologies and building materials can be beneficial in delivering sustainable and affordable housings. For instance, the industrialised building system (IBS), prefabrication technology, three-dimensional (3D) printing, or the Internet of Things (IoT) are found to accelerate delivery and enhance housing sustainability. With the integration of these innovative technologies, affordable housing could meet the environmental, economic and social needs of low to middle-income households while minimising negative environmental impacts, culminating in a sustainable and affordable housing notion. MHLG (2019) has also specified that affordable housings will be constructed with the Industrialised Building System (IBS) under the National Housing Policy (2018-2025). Unfortunately, Saikah et al. (2019) asserted that the current IBS still cannot meet the affordable housing needs.

On the other hand, demographic factors, such as age, income, gender, ethnicity, marital status are critical considerations that influence the selection and purchasing decision of housing. A working singleton may opt for housing with good accessibility, while those with younger children may prefer to live close to the natural environment. There are disparities between different generations and genders regarding their preferences for housing, location and the neighbourhood (Ismail and Shaari, 2019). Generation Y tends to own a home that uses sustainable technologies as they are environmentally conscious. They are also hesitant to purchase houses in the city fringe if they can afford houses in the city (Kam et al., 2018). In addition, Majid et al. (2012) claimed that different ethnicities have their own unique culture and perspectives that direct their housing location preferences. Housing affordability issues arises when a household's income is insufficient to cover basic expenses. Therefore, household income level has a strong association in preferred housing attributes. For example, higher-income households were more willing to pay extra for a sustainable house (Myeda et al., 2016), and similarly for highly educated people. However, the latter are constraint by their financial capabilities, limiting them from making green purchases (Tan, 2012; Khan et al., 2020). Hence, there is a substantial difference in their sustainable and affordable housing preferences.

There is a substantial body of literature devoted to studying sociodemographic determinants of preferred housing attributes (Majid et al., 2012; Myeda et al., 2016; Ismail and Shaari, 2019). However, limited empirical studies have examined sociodemographic determinants of preferred sustainable and affordable housing attributes. Homebuyers recognise the value of sustainable and eco-friendly practices that help conserve the natural environment. Previous research found that an increasing awareness or positive perception of green and sustainable housing will result in a greater appreciation of green features and thus intend to live in such housing (Tan, 2012). Therefore, this study investigates the effect of sociodemographic factors on their preferred sustainability criteria for affordable housing, including gender, generation, education level, marital status, ethnicity, and income level.

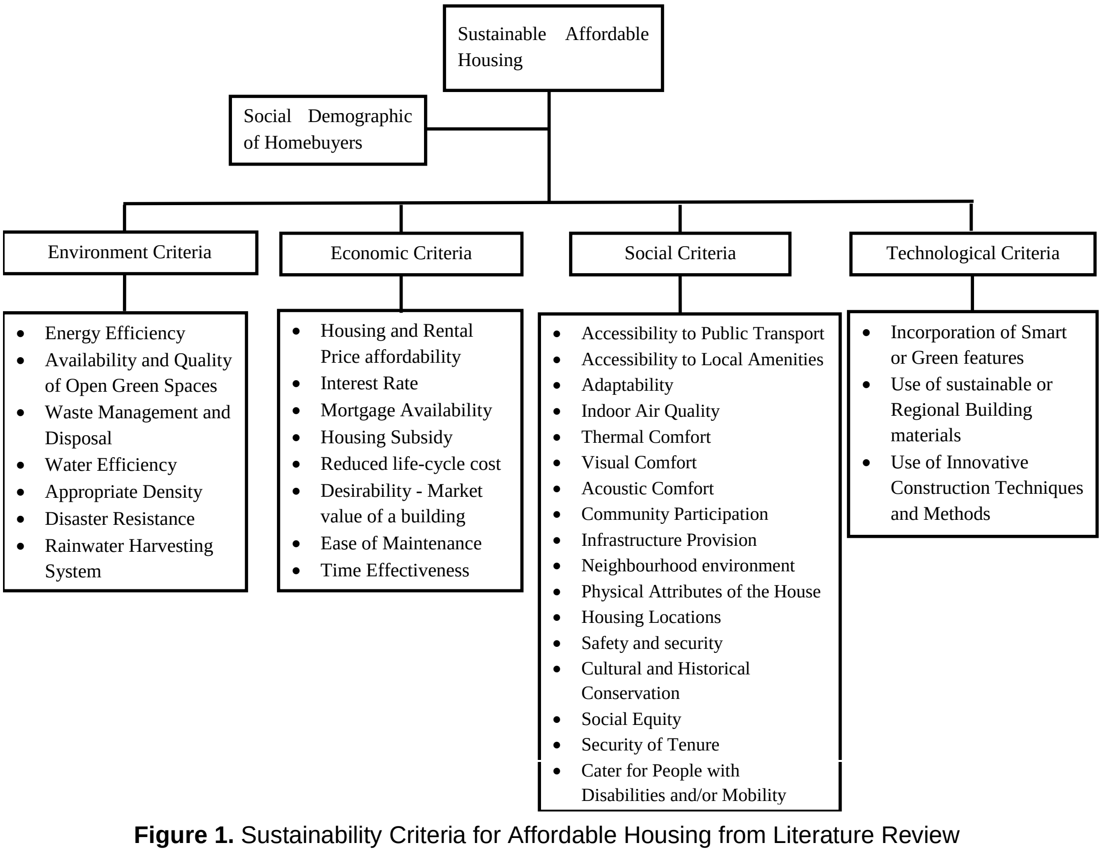

Figure 1. Sustainability Criteria for Affordable Housing from Literature Review

RESEARCH METHODOLOGY

A quantitative research method was used to examine the preferences of the B40 and M40 groups on the sustainability criteria for affordable housing. The target respondents were those aged 18 and above who live in the Klang Valley. Klang Valley is densely inhabited and highly urbanised, the findings of this study can thus be generalisable to the entire Malaysians. Besides, they are also low or middle-income individuals, with a monthly income of RM4,850 or less (B40) and RM4,851 to RM10,959 (M40). Convenience sampling was adopted to collect the primary data. A questionnaire was developed via Google Form. It was divided into two sections and was structured with close-ended questions. The questionnaire covered demographic background at section A and perceptions of sustainability criteria for affordable housings at section B. The respondents are required to indicate the relative importance level of all 35 sustainability sub-criteria for affordable housing using a five-point Likert scale, with 1 representing ‘not important’; 2 representing ‘less important’; 3 representing ‘moderately important’; 4 representing ‘very important’ and 5 representing ‘extremely important’. The questionnaire was disseminated to the respondents residing in the Klang Valley through social media.

The data obtained were analysed using Cronbach’s Alpha Reliability Test, Arithmetic Mean, Mann-Whitney U Test and Kruskal-Wallis Test. Cronbach’s Alpha Reliability test was used to assess the internal consistency of all sustainable criteria. Besides, Arithmetic Mean was utilised to determine the importance level of each sustainability criteria. In contrast, the Mann-Whitney U Test and Kruskal-Wallis Test were adopted to reveal the differences between each social demographic group on the sustainability criteria.

RESULTS AND DISCUSSION

A total of 256 questionnaires had been received for analysis. The reliability test for all sustainability criteria indicated an excellent internal consistency, at 0.96. The demographic characteristics of these respondents are tabulated in Table 1. Among the responses, there were 130 male and 126 female respondents, and about 47 % were Chinese, followed by 27% were Indian, then the remaining 26% were Malay. In addition, most respondents were Gen Y (85.2 %), while 14.5% were Gen X and 0.4% were Baby Boomers. Regarding educational background, 69.1 % of respondents were educated up to Bachelor’s Degree, 19.1% were to Master’s Degree, 5.9% were to Diploma, 1.6% were to secondary school, 1.6% were to Foundation / A-Level / STPM / UEC, and remaining 0.8% and 2% were Doctorate’s Degree and Other Qualification respectively. In terms of marital status, the respondents were dominated by the singles (75.4%). Besides, considering respondents’ income level, 59% respondents earned RM 4,850 and below (B40) while 41% respondents earned between RM4,851 to RM10,959 (M40).

Table 1. Respondents’ Demographic Characteristics

Demographic Information	Frequencies (n=256)	Percentage (%)
Gender		
Male	130	50.8
Female	126	49.2
Ethnicity		
Malay	67	26.2
Chinese	120	46.9
Indian	69	27.0
Age		
18 years old to 29 years old	170	66.4
30 years old to 38 years old	48	18.8
39 years old to 49 years old	25	9.8
50 years old to 60 years old	12	4.7
61 years old and above	1	0.4
Education		
Secondary School	4	1.6
Foundation / A-Level / STPM / UEC	4	1.6
Diploma	15	5.9

Table 1. Respondents' Demographic Characteristics (Continued)

Demographic Information	Frequencies (n=256)	Percentage (%)
Bachelor's Degree	177	69.1
Master's Degree	49	19.1
Doctorate	2	0.8
Others	5	2.0
Marital Status		
Single	193	75.4
Married (without children)	11	4.3
Married (with children)	51	19.9
Divorced (with children)	1	0.4
Income Level		
RM 4,850 and below	152	59.4
RM4,851 to RM10,959	104	40.6

Mean Ranking on Sustainability Criteria for Affordable Housing

As depicted in Table 2, economic sustainability was most prioritised by the homebuyers (mean=4.32), followed by environmental sustainability (mean=4.11), social sustainability (mean=4.07) and technological sustainability (mean=3.84). Economic sustainability is ranked highest as housing is usually an individual's most prominent investment (Ismail and Shaari, 2019), and affordable housing schemes aimed to improve the housing availability and affordability among low to middle-income nations (Gan et al., 2017; Zainon et al., 2017). On the contrary, technological sustainability was ranked lowest, which is aligned with the findings by Yap et al. (2019).It shows that housing with new technologies or materials is one of the less desirable housing qualities, as the built environment sector is slow to adopt new technologies, impeding the diffusion of innovation in the housing market. Harelimana (2017) also claimed that homebuyers would choose to invest in dwellings with conventional brick and mortar methods rather than a brand-new technology that is less familiarised. Besides, most Malaysian homebuyers prefer imported materials to reflect a better quality (Syed Jamaludin et al., 2018).

Table 2. Mean Ranking of Sustainability Criteria for Affordable Housing

Code	Description	Mean	Ranking
B	Economic Criteria	4.32	1
A	Environmental Criteria	4.11	2
C	Social Criteria	4.07	3
D	Technological Criteria	3.84	4

Kruskal Wallis Test

The Kruskal Wallis Test was used to determine whether the respondents' ethnicity, generation and educated level influenced the ranking of sustainability criteria for affordable housing. Out of the 35 sub-criteria, 18 criteria were significant among different ethnic groups. Generally, the Indian respondents had the highest mean rank for most sustainability criteria, notably on the environmental (A), economic (B) and technological (D) criteria, as shown in Table 3. Meanwhile, Malay respondents have the highest mean rank in "indoor air quality (C4)", "community participation (C8)", "infrastructure provision (C9)" and "cater for people with disabilities and/or mobility impairments (C17)". On the other hand, the Chinese respondents had the lowest mean rank for all sustainability criteria for affordable housing, as listed in Table. In addition, Majid et al. (2012) findings also reported significant differences among different ethnic groups on the environmental quality and proximity to commercial areas.

Table 3. Kruskal Wallis Test on Ethnicity Group

Code	Description	Ethnicity	N	Mean Rank	Asymp. Sig.
A1	Energy Efficiency	Malay	67	136.56	*0.001*
		Chinese	120	111.51	
		Indian	69	**150.22**	
A2	Availability and Quality of Open Green Spaces	Malay	67	130.01	*0.016*
		Chinese	120	116.98	
		Indian	69	**147.08**	
B2	Interest Rate	Malay	67	138.24	*0.019*
		Chinese	120	116.18	
		Indian	69	**140.46**	
B3	Mortgage Availability	Malay	67	137.90	*0.010*
		Chinese	120	114.87	
		Indian	69	**143.08**	
C1	Accessibility to Public Transport	Malay	67	139.63	*0.002*
		Chinese	120	112.38	
		Indian	69	**145.72**	
C2	Accessibility to Local Amenities	Malay	67	131.17	*0.001*
		Chinese	120	113.08	
		Indian	69	**152.72**	
C3	Adaptability	Malay	67	138.84	*0.017*
		Chinese	120	115.27	
		Indian	69	**141.47**	
C4	Indoor Air Quality	Malay	67	**140.62**	*0.031*
		Chinese	120	116.77	
		Indian	69	137.14	
C5	Thermal Comfort	Malay	67	132.94	*0.005*
		Chinese	120	114.57	
		Indian	69	**148.42**	
C8	Community Participation	Malay	67	**141.87**	*0.008*
		Chinese	120	114.20	
		Indian	69	140.40	
C9	Infrastructure Provision	Malay	67	**138.10**	*0.029*
		Chinese	120	116.46	
		Indian	69	140.12	
C14	Cultural and Historical Conservation	Malay	67	136.13	*0.010*
		Chinese	120	114.69	
		Indian	69	**145.12**	
C15	Social Equity	Malay	67	140.01	*0.016*
		Chinese	120	115.26	
		Indian	69	**140.34**	
C16	Security of Tenure	Malay	67	**143.37**	*0.050*
		Chinese	120	118.12	
		Indian	69	132.12	

Table 3. Kruskal Wallis Test on Ethnicity Group (Continued)

Code	Description	Ethnicity	N	Mean Rank	Asymp. Sig.
C17	Cater for People with Disabilities and/or Mobility Impairments	Malay	67	**142.83**	*0.007*
		Chinese	120	114.09	
		Indian	69	139.65	
D1	Incorporation of Smart or Green features	Malay	67	132.13	*0.003*
		Chinese	120	113.95	
		Indian	69	**150.28**	
D2	Use of Sustainable or Regional Building materials	Malay	67	131.66	*0.000*
		Chinese	120	112.22	
		Indian	69	**153.75**	
D3	Use of Innovative Construction Techniques and Methods	Malay	67	133.96	*0.000*
		Chinese	120	111.40	
		Indian	69	**152.93**	

Out of the 35 sub-criteria, only 1 criterion was significantly different among three generation groups. As reported in Table 4, Baby Boomers (61 years old and above) have the highest mean rank in the "Use of Sustainable or Regional Building materials (D2)". This result portrayed that baby boomers valued local or regional building materials suited to the local climate. Moreover, according to Ismail and Shaari (2019), Baby Boomers are empty nesters and prefer to live in the same neighbourhood for the rest of their lives. Hence, local building materials are expected to be versatile and improve the overall durability of their housing.

Table 4. Kruskal Wallis Test on Generation

Code	Description	Generation	N	Mean Rank	Asymp. Sig.
D2	Use of Sustainable or Regional Building materials	Gen Y	218	122.82	*0.006*
		Gen X	37	159.68	
		Baby Boomers	1	**214.00**	

There is a statistical difference for the importance level assigned to the respondents with different educated levels assigned to the "accessibility to public transport (C1)". High accessibility to public transport improves residents' mobility. As shown in Table 5, it has received the highest ratings from highly educated respondents. They are more environmentally conscious and knowledgeable about sustainable green buildings (Myeda et al., 2016). It implies that highly educated homebuyers recognised the consequences of poor public transportation on their travelling costs.

Table 5. Kruskal Wallis Test on Education Level

Code	Description	Education Level	N	Mean Rank	Asymp. Sig.
C1	Accessibility to Public Transport	Low	23	104.17	*0.047*
		Medium	177	126.36	
		High	56	**145.27**	

Mann-Whitney U Test

This research employed Mann-Whitney U Test to determine whether there are any significant differences in the ranking of sustainability criteria among the respondents regarding gender, marital status and income level. Table 6 revealed that there were statistical differences for 3 sub-criteria out of the 35 sub-criteria between genders, namely “water efficiency (A4)”, “rainwater harvesting system (A7)”, and “accessibility to public transport (C1)”, which is aligned with Haddad et al. (2011). The results have shown that females prioritised the three sustainability criteria mentioned above criteria more than males. The findings supported Sreen et al. (2018) statement that females are more concerned about the environment, which may thus cause them to consider eco-friendly features in their housing choices.

Table 6. Mann-Whitney U Test on Gender

Code	Description	Gender	N	Mean Rank	Sum of Ranks	Asymp. Sig. (2-tailed)
A4	Water Efficiency	Male	130	118.82	15446.00	*0.021*
		Female	126	**138.49**	17450.00	
A7	Rainwater harvesting system	Male	130	118.03	15344.00	*0.015*
		Female	126	**139.30**	17552.00	
C1	Accessibility to Public Transport	Male	130	119.42	15525.00	*0.036*
		Female	126	**137.87**	17371.00	

Table 7. Mann-Whitney U Test on Marital Status

Code	Description	Marital Status	N	Mean Rank	Sum of Ranks	Asymp. Sig. (2-tailed)
C1	Accessibility to Public Transport	Single	193	122.04	23553.00	*0.010*
		Married	63	**148.30**	9343.00	
C2	Accessibility to Local Amenities	Single	193	122.75	23691.00	*0.020*
		Married	63	**146.11**	9205.00	
C3	Adaptability	Single	193	123.19	23776.00	*0.034*
		Married	63	**144.76**	9120.00	
C8	Community Participation	Single	193	122.54	23651.00	*0.017*
		Married	63	**146.75**	9245.00	
C14	Cultural and Historical Conservation	Single	193	122.82	23703.50	*0.024*
		Married	63	**145.91**	9192.50	
C15	Social Equity	Single	193	122.59	23660.50	*0.017*
		Married	63	**146.60**	9235.50	
C17	Cater for People with Disabilities and/or Mobility	Single	193	122.90	23720.50	*0.023*
		Married	63	**145.64**	9175.50	
D2	Use of Sustainable or Regional Building materials	Single	193	122.90	23719.00	*0.026*
		Married	63	**145.67**	9177.00	

Table 7 presents the differences between single and married respondents regarding the importance level of sustainability criteria. Out of 35 sustainability sub-criteria, 8 sub-criteria were statistically significant between different marital statuses, mainly on the social criteria (C). Married respondents prioritised the social sustainability of affordable housing. Opoku and Abdul-Muhmin (2010) asserted that married people should be more concerned about the environment, affecting their children's upbringing. Meanwhile, Hurtubia et al. (2010) claimed that married households, particularly with small kids, may favour suburbs with easier access to the natural environment, while singletons favour urban areas with good accessibilities. However, this finding contradicted the findings mentioned above. Married respondents ranked higher for housing with good accessibility to public transport and local amenities. The results are consistent with the findings by Majid et al. (2012), claiming that marital status had a significant impact on a housing purchase. Married respondents also emphasized more on houses with better adaptability. As the family grows, Foo et al. (2018) stated that adaptable housing can evolve as the changing demands of the occupants, not only in terms of design and look, but also in terms of functionality.

As illustrated in Table 8, 5 out of the 35 sustainability sub-criteria were statistically significant among different income level groups (B40 versus M40). Housings in the urban areas with good accessibility are usually cheaper than those in the suburban due to the high land prices. Low-income groups may have difficulty purchasing such houses (Majid et al., 2012). As a result, low-income respondents are less inclined to consider the accessibility of housing. Meanwhile, individuals who are more concerned about their living space quality are willing to pay more for desirable attributes (Yap et al., 2019), such as better indoor air quality and visual comfort. High quality and contemporary design features are usually expensive (Ismail et al., 2020), making them unattainable among low-income groups. Therefore, low-income homebuyers will be less likely to consider these housing features in their housing purchase.

Table 8. Mann-Whitney U Test on Income Level

Code	Description	Monthly Income	N	Mean Rank	Sum of Ranks	Asymp. Sig. (2-tailed)
C1	Accessibility to Public Transport	RM 4,850 and below	152	120.67	18342.50	*0.031*
		RM4,851 to RM10,959	104	**139.94**	14553.50	
C2	Accessibility to Local Amenities	RM 4,850 and below	152	120.91	18378.00	*0.034*
		RM4,851 to RM10,959	104	**139.60**	14518.00	
C4	Indoor Air Quality	RM 4,850 and below	152	121.13	18411.00	*0.034*
		RM4,851 to RM10,959	104	**139.28**	14485.00	
C6	Visual Comfort	RM 4,850 and below	152	120.88	18374.00	*0.030*
		RM4,851 to RM10,959	104	**139.63**	14522.00	
D2	Use of Sustainable or Regional Building materials	RM 4,850 and below	152	121.19	18421.50	*0.045*
		RM4,851 to RM10,959	104	**139.18**	14474.50	

CONCLUSION

Sustainability is often neglected in most affordable housing policies especially in developing countries. Hence, this research aimed to analyse the sustainability criteria for affordable housing from the homebuyers' perspective. Based on the B40 and M40 homebuyers' perspectives, the results revealed that economic sustainability is highly prioritised for affordable housing, while technological sustainability is the least. This study indicated that homebuyers are more concerned about the affordability and the potential savings derived from affordable housing in their purchase. Meanwhile, the results concluded a significant disparity in the opinions of the homebuyers with different sociodemographic backgrounds, such as gender, income level, marital status, generation and education level.

This study contributes to the knowledge by combining the environmental, social, economic and technological criteria for affordable housings to be sustainable. Moreover, this research complies with the United Nations Sustainable Development Goal 11 (UNSDGs) to create sustainable cities and communities through affordable housing. The findings obtained from this study serve as a guideline and shed some light on the housing and local authority or government agencies in Malaysia. Government shall develop user-oriented affordable housing policies that are sustainable and aligned with the homebuyers' requirements.

Furthermore, recognising housing preferences can effectively promote sustainable living among the nations. Apart from that, since climate change has been a global concern, this research will thus contribute to cultivating the pursuance of sustainability practices and principles throughout the whole lifecycle of a house, specifically in developing countries.

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