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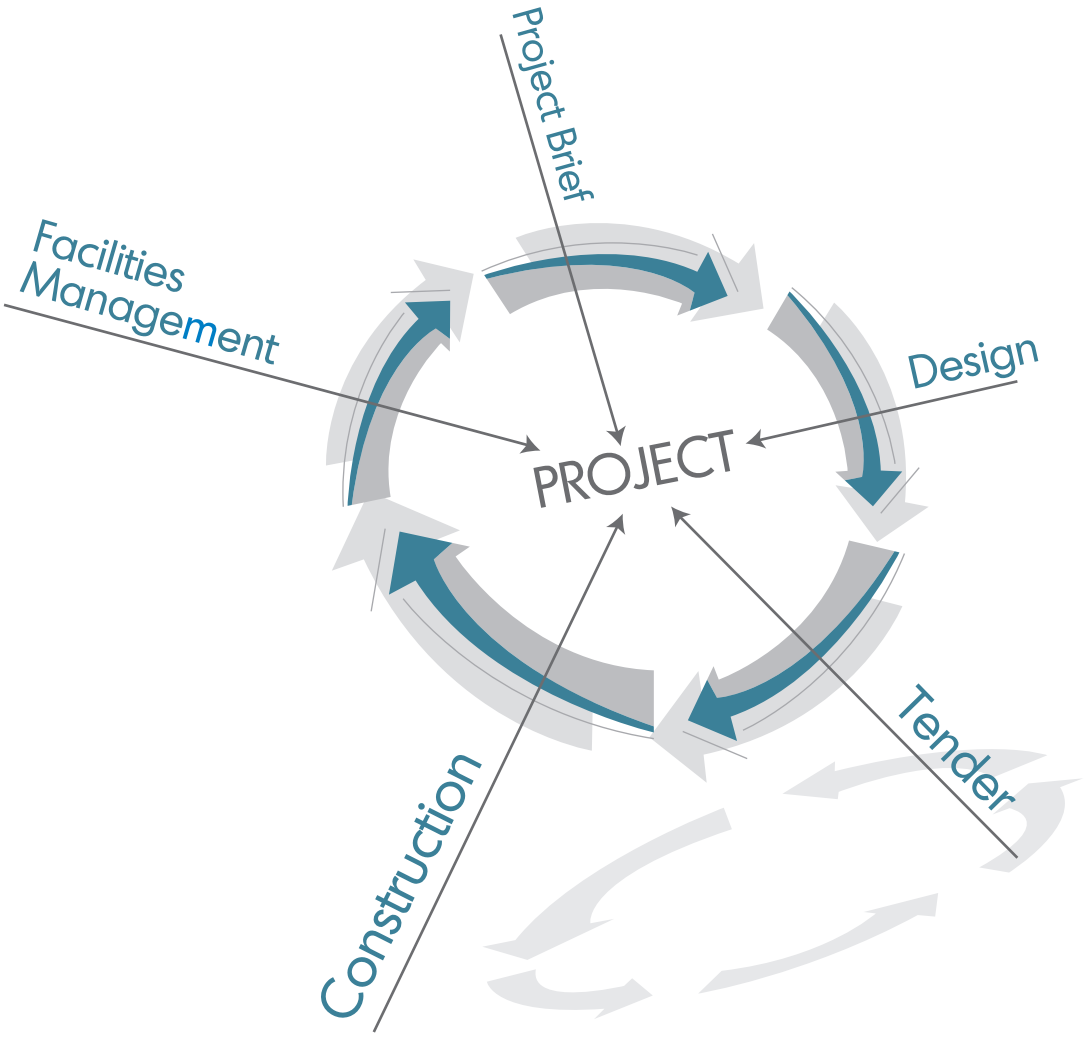

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Editorial

Welcome from the Editors

Welcome to the forty-third (43rd) issue of Malaysian Construction Research Journal (MCRJ). In this issue, we are pleased to include nine papers that cover a wide range of research areas in the construction industry. The editorial team would like to express our sincere gratitude to all contributing authors and reviewers for their contributions, continuous support and comments.

In this issue:

Chia Kuang Lee et al., have aimed to identify the relationship between attitude, subjective norm, perceived behavioural control towards the use of Kaikaku project management, elicit behavioural, normative and control beliefs with regards to the use of Kaikaku project management, and examine the influence between behavioural, normative and control beliefs towards attitude, subjective norms and perceived behavioural control. This study uses the mixed-methods approach in which Belief Elicitation Study (BES) is used to identify salient beliefs that is thematically analysed and reclassified into nine constructs to form the Theory of Planned Behaviour (TPB) survey. The PLS-SEM analysed data showed that the professional institute, government and client have no significant effect on the subjective norms towards KPM and the perceived behavioural control (PBC) has no significant effect toward the intention to use KPM. The perceived usefulness, perceived ease of use, project management team, self-efficacy and facilitating conditions are significant factors towards attitude towards KPM, subjective norms with regards to KPM and perceived behavioural control in KPM. The attitude towards KPM and subjective norms with regards to KPM are significant factors that affects the intention to use KPM.

Boon Tik Leong et al., have presented a systematic review on procurement system for PPVC project. PRISMA 2020 protocol is adopted on SCOPUS data base with search done in title, abstract and keywords, in all date range. The results conclude papers from 2018, which is parallel with the timing PPVC were introduce to industry. The review aims to clarify appropriate procurement system for PPVC project to ensure project success. The results shown the current major procurement systems do not match characteristics of PPVC project, also collaboration between supplier, contractor and client is very much encourage in PPVC to ensure project success. The results are critical reference for PPVC project players especially government and clients. The results will assist in ensure project success from the early stage of PPVC project.

Kai Chen Goh et al., have focused to identify the characteristic of resource management and its future trend: critical skills for construction graduates. The crucial elements in this study, such as the Construction Industry Transformation Programme (CITP), the issue of graduate unemployment, the issue of skilled labour shortage in the construction industry, construction resources, challenges in resource management, and its skills required also be discussed and redefined through the literature review to get the detail information and understanding from the aspect of the industry. The respondents are contractors from Johor Bahru. There are 146 respondents for questionnaires, and six among them accepted the interview sessions. This research shows that critical skill of resource management includes

negotiation, decision-making, problem-solving, reading and understanding drawings, and design activities and background. Besides that, the researcher found that resource management required the cooperation of many professionals and human resources, and communication problems were the primary problem. Future trends of resource management will advance in the direction of dispersion and technology development. In conclusion, this study ensures the crucial human resource management skills required for construction industry graduates.

Faraziera Mohd Raslim et al., have analysed the strengths, weaknesses, opportunities, and threats to improving the gap of exporting local business of Consultant Quantity Surveyors services to ASEAN countries mainly in Thailand, Cambodia, Vietnam, and Laos. For research methodology, semi-structured interview sessions were conducted with six respondents from Quantity Surveying consultant firms. A SWOT analysis has been provided as guidance to Malaysian Consultant Quantity Surveyors in exporting their services, for strengths they are experience and human capacity; weaknesses are firm size and financial capacity; opportunities are a global mindset and Service Export Fund (SEF); threats are global competition, location factor, and the host country is identified as a guide to the research. It is hoped that these findings may assist and encourage many local companies to carve new frontiers in global markets, to make the term 'Made-In-Malaysia' synonymous with innovation, efficiency, and trustworthiness to continue to bring the spotlight on capable Malaysian companies on the international stage.

Tung Yew Hou et al., have explored the application of agile practices by construction practitioners. Online questionnaire surveys were distributed to facilitate this study's data collection and analysis. Based on the total 210 returned responses received, a hypothesis test was conducted by using ANOVA and Tukey tests. The study hypothesized 70 agile practices among the senior manager, manager, and executive of the construction project-based companies. The result indicated statistically significant differences in the application of agile practices application according to the three main groups of designations. The analysis further revealed 16 and 11 agile practices statistically significant differences between executive with manager and senior manager groups, respectively, but only one agile practice statistically significant difference between manager and senior manager groups. It is worth noting that a significant gap exists in applying agile practices among construction practitioners, even though many agile practices are already being carried out by the industry practitioners who hold different designations in the construction project-based companies.

Mohammad Suzaime Sazali et al., have investigated the resistance factors in embracing changes among construction employees and determine the factors that influence the employee willingness to implement smart construction contracts in Malaysia. The quantitative method was adopted by distributing 120 questionnaire surveys to Malaysia's construction backgrounds. A total of 60 respondents' feedback has been received. Data collected are analysed using reliability, descriptive, one-way ANOVA, and correlation analysis. The findings show that most of the respondents agree that the factors such as employee behaviour, demographics, psychology, social and culture impact employee resistance towards change. Furthermore, the finding also illustrates that all respondents strongly agreed to the factors that influence employee willingness to change towards implementing Smart Contract. The factors influencing employee willingness to change are leadership, communication and collaboration, self-efficacy, personal valence, investment, and employee engagement. In supposition,

construction organization has realized the factors that influence employee resistance to change as well as the factors that can be practised to implement Smart Contract.

Mohd Nurfaisal Baharuddin et al., have identified and addressed the challenges in digitalising-built heritage information systems in Malaysia. The study employs a qualitative research method, conducting focus group interviews with stakeholders and conservation experts to gather in-depth insights into the issues. The study categorises the challenges into four main areas: People, Process, Technology, and Policy. Key findings reveal that the slow adoption of digital tools is due to a lack of expertise, inadequate training, high costs, technological incompatibility, and insufficient governmental policy and support. The results highlight the need for comprehensive education, investment in technology, standardised processes, and robust policy frameworks to enhance the digital preservation of heritage buildings.

Haitham Ahmed Muqaibal et al., explored the impact of Gulf climate conditions on the curing and early-age strength of ultra-high performance fiber reinforced concrete (UHPFRC). By comparing three curing methods - room temperature, Gulf climate simulation, and standard high-heat treatment - the research investigates the potential of utilizing natural hot climates as a cost-effective alternative to traditional heat curing. The findings indicate that UHPFRC specimens cured under Gulf climate conditions achieved comparable early-age compressive and flexural strengths to those cured with high-heat treatment, while also improving toughness and ductility. This approach not only reduces production costs but also supports the adoption of UHPFRC in hot weather regions. The study highlights the need for revising existing codes to better represent UHPFRC's mechanical properties and suggests areas for further research, including long-term performance and real-site curing applications.

Mafuzah Mohamad and Jady@Zaidi Hassim delve into the critical factors contributing to construction accidents, categorising them into human, management and material factors. Human factors include errors, lack of knowledge and experience, unsafe behaviour and insufficient safety awareness. This stresses the need for better training and promoting a safety-conscious attitude among construction workers. Management factors stress the management's role in ensuring safety by advocating for safety training, accurate design, proper documentation, regular inspections, government supervision, and prioritising safety over profits. Material factors underline the importance of using appropriate equipment while warning against faulty equipment and addressing structural and unsafe work conditions. Poor management often triggers accidents, and addressing safety concerns at the design stage is recommended. Employers should invest in safety training and monitor compliance with safety standards, advocate for safety awareness and a strong safety culture within construction companies with employee safety as a top priority, even in profit-driven environments.

Editorial Committee

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UNDERSTANDING THE USE OF KAIKAKU PROJECT MANAGEMENT IN CONSTRUCTION INDUSTRY: A PLANNED BEHAVIOUR APPROACH

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Abstract
The project management method used in every project plays a vital role in determining the success of a project. Kaikaku Project Management (KPM) is beneficial in many ways, however, the implementation of the method in the construction industry in Malaysia is not common. To address the issue above, the aim of this study is to (1) identify the relationship between attitude, subjective norm, perceived behavioural control towards the use of Kaikaku project management, 2) elicit behavioural, normative and control beliefs with regards to the use of Kaikaku project management, 3) examine the influence between behavioural, normative and control beliefs towards attitude, subjective norms and perceived behavioural control. This study uses the mixed-methods approach in which Belief Elicitation Study (BES) is used to identify salient beliefs that is thematically analysed and reclassified into nine constructs to form the Theory of Planned Behaviour (TPB) survey. Nineteen (19) professionals from the construction industry took part in the Belief Elicitation Study (BES) while ninety-five (95) contractors from G5, G6 and G7 took part in the Theory of Planned Behaviour (TPB) survey. The PLS-SEM analysed data showed that the professional institute, government and client have no significant effect on the subjective norms towards KPM and the perceived behavioural control (PBC) has no significant effect toward the intention to use KPM. The perceived usefulness, perceived ease of use, project management team, self-efficacy and facilitating conditions are significant factors towards attitude towards KPM, subjective norms with regards to KPM and perceived behavioural control in KPM. The attitude towards KPM and subjective norms with regards to KPM are significant factors that affects the intention to use KPM.

Keywords: *Kaikaku Project Management; Japanese Project Management; Theory of Planned Behaviour (TPB); Belief Elicitation Study (BES); Construction Industry*

INTRODUCTION

The construction industry has made many significant contributions to the country in terms of Gross Domestic Products (GDP), job opportunities, government revenues and benefits of investment (Ika et al., 2020; Nawi et al., 2011; Riazi et al., 2018). According to Barbosa et al. (2020); Ghimire and Biswakarma (2017) , the probability of a project success can be increased by selecting proper project management approaches at the beginning of projects. The organization implementing project management methods may also benefit from the implementation as it affects every functional unit of an organization (Badewi, 2016; Kerzner, 2017). The Kaikaku Project Management (KPM) is an upgraded version of Project and Program Management (P2M) consisting of 3 key elements which are Kakusin (Innovation), Kaihatsu (Development) and Kaizen (Improvement) (Ahmet & Yildiz, 2020). KPM is an alternative sought by the Japanese after experiencing their deflationary downfall in the 90s. This alternative was used to regain their competitive advantage and to maintain in the industry (Siang & Yih, 2012).

In Malaysia, the traditional project management method is commonly applied in the construction industry, whereas KPM has not been much implemented. The construction industry has been rapidly expanding, with construction work totalling up to RM146.4 billion

in 2019, up 0.6% from RM145.5 billion in 2018 (Department of Statistics, 2019). Therefore, many organizations have to step up their standards in order to stay in the market.

Recently, there are many studies that have been conducted regarding the Japanese management principles and practices, and the models and methods to address the need and importance of Kaikaku Project Management (F. S. Low, 2015; Yamamoto, 2010). However, no studies have been undertaken to provide light on how to intervene the usage of Kaikaku Project Management in Malaysian construction projects using the Theory of Planned Behaviour. To fill this need, a research on how to intervene the usage of Kaikaku Project Management in Malaysian construction projects is done by utilising the Belief Elicitation Study (BES) and Theory of Planned Behavior (TPB). The Theory of Planned Behaviour (TPB) is often used in explaining one's intention and behaviour, and its prediction is well-established (Downs & Hausenblas, 2005; Hegner, Fenko, & Teravest, 2017). In order to develop the foundation of one's salient exercise beliefs, the Belief Elicitation Study (BES) is suggested as TPB is in use. The BES is needed as the behavioural, normative and control beliefs of an individual contribute to interpreting one's attitude, subjective norm and perceived behavioural control.

At the end of the study, the relationship between attitude, subjective norm, perceived behavioural control towards the use of Kaikaku project management is identified, while the behavioural, normative and control beliefs with regards to the use of Kaikaku project management is elicited and the influence between behavioural, normative and control beliefs towards attitude, subjective norms and perceived behavioural control is examined. By conducting this study, the TPB model is extended, and practitioners may understand how to intervene in improving behavioural intention as the factors affecting the intention to use Kaikaku Project Management are identified. The outcome of the study would be beneficial to many parties as these factors can be used as reference to implement the use of KPM and also conduct in-depth studies related to KPM.

LITERATURE REVIEW

According to F. Low, Chong, and Lee (2013), Kaikaku Project Management (KPM) is implemented at management level which involves reformation or innovation in general. Kaikaku Project Management (KPM) is large scale and involves a wide range of activities which aims to achieve radical improvement in an organization. Kaikaku Project Management (KPM) consists of three (3) key elements which are Kakusin (Innovation), Kaihatsu (Development) and Kaizen (Improvement). Kakusin (innovation) has the target of having a drastic change in performance which relates with the combination of all knowledge and wisdom. Kaihatsu (development) is the challenges that an organization faces to obtain new knowledge and information in order to help achieve competitive advantage in the industry (Ohara, 2009). Kaizen (improvement) is a continual effort for improvement at work-floor level and can be carried out throughout the project.

In this study, the Theory of Planned Behaviour (TPB) is implemented and this theory has been used to forecast and alter human behaviour through many years of study in social psychology (Myers et al., 2019; Silvius & Schipper, 2020). There are three (3) antecedents to intention which are attitude, subjective norms and perceived behavioural control (PBC). TPB proposes that one's expectations and principles on conducting a behaviour form their

behavioural, normative and control beliefs. These beliefs influence one's attitude, subjective norms and perceived behavioural control towards their intention, and eventually, their behaviour (Downs & Hausenblas, 2005).

The behavioural belief of an individual has an influence on the attitude towards one's specific behaviour. The likelihood of conducting a behaviour depends on how an individual's attitude is towards the behaviour. If the behaviour if favourable, the likelihood would increase. Therefore, it is hypothesized in this study that:

H1: Behavioural beliefs have an impact on attitude towards KPM.

According Fang et al. (2017), internal and external factors influence the normative beliefs of an individual. Normative beliefs occur when an individual solely decides on an action. The society surrounding an individual, specifically their expectation on the individual has an influence on one's normative beliefs. The normative beliefs would affect the subjective norm in which is essential in making the decision of conducting the behaviour. In this study, it is hypothesized as:

H2: Normative beliefs has an impact towards subjective norms with regards to KPM.

An individual's control beliefs influences his or her perceived behavioural control (Ahmed & Ward, 2016; Schifter & Ajzen, 1985). The action of an individual will be affected by the control beliefs. The control factors can be seen individually as the perception of power of one factor may differ from the power of another control factor. If the probability of the presence of a powerful control factor is high, the individual is very likely to perform the action due to the powerful factor. This is hypothesized in the study as:

H3: Control beliefs has an impact on perceived behavioural control in KPM.

According to Oteng-Peprah, de Vries, and Acheampong (2020), a person's attitude toward a behaviour is described as the person's favourable or negative sentiments about the behaviour. Every individual has different attitudes which would have an impact towards the intentions of the individuals towards specific behaviours. According to Ashidiqi and Arundina (2017), attitude is one of the most crucial elements determining an individual's intention. In this case, the intention studied is the intention to use Kaikaku Project Management in the construction industry. Hence, it is hypothesized that:

H4: Attitude has an impact on the intention to use KPM.

The viewpoint of an individual regarding social pressure to portray a certain behaviour is referred to as subjective norm (LaMorte, 2019). For example, if the society shows a positive feeling towards a behaviour, it is highly likely that other individuals would think the same, this is due to the approval of the intention by the society or anyone that is trusted. The subjective norms tested is with regards to Kaikaku Project Management (KPM). Hence, it is hypothesized that:

H5: Subjective norms have an impact to the intention to use KPM.

The ability of an individual understanding the capability of performing a certain behaviour is referred to as perceived behavioural control (Warsame & Ireri, 2016). Perceived behavioural control has two aspects which are the internal control and the external control. The internal control is usually when the individual has control to the situation itself. The external control is usually based on external parties controlling the attitude of the individual towards a specific behaviour (Luenendonk, 2017). The perceived behavioural control in KPM is measured. Hence, it is hypothesized as:

H6: Perceived behavioural control has an impact towards the intention to use KPM.

The behavioural intention of an individual is impacted by the attitude, subjective norm and perceived behavioural control of an individual itself. According to Schifter and Ajzen (1985), the degree of willingness of an individual to endeavour and give out a certain amount of effort to conduct a specific behaviour is called behavioural intention.

METHODOLOGY

Data Collection

The mixed-methods approach was used in this study, in which the qualitative data obtained from the open-ended questionnaire survey related to the Belief Elicitation Study (BES) was used to develop the main questionnaire survey related to the Theory of Planned Behaviour (TPB), which produced the quantitative data.

For the qualitative approach, the online open-ended questionnaire survey comprised of three major sections which are: Section A (General Information), Section B (Eliciting Salient Beliefs) and Section C (Implementation of Kaikaku Project Management Activities). Respondents are given choices of answers to select from in Section A. Section B are open-ended questions in which respondents are able to provide answers based on their personal opinion. The questions for Section C were designated based on a seven-point Likert scale (Georgalas et al., 2020; Lee, 2017).

For the quantitative approach, the main survey consisted of three major sections which are Section A, Section B and Section C. Section A consisted of questions regarding the general information of respondents, while section B are questions regarding the implementation of Kaikaku Project Management (KPM) activities. Section C are questions related to the Theory of Planned Behaviour (TPB). The inputs from the Belief Elicitation Study (BES) are used to develop the questionnaire. The questions were also designated based on a seven-point Likert scale (Georgalas et al., 2020; Lee, 2017).

Survey Procedure

Three (3) experts from building and civil engineering contracting firms pre-tested the questionnaire survey. It was then pilot tested by ten (10) construction professionals. The feedback obtained from the tests were used to revise on the questionnaire. The questionnaire survey was then completed and sent out to respondents for the main survey.

The study was conducted in Kuala Lumpur and the contractors chosen for this study is from G5, G6 and G7. The minimum sample size of this study was obtained based on the rule of thumb provided by Cohen (1992) for multiple regression models. As there are is a maximum of four arrows pointing at the latent variables, the sample size for the study is 65. This is based on the recommended sample size for a PLS-SEM research with an 80 percent statistical power (Hair, 2014; Kock & Hadaya, 2018).

The survey was sent by email and LinkedIn invites to a total of 1800 Construction Industry Development Board (CIDB) contractors from G5, G6 and G7. Simple random sampling is used during the survey (Al Ghayab et al., 2016).

RESULTS

The results below are based on the qualitative data analysis and quantitative data analysis. The qualitative approach used the thematic analysis to analyse the data. SmartPLS 3.0 is used to analyse the data obtained from the quantitative approach. The data collected were presented in the form of tables and other statistical representations.

Demographic Results (Qualitative Analysis)

For Belief Elicitation Study (BES), there were 19 respondents who responded to the online open-ended questionnaire survey. 16 of them are male (84.21%) and 3 of them are female (15.79%). The majority of respondents are aged 21-25 years which accounts for 7 respondents (36.84%), whereas the least number of respondent (1 respondent) is from the age group 26-30 years which is 5.26% of the total number of respondents.

In terms of the respondents' years of experience, majority of respondents have the experience of 1-5 years (n=10, 52.63%), while there is only 1 respondent (5.26%) who has 21-25 years of experience. The majority of respondents are from G7 (n=12, 63.16%), followed by G2 (n=3, 15.79%) and G1 (n=2, 10.53%). There are 1 respondent (5.26%) from G4 and G6 respectively.

There are seventeen (17) respondents (89.47%) who are main contractors, while 2 respondents (10.53%) are sub-contractors. The top three positions in the organization are Project Manager (n=7, 36.84%), Project Engineer (n=2, 10.53%) and Engineer (n=2, 10.53%). The rest of the respondents hold different positions respectively (n=1, 5.26%). The top three positions in current projects are Project Manager (n=7, 36.84%), Project Engineer (n=3, 15.79%) and Site Manager (n=2, 10.53%). The rest of the respondents hold different positions respectively (n=1, 5.26%).

Project Details (Qualitative Analysis)

There are four (4) types of projects among the respondents. The highest number of respondents are involved in industrial projects which are 7 respondents (36.84%). The civil & infrastructure and residential projects have 5 respondents (26.32%) each. The least number of respondents are respondents who are involved with commercial projects at 10.53% (2 respondents).

The location of project varies, and the majority of projects are currently being carried out in Johor (n=8, 41.11%). The second highest number of respondents are respondents with projects in Kuala Lumpur (n=5, 26.32%). Projects in Negeri Sembilan, Terengganu and Kedah, Putrajaya have respondents of 2 respondents (10.53%) and 1 respondent (5.26%) respectively. In terms of project funding, majority of projects are private funded (n=16, 84.21%) while 2 respondents (10.53%) stated that their projects are both government and private funded. Only 1 respondent (5.26%) stated that the project is government funded.

There are 7 respondents (36.84%) with contract sum less than 10 Million while 6 respondents (31.58%) have contract sum between 10 Million to 50 Million. For contract sum of 100 Million to 150 Million and more than 250 Million, there are 2 respondents (10.53%) respectively for both categories. The contract sums of 150 Million to 200 Million and 200 Million to 250 Million, both have 1 respondent (5.26%) each. For the year of project commencement, year 2020 has the majority of respondents (n=14, 73.68%) followed by year 2019 (n=4, 21.05%) and then 2018 (n=1, 5.26%).

Implementation of Kaikaku Project Management Activities (Qualitative Analysis)

The Kaikaku Project Management activities were adopted from Bredillet (2007). The implementation of the activities was rated based on the 7-points Likert scale. From this study, it can be seen that most contractors implement the activities from Kaikaku Project Management. The activities are such as taking into consideration of detailed content, follow the organization mission, consider overall goal, provide integration management model, utilize resources in the company, utilize reformed projects, applying human perceptive ability in decision making and promote development of human resource.

Frequency of Elicited Beliefs

As Fishbein et al. (1980); C. K. Lee, T. W. Yiu, and S. O. Cheung (2018) indicated, not all elicited beliefs were included in this study. The modal salient beliefs were chosen using a 10% frequency cut-off in this study (C. K. Lee et al., 2018). The elicited beliefs were then analysed by using the thematic analysis. The beliefs that produce comparable results are grouped together, and the frequency of each response is determined. The process has no clear guidance and requires common sense (Fishbein et al., 1980; Chia Kuang Lee, Tak Wing Yiu, & Sai On Cheung, 2018). The respondents' results are reported in Table 1.

The salient behavioural beliefs are evaluations of the consequences of KPM implementation. The study yielded beliefs such as better work environment, improve project, increase innovation, beneficial to project, difficult to implement and lack of knowledge. The salient normative beliefs consist of beliefs on the viewpoint of important parties such as project management team, general workers, contractors, professional institute, government and client towards the implementation of KPM. Lastly, the salient control beliefs consist of beliefs on the factors facilitating the use of KPM. The beliefs obtained are support from management, resources and familiarity with KPM.

Table 1. Frequency of Elicited Beliefs

Item	Construct	Frequency	Percentage
Behavioural Beliefs			
Better work environment	Perceived Usefulness	3	16%
Improve project		12	63%
Increase innovation		2	11%
Beneficial to project	Perceived Ease of Use	9	47%
Difficult to implement		7	37%
Lack of knowledge		5	26%
Normative Beliefs			
PM team	PM Team	13	68%
General Workers		5	26%
Contractors		3	16%
Professional Institute	Professional Institute	2	11%
Government	Government	3	16%
Client	Client	3	16%
Control Beliefs			
Support from management	Facilitating Conditions	6	32%
Resources		8	42%
Familiarity with KPM	Self-Efficacy	3	16%

Revised Framework of Intention to Use KPM

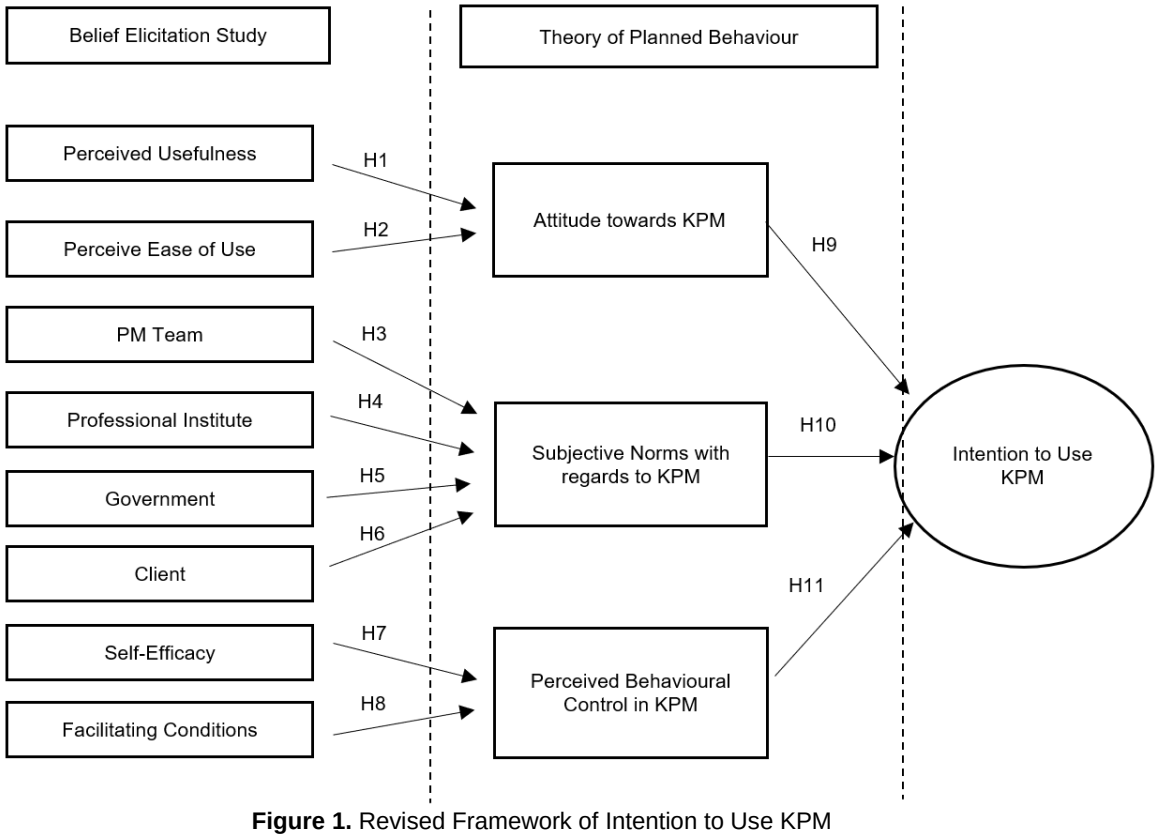

Figure 1. Revised Framework of Intention to Use KPM

Figure 1 shows the revised framework of this study as the original Theory of Planned Behaviour (TPB) model can be decomposed into smaller constructs and this would allow a better explanation on the behavioural intention of an individual (C. K. Lee et al., 2018; Taylor & Todd, 1995). In Figure 1, it can be seen that behavioural belief structures can be decomposed into perceived usefulness and perceived ease of use. The normative belief structures is decomposed into PM team, professional institute, government and client. Control belief structures can be decomposed into self-efficacy and facilitating conditions.

Decomposition of Behavioural Beliefs

In this study, the behavioural belief structures is decomposed into perceived usefulness and perceived ease of use. Perceived usefulness is defined by Davis (1989) as the degree to which an individual feels that implementing a given approach will improve the work performance. It may be stated that when an individual feels that a system will provide a favourable result, the individual's performance will improve. The degree to which a person believes utilising a certain technology will be easy is known as perceived ease of use. It may be stated that the easier it is to use, the more likely other individuals will adopt it.

Decomposition of Normative Beliefs

In this study, the normative belief structures is decomposed into PM team, professional institute, government and client. According to Taylor and Todd (1995), different groups of people have different viewpoints. In this case, the PM team, professional institute, the government and client may have different perspective on the implementation of KPM. Some level of organization may be supportive, and some may not even consider the implementation. Therefore, the decomposition of the normative beliefs is necessary to further understand the behavioural intention.

Decomposition of Control Beliefs

The control belief structures in this study is decomposed into self-efficacy and facilitating conditions. Self-efficacy can be related to the ability of an individual to implement KPM. The higher the self-efficacy, the higher the behavioural intention (Blomquist, Farashah, & Thomas, 2016; Compeau & Higgins, 1991). The facilitating condition is usually related to the availability of resources in terms of money and time and also the compatibility of an individual to technologies which may result in constraints. It can be said that the lesser the resources available, the lesser the compatibility of technologies, the lesser the behavioural intention (Taylor & Todd, 1995).

Revised Hypothesis

After the decomposing the salient beliefs obtained from the qualitative data, the salient beliefs were replaced into the hypothesis, resulting in an updated hypothesis which are:

Hypothesis 1 (H1): Perceived usefulness has an impact on attitude towards KPM

Hypothesis 2 (H2): Perceived ease of use has an impact on attitude towards KPM

Hypothesis 3 (H3): Project management team has an impact towards subjective norms with regards to KPM

Hypothesis 4 (H4): Professional institute has an impact towards subjective norms with regards to KPM

Hypothesis 5 (H5): Government has an impact towards subjective norms with regards to KPM

Hypothesis 6 (H6): Client has an impact towards subjective norms with regards to KPM

Hypothesis 7 (H7): Self-efficacy has an impact on perceived behavioural control in KPM

Hypothesis 8 (H8): Facilitating conditions has an impact on perceived behavioural control in KPM

Hypothesis 9 (H9): Attitude has an impact on the intention to use KPM

Hypothesis 10 (H10): Subjective norms has an impact to the intention to use KPM

Hypothesis 11 (H11): Perceived behavioural control has an impact towards the intention to use KPM

Response Rate

A 10% anticipated response rate was applied in the study. A total of 1800 invites were distributed, and a total of 95 respondents' data were used for the study. This indicates that the response rate for the study is 5.28% in which is acceptable as the minimum sample size (65 respondents) proposed by Kock and Hadaya (2018) has been achieved.

Demographic Results (Quantitative Analysis)

The demographic result of the main survey is explained in this section. The frequency of respondents is explained based on gender, age, years of experience, contractor grade, role of organization and the position of each respondent in the organization and the current project they are working on. For the main survey, a total of 95 respondents responded to the questionnaire survey. There are 80 male respondents (84.21%) and 15 female respondents (15.79%). In terms of the age of the respondents, majority of respondents are 31-35 years (n=24, 25.26%), followed by 26-30 years (n=21, 22.11%) and 21-25 years (n=18, 18.95%). There are 13 respondents (13.68%) who are 36-40 years and above 50 years are at 10.53% (10 respondents). The age group 41-45 years (n=5, 5.26%) and 46-49 years (n=4, 4.21%) are the least.

In terms of years of experience, 37 respondents (38.95%) have the experience of 1-5 years, while 20 respondents (21.05%) have 6-10 years of experience. There are 14 respondents (14.74%) with 11-15 years of experience and 10 respondents with 16-20 years of experience. For the category of 21-25 years, there are 5 respondents (5.26%), while 26-30 years have 6 respondents (6.32%). The least number of respondents (n=3, 3.16%) have experience of more than 30 years.

G7 grade had the highest number of respondents (n=83,87.37%), followed by G6 (n=8, 8.42%) and then G5 (n=4, 4.21%). Majority of the respondents are main contractors (n=76, 80.00%) for the current project they are working on, while the rest hold the role as sub-contractors (n=19, 20.00%).

The top three positions in the organization are Project Manager (n=24, 25.26%), Project Engineer (n=9, 9.47%) and General Manager (n=7, 7.37%). In terms of position in the current project the respondents are working on, the top three positions are also Project Manager (n=24, 25.26%), Project Engineer (n=7, 7.37%). and General Manager (n=6, 6.32%).

The respondents' understanding regarding KPM were also tested, in which the 5-point Likert scale was used. Majority of the respondents rated their understanding as good (n=38, 40.00%), followed by poor (n=19, 20.00%) and very good (n=16, 16.84%). The remaining respondents rated their understanding as fair (n=13, 13.68%) and excellent (n=9, 9.47%).

Project Details (Quantitative Analysis)

There are 6 types of projects which are civil & infrastructure, commercial, health-care, industrial, residential and sporting. There are 41 projects (43.16%) under the civil & infrastructure, while 26 projects (27.37%) under residential and 12 projects (12.63%) under commercial. The remaining projects are industrial (n=11, 11.58%), health-care (n=4, 4.21%) and sporting (n=1, 1.05%).

The top three location of projects are Kuala Lumpur (n=29, 30.53%), Selangor (n=24, 25.26%) and Johor (n=11, 11.58%). Most of the projects are private funded (n=50, 52.63%), while 30 projects (31.58%) are government funded and 15 projects (15.79%) are both government and private funded.

There are 44 projects (46.32%) with the contract sum of more than 250 Million, while 18 projects (18.95%) have contract sum of 10 Million to 50 Million. 14 projects (14.74%) have contract sum less than 10 Million, 6 projects (6.32%) have contract sum of 100 Million to 150 Million and 3 projects (3.16%) have contract sum of 200 Million to 250 Million. The contract sums of 50 Million to 100 Million and 150 Million to 200 Million have the same number of projects (n=5, 5.26%). For the year of commencement of construction activities, the top three years are 2019 (n=30, 31.58%), 2018 (n=24, 25.26%) and 2020 (n=23, 24.21%).

Implementation of Kaikaku Project Management Activities (Quantitative Analysis)

From this study, it can be seen that most contractors implement the activities from Kaikaku Project Management as majority of respondents rated most of the activities from somewhat agree, agree to strongly agree. There are a few respondents that rated the level of implementation from somewhat disagree, disagree to strongly disagree. However, the number of respondents were relatively small compared to the total number of respondents. The activities considered are such as taking into consideration of detailed content, follow the organization mission, consider overall goal, provide integration management model, utilize resources in the company, utilize reformed projects, applying human perceptive ability in decision making and promote development of human resource.

Descriptive Statistic and Normality Assessment

In this study, the normality assessment was conducted prior to the assessment of measurement model. The normality assessment was performed by analysing the excess

kurtosis and skewness data obtained from PLS 3.0. According to Al Azizah and Mulyono (2020), the accepted range for skewness is between -1 and 1, while the excess kurtosis range is between -2 and 2. The values in the table below shows that there is a normal distribution in the data.

Table 2. Descriptive Statistics and Normality Assessment

Construct	Item Code	No.	Min	Max	Mean	Std Deviation	Excess Kurtosis	Skewness
INT	INT_1	1	1	7	4.695	1.480	0.013	-0.428
	INT_2	2	1	7	4.863	1.374	0.596	-0.517
	INT_3	3	1	7	4.800	1.342	1.061	-0.714
SN	SN_1	4	1	7	4.663	1.448	0.238	-0.595
	SN_2	5	1	7	4.684	1.409	0.412	-0.591
	SN_3	6	1	7	4.811	1.300	0.880	-0.575
PBC	PBC_1	7	1	7	4.842	1.387	0.756	-0.626
	PBC_2	8	1	7	4.874	1.332	1.314	-0.824
	PBC_3	9	1	7	4.558	1.367	-0.049	-0.337
	PBC_4	10	1	7	4.453	1.457	-0.221	-0.476
ATT	ATT_1	11	1	7	5.032	1.293	1.181	-0.801
	ATT_2	12	1	7	4.537	1.527	0.020	-0.440
	ATT_3	13	1	7	4.832	1.397	0.262	-0.565
	ATT_4	14	1	7	4.758	1.351	0.490	-0.432
PU	PU_1	15	1	7	5.158	1.199	0.196	-0.385
	PU_2	16	1	7	5.168	1.211	0.181	-0.330
	PU_3	17	1	7	5.337	1.120	1.071	-0.564
	PU_4	18	1	7	5.189	1.136	0.610	-0.469
PEU	PEU_1	19	1	7	5.200	1.092	1.254	-0.606
	PEU_2	20	1	7	5.032	1.269	0.813	-0.689
	PEU_3	21	1	7	5.032	1.080	1.077	-0.420
	PEU_4	22	1	7	5.021	1.281	1.305	-0.803
PMT	PMT_1	23	1	7	4.716	1.279	0.518	-0.524
	PMT_2	24	1	7	4.811	1.284	0.423	-0.457
	PMT_3	25	1	7	4.758	1.359	-0.054	-0.316
PI	PI_1	26	1	7	5.011	1.261	0.586	-0.436
	PI_2	27	1	7	5.126	1.225	1.072	-0.630
	PI_3	28	1	7	5.053	1.251	0.647	-0.527
GOV	GOV_1	29	1	7	4.926	1.332	0.326	-0.515
	GOV_2	30	1	7	4.853	1.289	0.441	-0.528
	GOV_3	31	1	7	4.811	1.300	0.426	-0.399
CL	CL_1	32	1	7	4.800	1.202	0.930	-0.456
	CL_2	33	1	7	4.832	1.228	0.955	-0.503
	CL_3	34	1	7	4.779	1.224	0.961	-0.581
SE	SE_1	35	1	7	4.863	1.366	0.186	-0.504
	SE_2	36	1	7	4.389	1.725	-0.376	-0.460
	SE_3	37	1	7	5.326	1.090	1.261	-0.535
	SE_4	38	1	7	5.358	1.151	0.820	-0.487
FC	FC_1	39	1	7	4.684	1.332	0.387	-0.432
	FC_2	40	1	7	4.758	1.499	0.457	-0.758
	FC_3	41	1	7	4.495	1.500	0.263	-0.665
	FC_4	42	1	7	4.653	1.734	-0.390	-0.545

Common Method Bias Test (Harman's Single-Factor Test)

Harman's Single Factor Test was conducted to test the common method variance in the data. As shown in the table below, the value of the test is below 50%, which shows that this study had no common bias issue (Dupuis, Khadeer, & Huang, 2017).

Table 3. Common Method Bias Test

	Total Variance Explained					
	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	24.270	41.844	41.844	24.270	41.844	41.844

Measurement Model Assessment

The convergent validity of the measurement model is first observed in order to evaluate it. As shown in the table below, the convergent validity is evident as all values are satisfactory (Hair Jr et al., 2017).

Items with code PEU_3, PEU 4, PBC_3 and PBC_4 were removed in order to ensure discriminant validity and to ensure that the data is acceptable. To demonstrate discriminant validity, the squared root of each construct's AVE should be larger than its greatest correlation with any other construct (Hair Jr et al., 2017).

Table 4. Convergent Validity

Construct	Item Code	Outer Loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Attitude (ATT)	ATT_1	0.915	0.936	0.954	0.838
	ATT_2	0.888			
	ATT_3	0.921			
	ATT_4	0.938			
Client (CL)	CL_1	0.958	0.961	0.975	0.928
	CL_2	0.960			
	CL_3	0.972			
Facilitating Conditions (FC)	FC_1	0.891	0.869	0.910	0.718
	FC_2	0.801			
	FC_3	0.870			
	FC_4	0.824			
Government (GOV)	GOV_1	0.967	0.970	0.981	0.944
	GOV_2	0.981			
	GOV_3	0.968			
Intention (INT)	INT_1	0.962	0.964	0.977	0.933
	INT_2	0.963			
	INT_3	0.973			
Perceived Behavioural Control (PBC)	PBC_1	0.951	0.892	0.949	0.902
	PBC_2	0.948			
Perceived Ease of Use	PEU_1	0.941	0.880	0.943	0.893
	PEU_2	0.949			
Professional Institute (PI)	PI_1	0.938	0.946	0.965	0.902
	PI_2	0.955			
	PI_3	0.957			

Construct	Item Code	Outer Loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Project Management Team (PMT)	PMT_1	0.950	0.945	0.964	0.900
	PMT_2	0.953			
	PMT_3	0.944			
Perceived Usefulness (PU)	PU_1	0.947	0.963	0.973	0.899
	PU_2	0.938			
	PU_3	0.952			
	PU_4	0.956			
Self-Efficacy (SE)	SE_1	0.861	0.815	0.876	0.639
	SE_2	0.762			
	SE_3	0.803			
	SE_4	0.766			
Subjective Norms (SN)	SN_1	0.901	0.907	0.942	0.844
	SN_2	0.927			
	SN_3	0.927			

Table 5. Discriminant Validity (Fornell & Larcker Criterion)

	ATT	CL	FC	GOV	INT	PBC	PEU	PI	PMT	PU	SE	SN
ATT	**0.916**											
CL	0.728	**0.963**										
FC	0.756	0.710	**0.847**									
GOV	0.648	0.840	0.654	**0.972**								
INT	0.894	0.745	0.759	0.703	**0.966**							
PBC	0.864	0.652	0.710	0.571	0.860	**0.950**						
PEU	0.852	0.666	0.735	0.631	0.816	0.792	**0.945**					
PI	0.623	0.760	0.573	0.852	0.649	0.590	0.619	**0.950**				
PMT	0.830	0.698	0.817	0.631	0.816	0.796	0.854	0.553	**0.949**			
PU	0.845	0.723	0.733	0.716	0.791	0.743	0.905	0.674	0.805	**0.948**		
SE	0.763	0.730	0.779	0.727	0.732	0.755	0.767	0.697	0.738	0.773	**0.799**	
SN	0.832	0.711	0.745	0.697	0.906	0.809	0.791	0.645	0.827	0.757	0.729	**0.918**

Note: Diagonal values (bolded) are square root of AVE, whereas off-diagonals are correlation coefficients
Square root of AVE > correlation coefficients

Structural Model Assessment

Before the structural model assessment is conducted, the collinearity test is done in order to avoid collinearity problems. Items CL_3, GOV_2, INT_3, PI_3, PMT_2 and PU_4 were removed in order to achieve the proposed values (Hair Jr, Howard, & Nitzl, 2020). The variance inflation factor (VIF) values are less than 5, as indicated in the table below, indicating that there are no collinearity concerns.

The research hypotheses were tested by using SmartPLS in which bootstrapping was conducted to identify standard error of estimates of the model parameter which enables significance testing (Hair Jr et al., 2017). The Coefficient of Determination, R^2, was also tested to measure the model's in-sample predictive power and the R^2 values considered substantial, moderate and weak are 0.75, 0.50 and 0.26 respectively. Blindfolding was done to obtain the Q^2 values in order to assess the model's capabilities to predict relevance. The f^2 value was also taken to measure the impact of a specific latent construct on an endogenous construct.

Table 6. Collinearity Test

Construct	Item Code	Outer VIF	Inner VIF
Attitude (ATT)	ATT_1	3.698	4.931
	ATT_2	3.137	
	ATT_3	3.887	
	ATT_4	4.609	
Client (CL)	CL_1	4.074	3.912
	CL_2	4.074	
Facilitating Conditions (FC)	FC_1	2.607	
	FC_2	2.068	2.545
	FC_3	2.644	
	FC_4	2.020	
Government (GOV)	GOV_1	4.881	
	GOV_3	4.881	4.261
Intention (INT)	INT_1	4.444	
	INT_2	4.444	
Perceived Behavioural Control (PBC)	PBC_1	2.833	4.399
	PBC_2	2.833	
Perceived Ease of Use	PEU_1	2.616	4.895
	PEU_2	2.616	
Professional Institute (PI)	PI_1	3.353	2.891
	PI_2	3.353	
Project Management Team (PMT)	PMT_1	3.262	1.986
	PMT_3	3.262	
Perceived Usefulness (PU)	PU_1	4.987	4.895
	PU_2	4.892	
	PU_3	4.509	
Self-Efficacy (SE)	SE_1	2.126	2.545
	SE_2	1.766	
	SE_3	3.774	
	SE_4	3.409	
Subjective Norms (SN)	SN_1	2.689	3.630
	SN_2	3.209	
	SN_3	3.166	

Based on Table 6, the results show that perceived usefulness has a significant impact on attitude towards KPM (β=0.375, t-value=2.76, p-value<0.05). It can be seen that perceived ease of use has a significant impact on attitude towards KPM (β=0.518, t-value=3.456, p-value<0.05). Based on the result (β=0.653, t-value=6.122, p-value<0.05), it can be seen that the project management team has a significant relationship towards subjective norms with regards to KPM. The result shows that there is no significant relationship between the professional institute and the subjective norms (β=0.118, t-value=1.195, p-value>0.05). There is no significant relationship between the government towards the subjective norms (β=0.165, t-value=1.459, p-value>0.05). The result shows that client has no impact towards subjective norms with regards to KPM (β=0.024, t-value=0.194, p-value>0.05). Self-efficacy can be seen to have an impact on perceived behavioural control in KPM (β=0.513, t-value=5.345, p-value<0.05). Based on the summarized table, it can be seen that the facilitating conditions have an impact on perceived behavioural control in KPM (β=0.311, t-value=2.740, p-value<0.05). It can also be seen that attitude has a significant impact on the intention to use KPM (β=0.373, t-value=3.950, p-value<0.05). The subjective norms has a direct impact to

the intention to use KPM (β=0.461, t-value=4.879, p-value<0.05). Perceived behavioural control does not have an impact towards the intention to use KPM (β=0.15, t-value=1.569, p-value>0.05). In this study, only H4, H5, H6 and H11 were not supported while the rest were supported.

Table 7. Summary of Hypotheses Testing

Hypothesis	Path	Std Beta	Std Error	t-Value	Bias	Confidence Interval		p-Value	Decision
						5.00%	95.00%		
H1	PU -> ATT	0.375	0.136	2.760	0.007	0.176	0.598	0.003	Supported
H2	PEU -> ATT	0.518	0.150	3.456	-0.005	0.253	0.735	0.000	Supported
H3	PMT -> SN	0.653	0.107	6.122	-0.014	0.470	0.823	0.000	Supported
H4	PI -> SN	0.118	0.099	1.195	0.003	-0.035	0.284	0.116	Not Supported
H5	GOV -> SN	0.165	0.113	1.459	0.022	-0.027	0.348	0.073	Not Supported
H6	CL -> SN	0.024	0.126	0.194	-0.012	-0.167	0.244	0.423	Not Supported
H7	SE -> PBC	0.513	0.096	5.345	0.000	0.339	0.656	0.000	Supported
H8	FC -> PBC	0.311	0.113	2.740	0.009	0.117	0.487	0.003	Supported
H9	ATT -> INT	0.373	0.094	3.950	0.009	0.219	0.538	0.000	Supported
H10	SN -> INT	0.461	0.094	4.879	0.000	0.314	0.618	0.000	Supported
H11	PBC -> INT	0.150	0.096	1.569	-0.011	0.003	0.317	0.059	Not Supported

Note: P < 0.05 (one-tail test)

As seen in the table below, the R^2 values for intention (0.868), attitude (0.755) and subjective norms (0.751) are considered substantial. While perceived behavioural control is considered as moderate as the value is 0.607. For Q^2, the values higher than 0, 0.25 and 0.50 represents small, medium and large predictive relevance of the model. From the table below, it can be seen that all the items have large predictive relevance of the PLS-path model.

Table 8. Results of R^2, Q^2

Construct	Item	R^2	Q^2
Intention (INT)	INT	0.868	0.805
Attitude (ATT)	ATT	0.755	0.623
Subjective Norms (SN)	SN	0.751	0.614
Perceived Behavioural Control (PBC)	PBC	0.607	0.529

From the table below, the f^2 effect size 0.019, 0.097, 0.026, 0.001, 0.117 and 0.039 represent small effect of the exogenous latent variable. The values 0.224, 0.263 and 0.215 represent medium effect while 0.862 and 0.444 represent large effect of the exogenous latent variable.

Table 9. Results of f^2

Path	f^2
PU -> ATT	0.117
PEU -> ATT	0.224
PMT -> SN	0.862
PI -> SN	0.019
GOV -> SN	0.026
CL -> SN	0.001
SE -> PBC	0.263
FC -> PBC	0.097
ATT -> INT	0.215

Path	f^2
SN -> INT	0.444
PBC -> INT	0.039

DISCUSSION

In the past decade, many researches have studied on the Japanese management principles and practices, however, none have conducted a study on how to intervene the use of Kaikaku Project Management (KPM) using the Theory of Planned Behaviour (TPB). From this study, the TPB model was extended as a Belief Elicitation Study (BES) was conducted to identify the salient beliefs underpinning the attitude, subjective norms and perceived behavioural control.

As the behavioural beliefs such as perceived usefulness (H1) and perceived ease of use (H2) showed significant effect towards attitude, it can be said that if the outcome of a behaviour is favourable, it is more likely for an individual to conduct the specific behaviour.

In terms of normative beliefs, this study shows that the project management team plays an important role towards influencing the subjective norms with regards to KPM. The project management team would influence the subjective norms as Hypothesis 3 was supported in this study. However, Hypothesis 4, Hypothesis 5 and Hypothesis 6 were not supported. It shows that the professional institute, government and client does not influence the subjective norms with regards to KPM. According to the results from this study, the decision of the implementation of KPM may be affected more significantly by the internal party as compared to the external parties.

The self-efficacy and facilitating conditions under control beliefs shows a positive influence towards the perceived behavioural control in KPM. This can be seen as Hypothesis 7 and Hypothesis 8 were supported in this study. It can be seen that if an individual has the availability of resources and the capability of handling technologies, the likeliness of the individual performing the behaviour would increase (Compeau & Higgins, 1991).

From this study, it can be seen that the attitude and subjective norm has a significant effect towards the use of KPM. The attitude of an individual can be affected by many factors as each individual has their own preferences in making decisions. The social pressure exerted would also affect the intention to carry out a certain behaviour. In this study, the perceived behavioural control shows no impact towards the use of KPM. This shows that the ability of understanding an individual's capability on performing a behaviour does not affect the intention (Warsame & Ireri, 2016). This can be supported by the hypothesis testing done in which Hypothesis 9 and 10 were supported while Hypothesis 11 was not supported.

According to Hegner et al. (2017), TPB is often used in predicting an individual's intention to conduct a certain behaviour. Hence, this study would help practitioners to understand how to intervene in improving behavioural intention as the factors affecting the intention to use KPM are identified. The TPB model would also be expanded, in which contributes theoretically to the industry.

CONCLUSION AND IMPLICATIONS

In Malaysia, the traditional project management method is commonly used in the construction industry. As compared to the traditional project management method, the Kaikaku Project Management (KPM) is rarely implemented as not many studies have been conducted to intervene the use of KPM. In order to address the research gap, this study was conducted. To achieve the research objectives of this study, a mixed-methods approach was implemented. The main questionnaire survey was distributed to 1800 construction contractors. The data from the study was analysed using SmartPLS 3.0 PLS-SEM. 11 hypotheses were tested in the quantitative approach.

This study identified the salient beliefs underpinning the Theory of Planned Behaviour (TPB) model related to the intention of using KPM. The TPB model was extended in which the factors affecting the attitude, subjective norms and perceived behavioural control towards using KPM were identified. The overall framework of TPB showed that the intention of an individual to use KPM is affected by attitude and subjective norms. The rejection of Hypothesis 11 is aligned with Ajzen (1991)'s claim that it is not necessary for all the predictors in the TPB model to contribute to the prediction of intention, in this case, to use KPM in projects. As the attitude towards the KPM and the subjective norms with regards to KPM would affect the intention of an individual to use KPM, organization should analyse the factors affecting the attitude and subjective norms in detail.

When conducting this study, there were limitations that were present in which the data for this study were collected only from contractors. For future studies, researchers may consider carrying out the study from a different perspective in terms of other project professionals and parties such as clients and consultants. Other than that, the studies may also be carried out across different projects and countries.

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SYSTEMATIC REVIEW ON PROCUREMENT SYSTEM OF PREFABRICATED PREFINISHED VOLUMETRIC CONSTRUCTION (PPVC)

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Abstract
International Council for Building (CIB) defined procurement system as "The framework within which construction is bought about, acquired or obtained". Procurement system establish legal relationship between project players including contractors, consultants, client(s) and suppliers. Procurement system recognized as crucial element for project success. Under the principle of Design for Manufacture and Assembly (DfMA), Prefabricated Prefinished Volumetric Construction (PPVC) is LEGO like construction that building modules are manufactured in controlled factory environment off-site. The volumetric modules are prefabricated and prefinished with architectural finishes including painting, wallpaper, tiles. The PPVC modules also completed with mechanical, electrical, and plumbing (MEP) off-site before transport on-site for assembly. The documented benefits of PPVC are saving in time and cost, improve in quality, reduce construction waste, enhance health and safety, minimize pollution, and minimal impact to surrounding living environment and improve in social economy. PPVC require early involvement of PPVC suppliers and contractor even before design stage, this contributes different dynamic between project players from any current procurement systems. This paper is a systematic review on procurement system for PPVC project. PRISMA 2020 protocol is adopted on SCOPUS data base with search done in title, abstract and keywords, in all date range. The results conclude papers from 2018, which is parallel with the timing PPVC were introduce to industry. The review aims to clarify appropriate procurement system for PPVC project to ensure project success. The results shown the current major procurement systems do not match characteristics of PPVC project, also collaboration between supplier, contractor and client is very much encourage in PPVC to ensure project success. The results are critical reference for PPVC project players especially government and clients. The results will assist in ensure project success from the early stage of PPVC project.

Keywords: *Procurement; Prefabricated Prefinished Volumetric Construction; PPVC*

PREFABRICATED PREFINISHED VOLUMETRIC CONSTRUCTION (PPVC)

PPVC as an innovative game changing technology can bring massive changes to construction industry (Pan & Hon, 2018; Leong at al., 2019). PPVC observe Design for Manufacture and Assembly's (DfMA) principle to design. DfMA focuses on ease of manufacturing and efficiency of assembly. DfMA is not a new concept in manufacturing industry.

For construction industry, DfMA enables off-site manufacturing, it also reduces on-site construction activities - a process of design that allows specialist subcontractors or suppliers to manufacture building elements in controlled factory environment (Sinclair, 2016).

The primary purpose is to utilise design processes to enable a collaboration along the whole value chain.

Singapore Building Construction Authority define PPVC project as total of PPVC floor area should be at least of 65% of total constructed floor area. This is consistent with Pan and Hon (2018) which stated PPVC as highest order of prefabricated construction with off-site construction up to 80-90% of building projects can be engineered in off-site facilities.

According to Lau et al. (2019) and Seah (2019), the first PPVC project in Singapore is the Nanyang Technological University's student dormitory. The project utilised 1900 PPVC modules and was completed in mid-2016. A total of 54,000 square feet gross floor area took 30 months to complete. It is considered adoption of new construction technology in Singapore.

Traditional procurement method allows construction activities to be carried out consecutively, anyway PPVC enables construction activities to happen parallel. This will lead to a shorter construction period (Hwang et al., 2018). I.e.: PPVC modules manufacturing works can begin in factory at the same time, piling works can be carried out on-site.

Benefits of PPVC

Building Construction Authority (2019) listed benefits of PPVC as follows:

i. Increased productivity
ii. Reduction of manpower on-site
iii. Improved construction environment
iv. Higher quality control

In 2016, Royal Institute of British Architects (RIBA) Plan of Work - Designing for Manufacturing and Assembly declared that benefits of PPVC includes:

i. 20% - 60% reduction in construction period
ii. Greater work programme assurance
iii. 20% - 40% construction cost reduction
iv. Up to 70% on-site labour reduction, further improves in occupational health & safety
v. On-site skilled labour reduction
vi. Enhanced construction quality
vii. Greater environment sustainability, i.e.: reduced waste
viii. Fewer queries from site

PROCUREMENT

Naoum et al. (2012) described procurement system as framework that link project participants in a communication relational framework, for project period from design to construction and completion. The relationship is contractual and functional, i.e.: contractual via responsibilities and risks, functional via roles, authority and power.

Project risks and the characteristics of risks highly depends on type of procurement system selected. The project performances are impacted by the procurement system. (Ramanathan & Narayanan, 2016).

Masterman & Gamesan (1994) mentioned that clients are not homogeneous individuals or organisations, thus unable to apply uniform standards from their own or consultants' knowledge of available procurement system.

Popular Procurement Method in Malaysia

Malaysia inherited procurement system from the British (Jaafar & Nuruddin, 2012). Onosakponome et al. (2011); Jaafar & Nuruddin (2012); Ramananthan & Sarayanan (2016); Rashid & Khairuddin (2017) listed the three popular procurement systems in Malaysia:

i. Traditional
ii. Design and build
iii. Management system

Traditional

Rashid & Khairuddin (2017) described traditional procurement system as follows: Traditional procurement system often refers to Design-Bid-Build (BBD) has basis of processes are performed in sequential manner (Onosakponome et al., 2011). Design process is separated from construction process, all project participants bear respective risks (Ramanathan & Narayanan, 2016). The procurement system allows fixed contract price and usually designers fully control the design and contractors will take cares of the construction risks.

The disadvantages of traditional procurement system are longer development period and distribution of risks encourages promotes adversary amongst project participants (Pesamaa, 2009; Rashid & Khairuddin, 2017; Tajul Ariffin, 2018). Anyway, Rashid & Khairuddin found it is the most frequent used procurement system for public sector as it satisfies requirement for the procurement processes to be transparent and also the criteria for different project participants to be accountable for the works.

Ramanathan & Narayanan (2016) listed the tenders of traditional procurement system are invited by i) open tendering, ii) selective tendering, and iii) negotiated tendering.

Design and Build

Design and Build is different with traditional procurement system. Malaysia adopted design and build started from 1990s (Jaafar & Nuruddin, 2012). Ramanathan & Narayanan (2016) mentioned Design and Build is relatively suitable for large, complex and specialised projects. It puts the contractors as single point of responsibility, which place more risks to contractor (Onosakponome et al., 2011). Completion time and cost are firmer under design and build procurement system.

As both design and build responsibilities fall on the shoulder of contractor, it allows better coordination and allows overlapping of design and build, that make this procurement system the fast track system (Rashid & Khairuddin, 2017).

Rashid & Khairuddin (2017) also mentioned that one of the drawbacks of design and build is project lacks of aesthetic value, which aesthetic value sometimes contradict with the concern of buildability. If the contractor also in charge of supply, installation and commissioning of furniture and equipment of the project, it is often named as Turnkey procurement system.

Rashid & Khairuddin (2017) mentioned design and build, and turnkey procurement system is selected when time is the upmost concern of the project. Ramanathan & Narayanan (2016) concluded that design and build procurement system suits client who want fast completion and cost confirmation before the construction starts.

Management System

Onosakponome et al. (2011) and Ramanathan & Narayanan (2016) explained that management-oriented system is carried out by a project participant to work with consultants and contractors in order to produce design and manage the construction works done by the contractors. The management contractor can permit overlapping of design and build process and also overlapping of different work packages (Rashid & Khairuddin, 2017).

Rashid & Khairuddin (2017) described this procurement system as works were breakdown into packages and will be tendered out to different contractors. It has higher possibility to create higher competition and secure a lower overall price for the project.

Client has greater involvement than previous two types of procurement systems (Ramanathan & Narayanan, 2016). Anyway, this procurement system does not permit the contract price fixed before the construction started (Rashid & Khairuddin, 2017).

Collaborative Procurement

McDermotti & Khalfan (2012), mentioned that relationship-based method, for example: partnering and framework agreement base on teamwork, integrated teams become more prominent at late 1990s and early 2000.

Significant element for collaborative procurement is trust and commitment between project participants (Ng et al., 2002). Black (2000) listed trust, communication, commitment, clear understanding of each participants' role and consistency are necessary in a collaborative procurement.

Rahmani et al. (2017) mentioned that contradict to traditional procurement system, collaboration approach suggested project success likely to happen if all participants work together for the good of the project, not the good of themselves.

Rahmani et al. (2017) also illustrate that partnering have objective to establish relationships between project participants using a formal strategy of commitment and communication that mutually developed for everyone's benefits.

Bresnen & Marshall (2000) believe partnering in construction project potentially improve construction project performance and bring benefits to both clients and contractors.

Selection of Procurement System

In Malaysia, many clients are not quite aware of choice of procurement system (Rashid & Khairuddin, 2017), therefore traditional procurement system is often adopted as consultants prefer Status Quo and most project participants familiar with it, at the same time, this system also fulfils the requirement on transparency and accountability.

Love et al. (1998), Moon et al. (2011) and Shane et al. (2013) take procurement system as critical factor for project success. They advised clients to take project objectives and project performance into consideration while selecting procurement system. Love et al. (1998) also mentioned that selection of appropriate procurement system not only critical to clients but also all other project participants.

Rashid & Khairuddin (2017) carried out research to assess if the existing procurement system compatible with clients' priority. They conclude that based on client's need, priority and risk appetite, client need systematic selection matrix to assist them in choosing the appropriate procurement system.

The UK's National Economic Development Office (NEDO) Procurement Assessment Criterion (PAC) developed criteria on procurement system selection. The nine (9) generic selection criteria for project are widely used until today.

Table1. NEDO Procurement System Selection Criteria

Criteria	Description
Time (speed)	Is early completion required?
Certainty of Time	What is the extent of importance of the project completion?
Certainty of Cost	Is there a requirement in affirming a set price before any commitment to construction is distributed?
Price Competition	Is selecting a construction team by price through competition important?
Flexibility	Are variations necessary after work has begun on-site?
Complexity	Does the building need to be highly specialized, technologically advanced or highly serviced?
Quality	Is the high quality of the product important in terms of material and workmanship and design concept?
Responsibility	What is the sort of responsibility that is set, single point or a direct responsibility to the client from both designers and cost consultants after the briefing stage?
Risk	What is the transferring of risk of cost and time slippage importance to the client?

Procurement System Selection Criteria

Projects with different characteristics will need difference procurement strategy to ensure project success. Many researchers try to find out procurement system selection criteria in order to assist project participants, especially the client to make decision on procurement system.

SYSTEMATIC REVIEW ON PPVC PROCUREMENT AND PROJECT SUCCESS FACTORS

According to Meredith (1993) systematic literature reviews enable "integrating a number of different works on the same topic, summarizing the common elements, contrasting the differences, and extending the work in some fashion".

To fill in the gap of finding appropriate PPVC's project procurement system in Malaysia, a systematic literature review is carried out on 8th June 2021.

SCOPUS data base is used in this study. The search was done in article title, abstract and keywords, with all date range.

According to HKIS (2019) PPVC is synonymous with MiC, hence both PPVC and MiC were used in the systematic literature review.

Based on Page (2021), Diagram 2.1 is the PRISMA 2020 flow diagram for this systematic review for this study.

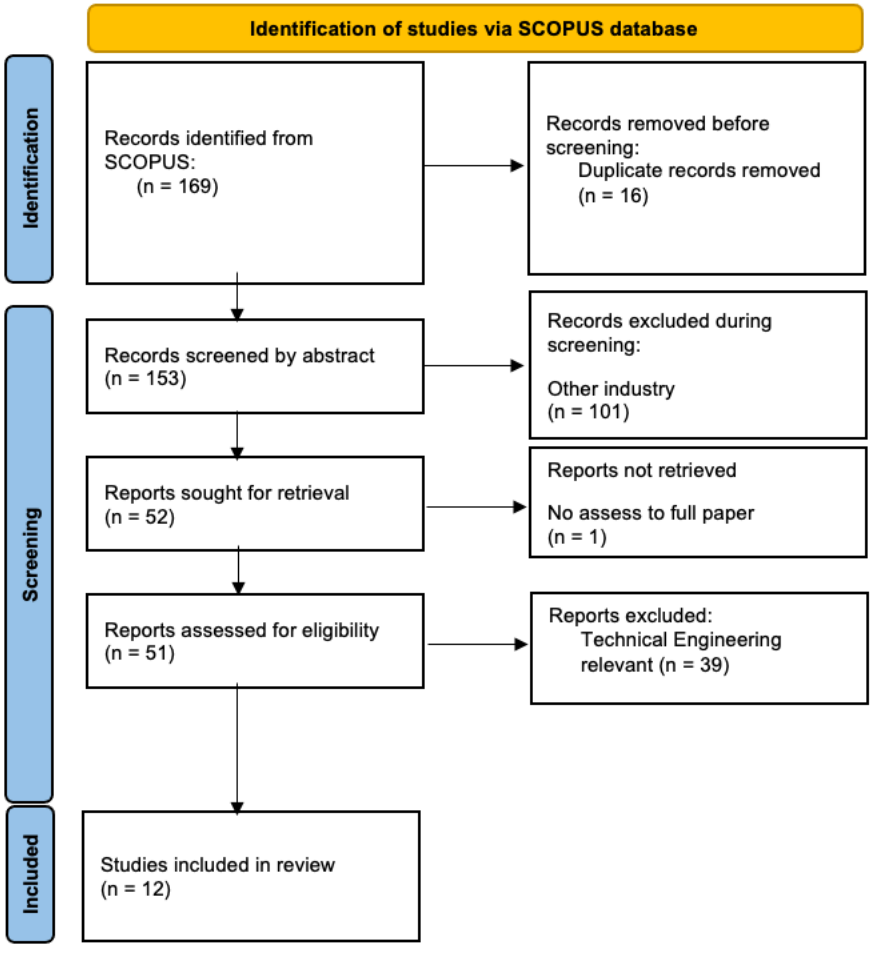

Figure 1. PRISMA 2020 Flow for Systematic Review on PPVC

The systematic review protocol used is Systematic Review and Meta-Analyses (PRISMA) 2020. The language selected is English. The scope of the review is PPVC and Procurement.

The first search on PPVC + procurement and Prefabricated Pre-finished Volumetric Construction + procurement returned to 0 paper. The search on MiC + procurement and Modular Integrated Construction + procurement also returned 0 paper.

The search was widened to PPVC, there were 106 papers. For Prefabricated Pre-Finished Volumetric Construction, there were 23 papers. As for Modular Integrated Construction, there were 40 papers. MiC returned 0 paper. Hence a total of 169 papers.

A total of 169 papers identified from SCOPUS data base. 16 out of 169 are duplicate records hence were eliminated.

The remaining 153 papers were screened by abstract. 101 papers were excluded as it is not paper on Prefabricated Pre-Finished Volumetric Construction, in these papers, PPVC do not means Prefabricated Pre-Finished Volumetric Construction but abbreviation for other words. The remaining number of papers sought for retrieval become 52.

Out of 52 papers sought for retrieval, the University data base has no assess to 1 of the paper. Hence the papers assessed for eligibility is reduced to 51.

There is a total of 39 papers is non-management relevant papers, that makes the papers valid for this systematic literature review to 12 papers. Those 39 non-relevant papers are paper related to PPVC engineering technical relevant matters but not management or procurement relevant.

The 12 papers were published between year 2018 to year 2021 and were produced by a total of 4 different authors.

The 4 main authors and their affiliation are as follow:

Table 2. Main Authors and Their Affiliation

Main Author	Affiliation	No. of papers
Hwang Bon Gang	Department of Building, National University of Singapore	1
Ibrahim Yahya Wuni	Department of Building and Real Estate, The Hong Kong Polytechnic University	9
Sherif Abdelmageed	Department of Building and Real Estate, The Hong Kong Polytechnic University	1
Pan Wei	Department of Civil Engineering, University of Hong Kong	1

It is found that 1 author based in Singapore and another 3 are based in Hong Kong, both cities currently actively implementing PPVC projects.

There is 1 paper published in 2018, 2 published in 2019. 8 papers published in 2020 and 1 paper in 2021.

The publications involved 8 different Journals. The details of the publications as follow:

Table 3. Summary of Journals

Journal	No. of papers
International Journal of Construction Management	4
Journal of Cleaner Production	2
Building Research and Information	1
Built Environment Project and Asset Management	1
Engineering, Construction and Architectural Management	1
Journal of Cleaner Production	1
Journal of Financial Management of Property and Construction	1
Proceedings of the Institution of Civil Engineers: Municipal Engineer	1

Table 4. Relevant Papers and Authors

Authors	Title
Hwang B. G., Shan M., Looi K. Y. (2018)	Key constraints and mitigation strategies for prefabricated prefinished volumetric construction
Wuni I. Y., & Shen G. Q. (2019)	Towards a decision support for modular integrated construction: an integrative review of the primary decision-making actors
Wuni I. Y., Shen G. Q., Mahmud A. T. (2019)	Critical risk factors in the application of modular integrated construction: a systematic review
Wuni I. Y., & Shen G. Q. (2020)	Critical success factors for management of the early stages of prefabricated prefinished volumetric construction project life cycle
Wuni I. Y., & Shen G.Q. (2020)	Stakeholder management in prefabricated prefinished volumetric construction projects: benchmarking the key result areas
Abdelmageed S. & Zayed T. (2020)	A study of literature in modular integrated construction - Critical review and future directions
Pan W., & Hon C. K. (2020)	Briefing: Modular integrated construction for high-rise buildings
Wuni I. Y., & Shen G. Q. (2020)	Critical success factors for modular integrated construction projects: a review
Wuni I. Y., & Shen G. Q. (2020)	Fuzzy modelling of the critical failure factors for modular integrated construction projects
Wuni I. Y., Shen G. Q., Osei-Kyei R. (2020)	Quantitative evaluation and ranking of the critical success factors for modular integrated construction projects
Wuni I. Y., Shen G. Q., Osei-Kyei R., Agyeman-Yeboah S. (2020)	Modelling the critical risk factors for modular integrated construction projects
Wuni I. Y., Shen G. Q., Osei-Kyei R. (2020)	Evaluating the critical success criteria for prefabricated prefinished volumetric construction projects
Zhang S., Rong X., Bakhtawar B., Tariq S., Zayed T. (2021)	Assessment of Feasibility, Challenges, and Critical Success Factors of MiC Projects in Hong Kong

The review shown there is 1 stakeholder management paper, 1 mitigation strategy paper, 1 determinant factor to use PPVC research, and 2 review papers that enhance the understanding on PPVC in construction industry.

The remaining 7 papers are about critical factors, namely: 1 critical failure factors, 2 critical risks factors and 4 critical success papers.

As PPVC just started to gain popularity, there is not much understanding on critical success factors, critical risks factors and critical failure factors.

The critical factors mentioned are categorized as follows:

Table 5. Critical (Success, Failure, Risks) Factors for PPVC Project

Critical (Success, Failure, Risks) Factors for PPVC Project	Category
Active involvement of key participants throughout the project	Collaboration and Communication
Communication and information sharing among project participants	Collaboration and Communication
Effective communication and information sharing among project participants	Collaboration and Communication
Effective coordination of involved stakeholders in the PPVC project	Collaboration and Communication
Effective coordination of the supply chain	Collaboration and Communication
Effective working collaboration, communication and information sharing among participants	Collaboration and Communication
Good contractor relationship	Collaboration and Communication
Good working collaboration	Collaboration and Communication
Good working collaboration and effective communication among project participants	Collaboration and Communication
Involvement of key project participants throughout the project	Collaboration and Communication
Use of BIM to improve coordination and facilitate communication among project stakeholders	Collaboration and Communication
Cost savings and profitability	Cost
Financing risks, and regulatory risks	Cost
Higher initial capital cost	Cost
Higher initial cost than conventional construction method	Cost
Overall cost control requirement	Cost
Stringent project cost and strict requirement for certainty	Cost
Accurate drawings and early design freeze	Design
Design and capabilities risk	Design
Poor design and dimensional variability management	Design
Reduced environmental impact and sustainability requirements	Design
Robust design specifications	Design
Adequate knowledge	Experience
Availability and accessibility of skilled and experienced factory labour force	Experience
Availability of skilled management and supervising team	Experience
Availability of skilled onsite labour	Experience
Comprising adequate technical capability and infrastructure	Experience
Effective use of information and communication technology	Experience
Fabricator experience and capabilities in modules design and production	Experience
Limited technical knowledge, capability and experience	Experience
Offering training courses for project team and workers to enhance their knowledge and skills	Experience
Poor government support and regulations	External Environment
Regulatory risks	External Environment
Increased transportation and logistics considerations	Logistic
Transport infrastructure, size restrictions, and equipment availability	Logistic
Effective use of integrated project delivery method and contracting	Procurement
Suitable procurement strategy and contracting	Procurement
Client and owner satisfaction	Project Participant
Effective stakeholder conflict resolutions and management	Project Participant
Effective stakeholder management	Project Participant
Extensive planning and analysis of stakeholder salience, needs, constraints and interest areas	Project Participant
Stakeholder fragmentation and management complexity	Project Participant
Need for additional project planning and design efforts	Project participants

Critical (Success, Failure, Risks) Factors for PPVC Project	Category
Extensive coordination required prior to and during construction	Quality
Meeting project quality specification	Quality
Strict requirement for project quality control	Quality
Meeting safety requirements	Safety
Need for improved construction safety	Safety
Standardization & benchmarking of best practices	Standardization
Standardization and mass production	Standardization
Effective management of stakeholder-associated risks in the PPVC supply chain	Supply Chain
Effective coordination of the PPVC supply chain segments	Supply Chain
Effective stakeholder and supply chain management	Supply Chain
Effective supply chain management	Supply Chain
Poor stakeholder and supply chain management	Supply Chain
Poor supply chain integration and disturbances	Supply Chain
Stakeholder and supply chain risks	Supply Chain
Adherence to project schedules	Time
Delays in delivery of modular components to the site	Time
Demanding and tight project schedule and need for expedition	Time
Extensive project planning and scheduling	Time
Requirement for early commitment	Time
Early design freeze	Time
Early commitment	Time
Early involvement of relevant stakeholders in the PPVC project	Time
Encouraging close collaborations between project stakeholders during the early phase of the project	Time
Robust drawing specifications and early design freeze	Time
Understanding of early decisions and their implications on the roles of project participants	Time
Early engagement of key players	Time

CONCLUSION

From the systematic literature review, it is found that else than the traditional time, cost, quality, experience, design, external environment and safety factors, there are also clear concern on supply chain, standardization, project participants, collaboration and communication factors on project success. By using traditional considerations and factors on a new technology maybe not leading to project success.

It is proposed, based on the finding of this research, further investigate the how each factors impact PPVC project success and the relationship of different factors.

The impact of each factor and the relationship of factors will be significant considerations for all stakeholders, including PPVC supplier, contractor, crane operator, logistic supplier, government, client, architect, engineer, quantity surveyor, project manager, up to workers to ensure project success.

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HUMAN RESOURCE MANAGEMENT AND ITS FUTURE TREND: CRITICAL SKILLS FOR CONSTRUCTION GRADUATES

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Abstract
Construction resource management is a discipline to plan, manage, direct, and schedule the resources, mainly focus on human resources. Due to the constant evolution of science and technology, managing human resources are becoming more challenging. This study aims to identify the characteristic of resource management and its future trend: critical skills for construction graduates. The crucial elements in this study, such as the Construction Industry Transformation Programme (CITP), the issue of graduate unemployment, the issue of skilled labour shortage in the construction industry, construction resources, challenges in resource management, and its skills required also be discussed and redefined through the literature review to get the detail information and understanding from the aspect of the industry. The methodology to obtain data is the mixed method of qualitative and quantitative methods, interviews, and questionnaires. SPSS and thematic analysis are the methods to analyse data. The respondents are contractors from Johor Bahru. There are 146 respondents for questionnaires, and six among them accepted the interview sessions. This research shows that critical skill of resource management includes negotiation, decision-making, problem-solving, reading and understanding drawings, and design activities and background. Besides that, the researcher found that resource management required the cooperation of many professionals and human resources, and communication problems were the primary problem. Future trends of resource management will advance in the direction of dispersion and technology development. In conclusion, this study ensures the crucial human resource management skills required for construction industry graduates.

Keywords: *Level of Absorptive Capacity; Technology Transfer; New Technology; ETS Project*

INTRODUCTION

Malaysia is a developing country, and the building industry is critical to its development. Construction projects involving foreign nations have also increased significantly, demonstrating that globalisation is no longer a mirage and affects construction. Additionally, the Construction Industry Transformation Programme (CITP) indicated that the five-year initiative resulted in favourable changes to the industry, including significant productivity benefits. Construction projects are intricate and require expertise in various sectors, including human resources, equipment, finance, and management. As a result, effective management is critical to completing the project on schedule, within budget, and with the desired quality. However, the ongoing innovation of science and technology has resulted in a growth of construction business complexity. As a result, resource management has gotten more complicated, and the knowledge required for resource management has increased proportionately. Graduate unemployment in developing countries is an unavoidable occurrence (Fakih et al., 2020). The causes for this phenomenon are numerous, and one of

these reasons is that graduates' skills and knowledge do not meet market needs. Numerous statistics demonstrate that Malaysian graduates frequently face difficulties due to a lack of English proficiency and poor communication skills (Heang et al., 2019).

Bank Negara Malaysia's 2016 annual report, which was released on 23 March 2017, revealed that while the national unemployment rate was 3.1 percent in 2015, the rate among young (15 to 24 years old) was three times that at 10.7 percent (Ibrahim & Mahyuddin, 2017). Malaysia's building industry is facing a labour crisis (Alaloul et al., 2021). Due to a dearth of experienced personnel in the business, Malaysian construction continues to rely mainly on labour (Rahim et al., 2016). The purpose of this research is to establish the competencies required for construction resource management in a challenging environment and critical skills required for construction graduates in an ever-changing situation. It is beneficial to establish guidelines for the resource manager, the project manager, the project planner, the human resource manager, the financial manager, and anybody else interested in construction resource management.

Additionally, this research can serve as academic material as a foundation for future research on construction human resource management trends. This research is being conducted in Johor Bahru, and the target population is construction firm personnel, as there are numerous construction companies in the city, and some of them have expertise with large-scale building projects, including international construction projects. Their experience is critical in enhancing the accuracy of this research. Employees' resource management practices and perspectives should be gathered to determine the future resource management model.

LITERATURE REVIEW

The Malaysian government proposed the Construction Industry Transformation Programme (CITP) in 2015. CITP is a five-year programme that runs from 2016 to 2020. It tries to improve the bad perception of the building sector by illustrating it in three dimensions (dangerous, difficult and dirty). CITP turns the construction sector into highly productive, ecologically sustainable, and globally competitive players while maintaining strict adherence to safety and quality standards. It proposed four strategic axes, 117 key performance indicators, and 21 initiatives (Construction Industry Development Board Malaysia, 2016).

Quality, safety, and professionalism are the pillars upon which every industry can grow responsible and advanced. This can be implemented in all building projects through institutional control to assure the product's quality and site safety (Love et al., 2018). According to the "TRENDS IN GLOBAL CO_2 EMISSIONS 2016 REPORT," Malaysia's carbon dioxide emissions increased 345 percent between 1990 and 2015, reaching 245,371 kt (Olivier et al., 2016). CITP's objective is to reduce the construction industry's carbon emissions by 4 million tonnes of CO_2 per year, contributing to global carbon reduction.

Malaysia has always aimed to be a high-income country. Productivity is critical to achieving this goal. CITP suggested a plan that aims to quadruple the construction industry's productivity while also increasing wages. Internationalisation is defined in CITP as developing domestic contractors to the point where they can compete against foreign contractors. Internationalization of construction methods and standards, increased access to funding, facilitation of consortia formation, and collection of abroad market intelligence are

all activities aimed at achieving this goal. The four primary construction resources are material, men, machines, and money (Chang et al., 2019). The main building construction components are bricks, concrete, iron rods, wood, insulating material, and waterproofing material. A study was conducted with the objective of forecasting and comparing future input and output flows, defining future recycling potential, estimating future stock composition, comprehending urban metabolism, and analysing the interplay between flows and stock (Augiseau & Barles, 2017). Manpower is a term that refers to a company's human resources, which include its employees and contractors. Machines refer to the construction equipment utilised to eliminate tiresome and inconsequential tasks while increasing productivity and safety. Nowadays, robots with increased efficiency and the ability to work in hazardous environments have been developed (Davtalab et al., 2018). Money, or financial resources, is one of the four primary construction resources. There is information regarding the distinctive characteristics of financial management in multinational corporations and trade finance, intrafirm transfers, and capital planning (Melvin & Norrbin, 2017).

Resource management is the process by which a business utilises its resources. The resource can be personal, financial, or tangible, such as material or equipment. Resource management attempts to make the best use of available resources to minimise waste and maximise benefit. Human capital is a critical asset for any industry or business since it can be developed and increased via education and training. Thus, human resource management is a discipline that manages, effectively utilizes, and even boosts human potential (Tweedie eu al., 2019). All critical organisational decisions have financial consequences. Financial management may effectively and efficiently organise, direct, and control an organization's operations to ensure a positive outcome (Atnafu & Balda, 2018).

Planning is the process by which we organise and sequence the actions necessary to accomplish a goal, whereas scheduling is the technique used to establish the activities necessary and their sequence, as well as the time frame within which the project must be completed. The complementary nature of planning and scheduling is completely reflected in the construction industry's daily practise. Thus, the integration of planning and scheduling will require much study and discussion to determine the most effective integration technique (Rafiei & Ricardez-Sandoval, 2020). Integrated management is a concept that unifies diverse disciplines and company processes to maximise efficiency while retaining the uniformity and diversity of all stakeholders. Integrated management enables an organisation to function as a single entity despite having numerous distinct disciplinary units. According to the findings of a study, integrated management has a positive effect on the performance of project managers (Demirkesen & Ozorhon, 2017).

Graduate unemployment is a global problem, made worse in developing countries. This phenomenon also happens in Malaysia. According to The Graduate Tracer Study 2016, 22.7 percent of respondents (238187) are unemployed. The study concluded that the cause of this issue is a lack of communication skills, a lack of soft skills, graduates picking jobs, a lack of experience, and a lack of industrial training (Zulkifli et al., 2016). Malaysian construction industry is not alone in having a skilled labour shortage; other countries such as United States, United Kingdom, Canada, India, and the Bahamas are also affected (Stiglitz, 2020).

Challenging in Resource Management of Construction Industry

Three significant challenges confront construction resource management: (1) developing a knowledge representation scheme that accurately represents the project, its constraints, and sources of uncertainty; (2) developing techniques for computing execution time deviations from the APS; and (3) controlling the project while mitigating the adverse effects of the deviations (Pellerin & Perrier, 2019). The skills necessary for resource management are comprehensive, as it encompasses a wide variety of fields, including human resources, finance, material management, and equipment. Each type of resource has its management strategy. Science and technology innovation is transforming the way humans do things. Additionally, the manner of resource management will be altered in comparison to the old method. As a result, training and courses are essential to keep employees' and workers' knowledge and skills current.

CIDB's responsibility is to aid the construction sector, and BIM training is one of such services. According to the chief executive officer of CIDB Malaysia, "We are transitioning away from AutoCAD and toward BIM. Once we have accumulated all of the necessary experience in terms of consultation and design training, we can finally establish an industrialised building system (IBS)." (Ayisy & Aliza, 2017). National Dual Training System (NDTS) is a programme created in 2005 by the Ministry of Human Resources Malaysia's Department of Skills Development (Yahaya et al., 2020). NDTS seeks to strengthen collaboration between educational institutions and industry firms.

SGS (Société Générale de Surveillance) is a Swiss multinational corporation with its headquarters in Geneva. SGS does inspections, verifications, testing, certification, and training services include health, safety, environmental management, risk management, information security management systems (ISMS), and supply chain security management systems (SCSMS).

Most research on technological absorptive ability focuses on large organisations with staff, finance, complex structure, and research and development. Investment in research and development is a highly effective method for organisations to increase their baseline knowledge and absorptive ability (Jeong et al., 2020). According to Lavoie & Daim (2019), enhancing absorptive ability is a critical component of regional technology transfer networks involving universities, industry, and organisations. Higher levels of expenditure in R&D can be used to quantify the attribute of greater absorptive capacity of products generated by contractors, as professional institutions play a critical role in producing and spreading information.

RESEARCH METHODOLOGY

This study employs a balance of qualitative and quantitative methodologies. In this study, quantitative methods were utilised to generate the conclusions, while qualitative methods provided further context for the outcomes. Quantitative methods include questionnaires, and qualitative methods include in-person interviews. This research will be conducted in Johor Bahru and will focus on the employees of a local construction company. This is because there are numerous construction companies in Johor Bahru, and some of them have experience working on large-scale building projects, including those that are international in scope. Their

experience is critical in ensuring the accuracy of this research. Employees' resource management practises and perspectives will be gathered to determine the future resource management model. According to CIDB data, Johor Bahru has 6764 registered contractors. G1 registered contractors in Johor Bahru number 1720, G2 registered contractors' number 1509, G3 registered contractors' number 1753, G4 registered contractors' number 371, G5 registered contractors' number 606, G6 registered contractors' number 168, and G7 registered contractors' number 637. The respondents chosen should be as representative as feasible of the whole population. The research will be conducted on resource managers, project managers, project planners, human resource managers, and financial managers. This study questionnaire will be distributed to about 363 resource managers, project managers, project planners, human resource managers, and financial managers.

FINDINGS AND DISCUSSIONS

Table 1. Demography of Respondents

Characteristic		Frequency	Percentage (%)
Position	Resource manager	27	18.5
	Project manager	27	18.5
	Project planner	17	11.6
	Human resource manager	23	15.8
	Financial manager	14	9.6
	Quantity surveyor	24	16.4
	Quality assurance and quality control	9	6.2
	Site supervisor	5	3.4
Working Experience	Below 5 years	76	52.1
	6 years – 10 years	53	36.3
	10 years above	17	11.6
	Total	146	100.00

There are 146 respondents who are accepted to participate in the questionnaire survey. The background statistics and analysis consist of two aspects: the working position of the respondent and the other is work experience. Additionally, Table 1 indicates a total of 17 respondents with a percentage of 48.57 percent for those with fewer than five years of work experience. Individuals with six to ten years of job experience come in second with a proportion of 34.29 percent and 12 respondents. Individuals with 11 to 15 years of work experience had an 8.57 percent percentage value, with three replies. Following that, individuals with job experience between 16 and 20 years had a peritus value of 5.71 percent with two individuals, while individuals with work experience greater than 20 years had 2.86 percent with one individual. According to the data, researchers can conclude that this study was conducted with input from various individuals with varying levels of job experience. The 146 respondents' occupations fall into seven categories: resource manager, project manager, project planner, human resource manager, finance manager, quantity surveyor, quality assurance and quality control, and site supervisor. Most of the respondents are resource managers and project managers. Both accounted for a sizable proportion of respondents, 27 respondents or 18.5 percent for each. The third-largest share of respondents is quantity surveyors. There are 24 responders (16.4%) who work as quantity surveyors. Human resource managers are just one less than quantity surveyors and now account for the fourth most significant proportion of responses, at 23 or 15.8 percent. The remaining respondents included project planners, finance managers, quality assurance and quality control professionals, and

site supervisors, with 17 respondents (11.6 percent), 14 respondents (9.6 percent), nine respondents (6.2 percent), and five respondents (3.4 percent) respectively. Respondents' working experience is classified into three categories: less than five years, six to ten years, and ten years or more. The respondents with less than five years of work experience are the largest, with 76 respondents (52.1 percent). On the other hand, the group with 6 to 10 years of job experience has 53 respondents (36.3 percent), while the group with more than ten years of work experience has 17 respondents (11.6 percent).

This part is an analysis of the data collected through the interview. There are three sections in this part: demographic of respondents, their feedback to the resource management's characteristics, and opinion on the future of resource management: technology adoption and technology transfer between graduates. Six interviewees were selected randomly from 146 questionnaire respondents to participate in the interview sessions in this research. The working position and working experience of six interview interviewees are shown in Table 2.

Table 2. Working Position and Working Experience of Interviewees

Interviewee	Working Position	Working Experience
Interviewee 1	Project planner	Below 5 years
Interviewee 2	Human resource manager	Below 5 years
Interviewee 3	Project manager	6 years – 10 years
Interviewee 4	Quantity surveyor	6 years – 10 years
Interviewee 5	Project manager	Below 5 years
Interviewee 6	Quantity surveyor	10 years above

Critical Skills for Resource Management Graduates

This research aims to identify the critical skills required to graduate for resource management. The feedback from 146 respondents was analysed and presented in Table 3.

The findings indicate that the five critical skills required for effective resource management are negotiating, making decisions, solving problems, comprehending drawings, and applying design principles. According to 66 respondents, negotiation skill is considered the most crucial skill obtained, while 14 respondents think it is neutral. The analysis found that negotiation ability with a mean score of 4.30 was more critical than previously assumed and became the most significant skill necessary for resource management. Only seven people were neutral about the decision, while 94 respondents agreed, and 45 respondents strongly agreed.

The third essential skill for graduates is creative and problem-solving skills, the ability to handle problems, obtained a mean score of 4.23. In total, there were 13 critical skills which had an average of 4.19 or 4.06 points each. Resource management consists of crucial decision-making, delegating, analytical, teamwork, problem-solving, and leadership (Hwang & Ng, 2013). The findings of this research are a bit different from what we anticipated. More importantly, to succeed in resource management, three noncritical abilities, namely marketing and sales skills, public speaking skills, and chairing meetings skills, must be verified.

Table 3. Critical Skills for Resource Management Graduates

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Means	Rank
Negotiation	0	0	14	66	66	4.30	1
Decision-making	0	0	7	94	45	4.26	2
Problem solving	0	0	46	21	79	4.23	3
Reading and understanding drawings	0	0	22	74	50	4.19	4
Design activities and background	0	0	32	73	41	4.06	5
Estimating and tendering	0	1	41	86	18	3.83	6
Human behaviour	0	0	49	94	3	3.68	7
Site layout and mobilization	0	3	60	65	18	3.67	8
Stress handling	0	17	65	31	33	3.55	9
Team working	0	9	75	38	24	3.53	10
Basic technical skill	0	6	72	55	13	3.51	11
Report writing	0	7	72	67	0	3.41	12
Delegation	0	30	53	54	9	3.29	13
Leadership	1	19	80	35	11	3.25	14
IT skills	0	28	61	53	4	3.23	15
Public relation	0	35	67	35	9	3.12	16
Technical writing	10	23	65	41	7	3.08	17
Drafting contracts	0	45	59	27	15	3.08	17
Presentation	13	36	72	15	10	2.82	19
Chairing meetings	8	70	34	34	0	2.64	20
Public speaking	11	68	46	21	0	2.53	21
Marketing and sales	51	62	24	9	0	1.94	22

Level of The Adoption of New Technologies of Graduates

According to Pirotti et al. (2020), and Palvia et al. (2016), the adoption potential of new technologies on the ETS project can be classified into four categories. The category encompasses a variety of subcategories. Organizations, technologies, skilled, and financial personnel fall into these four categories. Malaysian construction practitioners regard the deployment of new technology in building as a short-term endeavour, rather than contemplating long-term use due to budgetary restrictions (Pirotti et al., 2020). Finance also plays a significant part in absorptive ability, as it influences the level of individual recipients. The average quantity at this level of technology transfer among graduates, with the mean score of 4.15. According to the researchers' expectations, the mean quantity implies a high level of absorptive ability for skilled graduates.

Palvia et al. (2016) states that technology transfer across graduates entails various other factors or impacts, such as inconsistency in the application of technology in infrastructure construction projects. Following that, Yunus & Hamid (2019) stated that the absorption of trained human capacities for applying new technologies in Malaysia is sluggish due to the lack of available technology. The findings concluded that the average minute at the level of technology adoption has the second-highest mean of 3.89. According to the researchers' findings, the mean quantity implies a high level of absorptive ability for skilled graduates, demonstrating that respondents have a strong capability to absorb trained workers during the technology transfer process.

Researchers can use the findings to determine the capacity of contractors to use new technology on ETS projects. According to the assessment, contractors' total level of absorptive ability on the ETS project was determined to be high, with a high average score of 4.15. Additionally, researchers found that the capacity adoption ability for new technologies among graduates participating in the ETS technology transfer process is relatively average, as shown in Table 4.

Table 4. Overall Score of Technology Adoption Level

Categories	Average Total Mean	Level
Organisation	3.86	High
Technology	3.83	High
Skill Worker	3.89	High
Financial	4.15	High

Measures To Improve Technologies Adoption Among Graduates

Technology transfer is a complicated process that requires detailed description from the start to guarantee that both the seller and the technology buyer understand the ramifications and strive to maximise mutual interest (Swinnen & Kuijpers, 2019). Technology transfer is a process by which a recipient firm has access to or imitates the donor firm's comprehensive technological capabilities (Günsel et al., 2019). In other words, enhancing technology transfer stages refers to transmitting technology from one individual, organisation, or country to another via several communication channels (Mendoza & Sanchez, 2018). Based on the researchers' findings, the mean score of 4.21 indicates communication plays a crucial role in technology transfer, relying heavily on better communication.

Following that, the organisation's ability to adopt new technologies to realise the anticipated benefits of the technology acceptance process is contingent upon existing technical and organisational capabilities. The technology transfer process is a critical stage in enhancing the use of technology in product creation and service management, and it has also been recognised as a very effective method of remaining competitive against other organisations. The finding indicates that graduates can increase technology adoption through skills development, as indicated by the highest mean value of 4.21, where contractors are willing to send their employers to CIDB-sponsored training programs, motivate their workers to use new technologies, and maintain an excellent worker system to ensure the company's success.

Meanwhile, organisation policy on the ETS project have a high degree of technology adoption, with an average value of 4.14. The findings demonstrate that an organisation's robust finance mechanism is required to maintain an excellent level of adoption for new technologies in ETS projects. Noting that finance has a significant role in determining an organisational level of employing new technologies during the technology transfer process on the ETS project, as shown in Table 5.

Table 5. Measures to Improve Technology Adoption

Categories	Average Total Min	Level
Organization	4.14	High
Communication	4.21	High
Skills	4.21	High

CONCLUSION AND RECOMMENDATION

The study's findings established that effective resource management required the collaboration of numerous specialists and human resources. As a result, confrontation is unavoidable. The findings attest to the critical nature of negotiation abilities. Additionally, as subcontractors become more specialised in a specific area, their adoption rate increases. This research endorses the construction industry's future trend in human resource management is toward dispersion in practice. With the expansion of people's contact networks and the possibility for conflict, negotiation has become an increasingly crucial and critical skill for human resource management. Decision-making and problem-solving skills are also required to resolve conflict and other issues that arise because of conflict.

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MALAYSIAN CONSULTANT QUANTITY SURVEYORS' CHALLENGES IN EXPORTING SERVICES TO ASEAN COUNTRIES: SWOT ANALYSIS

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Abstract
Malaysia is known to be a professionally matured country and comprises many competent professionals who are capable to export their services and emerge as champions in the ASEAN Region. However, this niche market and expertise were not capitalized in maximum. This role appears to be undertaken by other professionals from neighbouring ASEAN countries such as Singapore, the Philippines, and Thailand. The Malaysian government has initiated many activities to promote exporting of services under the Malaysia External Trade Development Corporation yet Malaysian professional firms in general and Quantity Surveying firms in specific are not much involved in the international market. Hence, the aim of this is paper is to analyse the strengths, weaknesses, opportunities, and threats to improving the gap of exporting local business of Consultant Quantity Surveyors services to ASEAN countries mainly in Thailand, Cambodia, Vietnam, and Laos. For research methodology, semi-structured interview sessions were conducted with six respondents from Quantity Surveying consultant firms. A SWOT analysis has been provided as guidance to Malaysian Consultant Quantity Surveyors in exporting their services, for strengths they are experience and human capacity; weaknesses are firm size and financial capacity; opportunities are a global mindset and Service Export Fund (SEF); threats are global competition, location factor, and the host country is identified as a guide to the research. It is hoped that these findings may assist and encourage many local companies to carve new frontiers in global markets, to make the term 'Made-In-Malaysia' synonymous with innovation, efficiency, and trustworthiness to continue to bring the spotlight on capable Malaysian companies on the international stage.

Keywords: *Export; Quantity Surveying services; ASEAN Countries; SWOT Analysis*

INTRODUCTION

The service sector assumed a rising share of GDP as the economy evolves toward a developed country. As Malaysia moves to become a developed country, a significant focus should be put on the improvement of the service sector in order to serve as part to enhance economic growth. (MIDA, 2020). According to MIDA (2020) report, the service sector is forecast to expand at 6.8 percent annually and contribute 56.5 percent to GDP in 2020.

The global trade and services sector is being increasingly liberalized. The Malaysia Third Industrial Master Plan (IMP3) 2006-2020 focuses on the service sector as the economy's key growth factor. Professional services are one of the eight sub-sectors of services listed for development. This involves improving the competitiveness of the service sector by progressively encouraging the export of services (MITI, 2006; Wong, 2012). However, according to the literature available on the internationalization of the professional service sector, the actual export of services is very small (Abdul-Aziz et al., 2011). This raises the question of why?

The Quantity Surveying profession has established almost 70 years ago and still growing. There are 380 Quantity Surveying Consultant firms registered with the Board of Quantity Surveyors Malaysia (BQSM, 2020) which plays an increasingly important role in the construction industry (Bee Ling Chong, 2020) however, not many firms are involved in the exportation of their services abroad (Wang et al., 2017). Tragically, being the pioneer among the ASEAN countries with more than half a century of experience yet we are left so much behind in competing in the niche market. Several studies have been made on this subject yet there is not much improvement in this sector.

Malaysia is known to be a professionally matured country and comprises many competent professionals who are capable to export their services and emerge as champions in the ASEAN Region. However, this niche market and expertise were not explored and capitalized in maximum. This role appears to be undertaken by other professionals from neighbouring ASEAN countries such as Singapore, the Philippines, and Thailand (refer to Figure 1) have emerged as leaders in exporting their services overseas and leaving Malaysia in the backseat (Gdp et al., 2017).

Country/Economy	Total GDP(PPP) (US$MM)	Agricultural	Industrial	Service	Agricultural	Industrial	Service
World	**127,800,000**	**6.4%**	**30.0%**	**63.0%**	**8,179,200**	**38,340,000**	**80,514,000**
Singapore	528,100	0.0%	24.8%	75.2%	0	130,969	397,131
Philippines	877,200	9.6%	30.6%	59.8%	84,211	268,423	524,566
Thailand	1,236,000	8.2%	36.2%	55.6%	101,352	447,432	687,216
Malaysia	933,300	8.8%	37.6%	53.6%	82,130	350,921	500,249
Vietnam	648,700	15.3%	33.3%	51.3%	99,251	216,017	332,783
Burma	329,800	24.1%	35.6%	40.3%	79,482	117,409	132,909

Figure 1. Global Distribution of Gross Domestic Product (GDP) 2017

The professional service sector is one of the potential sectors that play an eminent role in the Gross Domestic Product (GDP) contribution to Malaysia. Our government has initiated many activities to promote exporting of services under the Malaysia External Trade Development Corporation (MATRADE)(MATRADE, 2013), yet Malaysian professional firms in general and Quantity Surveying firms in specific are not much involved in the international market (Abdul-Aziz et al., 2011). According to Wang et al. (2017), the Quantity Surveying sector in Malaysia has overlooked the foreign market although export services are now becoming essential to maintaining business, only 21 Quantity Surveying firms have been involved in projects abroad (Jafrey Hisham & Zainordin, 2019).

Realizing the challenges faced by Malaysian professionals, the government had formed PSDC (Professional Service Development Corporation) in the year 2007 headed by Datuk Ir. Ahmad 'Asri Bin Abdul Hamid (Abdul-Aziz et al., 2009), however, the corporation was disbanded in 2012. Datuk Ir. Ahmad 'Asri Bin Abdul Hamid who is currently the Chairman of the Chief Executive Officer and Corporate Division of the Construction Industry Development Board (CIDB) mentioned in an article (Jurutera, Eng, 2012), that the main challenges now with the defunct PSDC in promoting the export of professional services are lack of a distinct competitive advantage of Malaysian companies over the international counterparts. He also added that more Malaysian consulting firms must be encouraged to take the daring step of venturing abroad. According to the CEO of MATRADE, Dr. Wong Lai Sum, she has urged that Malaysian service provider should redirect their market focus to those countries closer to home, hence urging businesses in ASEAN countries to take advantage of the economic establishment of the ASEAN Economic Community (ACE). By doing so, bilateral trade between the member state could be enhanced (Jurutera, Eng, 2012).

Exporting services to ASEAN countries can be challenging especially the professional services. According to Dr. Wong Lai Sum, the CEO of MATRADE, the challenges do constrain the firms from exporting their services but rather conducting their business locally (Jurutera, Eng, 2012). Perceiving this matter, this research is conducted to identify challenges and threats faced by the Malaysian Consultant Quantity Surveyor (CQS) in exporting their services to ASEAN countries especially to the neighbouring countries, Thailand, Cambodia, Vietnam, and Laos which are closer to Malaysia, and explore the countries which share a similar culture, food, tradition, weather and socio-economic hence, echoing Dr. Wong Lai Sum view to redirect our market focus to those countries closer to home (Jurutera, Eng, 2012). Moreover, the respondence for my research will be chosen among the professionals operating their consultant firm in the targeted host countries. This research also may identify the core strength in Malaysia Consultant Quantity Surveyor and elements to be anticipated in order to compete with other developing countries in exporting their services along with to explore the opportunities available and recommendations for successful entry to the ASEAN market. Through a SWOT analysis (Strength, Weakness, Opportunities, and Threats), the above said problem statement shall be identified. The outcome of the research may assist and benefit the Consultant Quantity Surveyors in exporting their services.

LITERATURE REVIEW

Developing countries not only export conventional services, such as transportation and tourism, but also modern services, in particular, high-quality services, such as computer and information services, communication, professional services, and other business services (Goswami et al., 2011; Mattoo, 2014). In fact, the exports of number of developing countries to the service sector are increasing faster than their exports of goods and are contributing to the diversification of their exports (Goswami et al., 2011; Mattoo, 2014). There is a "service revolution" providing an alternative channel for rapid economic growth and reduction of poverty (Goswami et al., 2011).

To maintain its growth and development, Malaysia depends on export earnings. Compared to the primary and secondary industries, service exports represent the lowest percentage of overall production in the service sector (Wong, 2012). In Malaysia, for its potential to influence all aspects of the growth of a country, the service sector has been

targeted as the new growth engine. The more established the economy, the expectation of GDP contribution is higher from the services sector. The service industry is becoming a significant contributor to the Malaysian economy (Wang et al., 2017).

According to Lim (2019), in 2020, the service industry was expected to grow 6.2 percent year on year, from 6.1 percent in 2019, making it the economy's fastest-growing sector. Expansion in the majority of sub-sectors would underpin development in 2020. The sub-sector of wholesale and retail trade is projected to rise to 6.8 percent and 7 percent respectively in 2019 and 2020 (Lim, 2019). The Ministry of Finance (MoF) says that the service sector is one of the fast-growing sectors in Malaysia especially the tourism sector, e-commerce, finance, insurance, information, and communication, as well as real estate is expected to grow in 2020 (Lim, 2019).

Malaysia's exports of services will in the future play a greater role in international trade. Professional construction firms covering the fields of structural engineering, architecture, quantity surveying, and civil engineering have also had an influence overseas, minimal as it may be (A.R. Abdul-Aziz, D. N. Pengiran, Y. H. Law, H. A. C. M. Nor Azmi, 2013). Recognizing that trade in services will increase in volume in the coming years, the Malaysian government has taken progressive measures to liberalize the services sector in the context of the ASEAN Framework Agreement on Services (AFAS)(ASEAN.org.) and the General Agreement on Trade in Services (GATS)(WTO.org.) intending to improve the services sector's capacity, competitiveness and efficiency so that market openings can be utilized (A.R. Abdul-Aziz et al., 2013).

Challenges Faced by Exporting Quantity Surveying Services

Firms find in their efforts to market and export their services to foreign markets, they face numerous obstacles, barriers, and challenges (Wong, 2012). According to Dr. Wong Lai Sum, CEO of MATRADE, the global market is a complex environment consisting of contractual, technical, legal, social, and political factors, and each country has its own rules and, in terms of its domestic legislation, is more often than not related to protectionism and the promotion of local firms and entities (Eng, 2012). It is therefore unavoidable that Malaysian companies will have to compete and understand their risks, especially when preparing to enter the overseas market (Eng, 2012). The challenge is to access and identify the process for efficient bidding and execution of projects in different markets to optimize market entry (Eng, 2012). Some firms may find that they prefer doing business locally rather than exporting because of these challenges (Eng, 2012).

RESEARCH METHODOLOGY

Qualitative approaches are the key methods used for this research. For this method, a semi-structured interview session will be held with Quantity Surveying consultant firms. By using the semi-structured interview method, the interviewer can further explore the particular themes of responses instead of solely asking the pre-determined set of open questions. The interview would be conducted face-to-face if possible or via online to comply with the current situation and SOP. The approach and data collection will be based on SWOT analysis to determine the challenges faced by the Consultant Quantity Surveyors in exporting the services.

DATA ANALYSIS

The data consists of 3 parts which are Section A, Section B, and Section C which is divided according to the research questions and objectives.

Section A: General Information (Question 1 – Question 12)
Section B: Understanding the challenges in exporting the services (Question 13 – Question 19)
Section C: Miscellaneous Questions related to the topic.

The interviews with all the selected respondents were carried out from March 2021 until April 2021. Four (4) of the interviews were done via zoom meeting and two reverts through writing by answering the pre-structured interview questions that were sent via email. Each online interview was recorded for reference purposes with the respondent's consent and took approximately forty (40) minutes to one (1) hour. The following analysis indicates the respondent's thoughts and opinions from the service exporter's perspective and also related opinions, especially from the Cambodian respondent. Findings from the collected data will be separated to answer the objectives of this research.

General Information of the Respondents

During the interview, the respondents were asked to answer the general information of their respective position in the company, years of experiences in the construction industry, professional recognition, years of experience in exporting Quantity Surveying services, the countries they have exported service and is there potential clients in the ASEAN countries. The data of the six respondents are tabulated as below.

Table 1. General Information of the Respondents

	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E	Respondent F
Position	Director	Director	Director	MD	QS	QS
Age	≥51	≥51	31 – 40	≥51	31 – 40	20 – 30
Working Experience	≥16	≥16	≥16	≥16	≤5	≤5
Professional Recognition	BQSM, RISM, FRICS, SISV, CIArb & AIQS	BQSM, RISM, RICS, AIQS	BQSM, RISM, RICS,	BQSM, FRISM, MRICS, FCIArb, MMIArb. MMSAdj, MIVMM, AACS, AMCCS	No	Nil
Ownership of Firm	Multi-National Company	Body Corporate	Body Corporate	Body Corporate	Partnership	Nil
Service Exporting Experience	≥16	11 – 15	≥16	≥16	≤5	Nil
Nature of Projects	Res, Bldg., Com, Inst, Ind, H&B D&I, CC&C, PA, LM	Res, Bldg., Com, Inst, H&B D&I, CC&C	Res, Bldg., Com, Inst, Ind, H&B CC&C, Rt	Res, Bldg., Com, Inst, Ind, H&B D&I, CC&C	Res	Res, Bldg., Com, Inst,

	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E	Respondent F
Current Involvement	Yes	Occasionally	Occasionally	Occasionally	Yes	Yes
1st International Project	1988	2007	2002	2007	2014	Nil
Country/s	TH, KH, VN, LA, MM, HK, CN BD, BN, SG, ID	KH, VN, LA, SA	TH, VN, CN, ID, IN	ID, DE, GB, MV	KH	VN, SG, CN, GB, KR
Quantity	A lot	5	≥10	4	4	Nil
Potential Market Identification	Yes	Limited	Limited	Yes	Yes	Nil

Abbreviations

Nature of Project		Countries			
Bldg.	Building	BD	Bangladesh	KR	Korea
Com	Commercial	BN	Brunei	LA	Laos
CC&C	Contract claim and Consultancy	KH	Cambodia	MV	Maldives
D&I	Dam and Irrigation	CN	China	MM	Myanmar
H&B	Highway and Bridges	DE	Germany	SA	Saudi Arabia
Ind	Industrial	GB	UK, England	SG	Singapore
Inst	Institutional	HK	Hong Kong	TH	Thailand
LM	Loan Monitoring	IN	India	VN	Vietnam
PA	Project Audit	ID	Indonesia		
Res	Residential				

The work position of the company was asked to know the extent of their expertise. It also indicates if they are professions that are eligible to answer the questionnaires. From here, we can see only Respondent A, B, C, and D are directors which firms that export services, and Respondent E, and F are Quantity Surveyors that are working with the firms that export services. The working experience of more than 16 years of Respondent A, B, C, and D. Respondent E and F are with less than 5 years of experience. As can be seen from Table 1, the average of the respondent has wide experience and knowledge regarding the discussed matter.

The Findings

Findings are divided into five parts; 1) the core challenges faced by Malaysian Consultant Quantity Surveyor in exporting services to ASEAN countries, 2) the weakness encountered when involved in exporting services to ASEAN countries, 3) the threat encountered when involved in exporting services to ASEAN countries, 4) the core strength in exporting services to ASEAN countries, 5) the opportunities available for successful entry to the ASEAN market. Table 2 indicates the summary of findings.

Table 2. Summary of Findings

Literature Review	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E	Respondent F
Challenges Contractual & Technical	√	√	√	√	-	-
Social	√ (Work culture & Language barrier)	√ (Work culture)	√ (Work culture & Language barrier)	√ (Work culture & Language barrier)	-	√ (Work culture & Language barrier)
Legal	√	-	√	√	-	√

Literature Review	Respondent A	Respondent B	Respondent C	Respondent D	Respondent E	Respondent F
Others	International Recognition, competition	International Recognition, job continuation	-	-	International Recognition	-
Strength Experience	√	√	√	√	-	-
Human Capacity	√	√ (Strong leadership)	√ (Strong team)	-	√ (Strong team)	√ (Strong team & Strong leadership)
Others	International Recognition & Partners	Latest technology	International Recognition Latest BIM software	Pulling the resources together (Consortium)	-	-
Weakness Firm Age	-	-	-	-	-	-
Firm Size	√	√	√	-	-	-
Financial Capacity	√	√	√	X	-	-
Others	Language.	Delegation of work to local staff. Continuation of work overseas.	Material knowledge. Work allocation & monitoring.	Resource pulling	Heavy workload for a lesser fee.	Language, culture & market price knowledge. Local Law & regulations.
Opportunity Global Mindset	√	√	-	-	-	-
Service Export Fund (SEF)	X	√	X	√	-	-
Others	Go through MATRADE. Joint venture with local firm	QS is still a new profession in developing countries	Consortium	Collaboration	-	Big developers need QS in developing countries.
Threat Global Competition	√ (Internationally fit)	√	√ (Opportunity)	√	√ (Opportunity)	√
Location Factors	√	√	√ (Market condition, labour, material price)	√ (Legal hurdles)	-	√ (Market condition, labour, material price)
Home Country	-	Less government support	-	-	-	-
Host Country	√ (Language, culture. Limitation on business ownership & QS not protected by BQSM)	√ (Language, culture)	√ (Language, culture)	√ (Language, culture)	-	√ (Language, culture)
Others	-	Less skills staff in the host country. Trust issue with host country partner.	Work permit.	Suspicion of the local players (professionals)	Less understanding of QS profession in host countries	-

DISCUSSION

Table 3. Summary Comparison of Literature Review and Findings

Category	Description	Likelihood	Reference
Challenges	A complex environment consisting of contractual, technical, legal, social, and political factors.	Respondent A, B, C, D, F	(Eng, 2012; Wong, 2012)
Strength			
i. Experience	Firms with more than one overseas project show that they develop a strong reputation through superior export results, rather than experience gained in contributing to another project.	Respondent A, B, C, D	(Lynn et al., 2016)
ii. Human Capacity	Employees who are professional and experienced.	Respondent A, C, E, F	(Lynn et al., 2016)
Weakness			
i. Firm Age	Is estimated from the foundation year of the organization as the normal logarithm of years.	-	(Wang et al., 2017)
ii. Firm Size	Higher levels of capital.	Respondent A, B, C	(Asmat-Nizam Abdul-Talib, Mohd Faisol Md Salleh, 2011)
iii. Financial Capacity	Own investments or internally generated funds, borrowings from friends or relatives, or informal lenders.	Respondent A, B, C	(Wong, 2012)
Opportunity			
i. Global Mindset	Mindful diversity across cultures and markets and ability to adapt quickly and accurately in the rapidly evolving internationalized world.	Respondent A, B	(Wong, 2012)
ii. SEF	Reimbursable grant and soft loan assistance to conduct activities to extend and enter the international market.	Respondent B, D	(www.matrade.gov.my, n.d.)
Threat			
i. Global Competition	Services or goods offered by competing firms that serve international customers.	Respondent A, B, C, D, E, F	(Study.com, n.d.)
ii. Location Factor	Costs, infrastructure, characteristics of labour, aspects of government and policy, political stability, economic factors such as market size and market growth, and cultural similarities.	Respondent A, B, C, D, F	(Abdul-Aziz et al., 2011; MacCarthy & Atthirawong, 2003; Wang et al., 2017)
iii. Home Country	Environmental conditions, domestic competition, home market size and growth, home country image, home country assistance, and political efforts to become members of the international community.	Respondent A, B	(Ling & Chan, 2008; Wang et al., 2017)
iv. Host Country	Size of the market, the social climate, including various rules, cultures, and customs, variations in language and regulations, trade barriers, incentives, ownership limitations, and laws or gaps in legal systems.	Respondent A, B, C, D, F	(Ling & Chan, 2008; Wang et al., 2017)

The objectives of the research are to identify the core challenges and threats faced by Malaysian Consultant Quantity Surveyor in exporting services to ASEAN countries mainly in Thailand, Cambodia, Vietnam, and Laos; to identify core strength of Malaysian Consultant Quantity Surveyor in exporting their services to ASEAN countries; and lastly to identify the weakness and reformation elements to be adopted by Malaysian Consultant Quantity Surveyor in order to compete with other developing countries and to recognize the opportunities available for successful entry to the ASEAN market. The relative relevance of the strengths, weaknesses, opportunities, and threats (SWOT's) associated with the objectives is examined in this part. Table 3 above highlights the comparison summary of the literature review and the findings.

Core Challenges and Threats Faced by Malaysian Consultant Quantity Surveyor in Exporting Their Services to ASEAN Countries

The Challenges in Exporting the Services

The challenges in exporting services from the literature review are the challenges in the global market usually in contractual, technical, social, legal factors, and each country would have its own rules and, in terms of its domestic legislation, is more often than not related to protectionism and the promotion of local firms and entities (Eng, 2012). From the study, it is understood that there are similarities between the literature review and the research.

The contractual issue is similar to the literature review by Dr. Wong Lai Sum, the CEO of MATRADE (Eng, 2012) where he highlighted it a common challenge in the global market. It is mentioned by most of the respondents that the practice of not having a standard form of contract would be the biggest challenge for Malaysian Consultant Quantity Surveyors where it has to be drafted and produced by the consultant. Developing countries such as Thailand, Cambodia, Vietnam, and Laos do not practice a standard form of measurement as well. It is the Quantity Surveyor's duty to include the measurement guide attached in the contract to indicate that the quantities are derived by certain guidelines. However, every country has its own rules of measurement, and that knowledge is very important for a Quantity Surveyor to obtain to produce a good contractual document.

Developing countries such as the Indochina countries are very active in construction especially in the infrastructure, dam, wastewater, bridges, and more. They not only require a Quantity Surveyor with vast knowledge in the traditional practices but also equipped with additional knowledge in mechanical and electrical knowledge to cater to the current need where is another challenge for the Malaysian Consultant Quantity Surveyor who mostly experts in traditional roles. This indicates that the findings are similar to the literature review where Dr. Wong Lai Sum, the CEO of MATRADE (Eng, 2012) where he highlighted that technical issue is one of the challenges in the global market.

Dr. Wong Lai Sum, the CEO of MATRADE (Eng, 2012) highlighted that social factor is one of the challenges in the global market in the literature review. This is very similar to the findings where the respondents mentioned that the working culture, language barrier in ASEAN countries mainly in Thailand, Cambodia, Vietnam, and Laos differs from what we practice here in Malaysia. More attention is given to the festival and prayers where the labours are allowed to take off due to these reasons. The regulations are also very precise in the working hour of the labours where they do not practice over time even if it an urgent work. As also mentioned by the respondents, the labours incentive is also one of the local regulations. Implementation of machinery for instance for excavation work is not recommended, this is to give more opportunities for local labour. IBS system that requires less labour could not be implemented in ASEAN countries; it is a challenge to emphasize the mechanical process of technology.

The law and regulations of any country will be a challenge for Malaysian Consultant Quantity Surveyor to export services. From the literature review by Dr. Wong Lai Sum, the CEO of MATRADE (Eng, 2012) that the law can be classified as a challenge in the global market. The findings showed similarities in the fact that the law of a country should abide by

at all costs when exporting services directly or by opening a branch office in the host country. The knowledge of the regulations such as the fire requirements also needs to be considered.

Language is also the law of any country; ASEAN country's first language is not English but their native languages. This is one of the challenges that the respondents mentioned during the interview session. The respondents opined that, any Malaysian Consultant Quantity Surveyor that would want to export their services to these countries to learn the local language not only to communicate with the local players but also to understand the contract where it will be either in dual language or two separate contracts. In any case of disputes or issues, the contract in the local language will be considered in the court.

Additionally, the findings highlight that most ASEAN countries do not recognize the term Quantity Surveyor. They are more prone to recognize Quantity Surveyors as Cost Engineer, Building Economist, Cost Manager, or even Construction Accountant. In some countries, they do not even understand the duties of a Quantity Surveyor where it is a big challenge for the Malaysian Consultant Quantity Surveyor to market or promote their services. Based on the respondent's comment, our local professional identification by the board is well not recognized in ASEAN countries hence the international organizations such as the Royal Institution of Chartered Surveyors (RICS) or Australian Institute of Quantity Surveyors (AIQS) are more welcomed. However, this is not stated in the literature review because the subject matter was mainly on the Engineering sector and not the Quantity Surveying sector.

Another challenge that was mentioned by the respondents is that a Malaysian Consultant Quantity Surveyor would encounter is the continuity of the job where a learning curb acquires a lot of money, time, and energy. In cases of non-repetition of job offers would be fruitless. According to the respondents, the first job offer is considered as an investment and the subsequent offers are the ones that can hit the profit-making margin. Moreover, the flexibility on the service provider who can be from any discipline or background not limited to Quantity Surveying opens a wide range of competitions, locally and internationally. This additional information is also not mentioned in the literature review, where it was by virtue of the respondent's own experience.

The Threat Encountered When Involved in Exporting Services

From the literature, we found that the global competition, location factor, home country, and host country to be the threat that Malaysian Consultant Quantity Surveyors encounter when involved in exporting services to ASEAN countries. Table 3 above clearly identifies the opinions of the respondents versus the literature reviews. Most of the factors are accepted by the respondents for instance almost all the respondents agree when it comes to global competition similar to the literature review, according to Study.com, a firm that operates successfully nationally does not necessarily could operate internationally well too. The respondents highlighted that the global market is considered as warfare where all the other international companies compete with the local service providers, international Quantity Surveyors, and investors. They also highlighted that Malaysian Consultant Quantity Surveyors need to seek harder and internationally fit to get the opportunity.

Similar to the literature review that international location factors such as costs, infrastructure, characteristics of labour, aspects of government and policy and political stability are factors of threat to exporting services by Abdul-Aziz et al. (2011) and Mac Carthy (2003), mostly agreed by the respondents that the location factor is also a big threat to Malaysian Consultant Quantity Surveyor when exporting services, where the law, market condition of the material price, labour wages, the transportation, logistic, import-export, working hour differs from Malaysia. It is a vast essential knowledge that every Malaysian Consultant Quantity Surveyor needs to be equipped with when involved in exporting services. Legal is an important factor to look into in any sort of service exportation because the law and regulations of a country need to be followed to operate legally. Without the market condition knowledge, the BQ can't be produced accurately where it can lead to future risks such as variation orders (VO) or disputes. Most of the respondents commented on this matter.

According to two of the respondents, the home country factor is considered a threat too where the Quantity Surveying profession is not protected by the board in the host country and also mentioned that the service exporters need more support from the government in areas such as financial support where there should be a mechanism where the local bank or government funding the initial expenditure of the firm with low-interest loan based on the letter of award with easy payment scheme similar to the literature as mentioned by Wang (2017) and Ling & Chan (2008) that home market environmental conditions, domestic competition, home market size and growth, home country image, home country assistance and political efforts to become members of the international community.

The threat in the host country in terms of language and culture is also a factor discussed by six of the respondents similar to the literature mentioned by Ling & Chan (2008) and Wang (2017) that the size of the market, the social climate, including various rules, cultures and customs, variations in language and regulations, trade barriers and fourth, incentives and the possibility of continued use of benefits, ownership limitations, and laws or gaps in legal systems. The respondents discussed that not knowing the culture in sense of work culture and language can be one of the threats when it comes to coordination of the labours and communications. The local language is the law in any ASEAN country, all the dealings and contracts would be in the local language and supported with English contact documents. In any case of disputes or any legal matters, only the contact in the local language will be accepted and presented in the court. The language proficiency will not only help to communicate with the client but also the contractors.

Additionally, the respondents opined that limitation on opening a firm in the host country where the ownership of a company should be more than 50% of the local partners. The application for the work permit is also a hustle because it takes a very long process. On the other hand, it is difficult to find skilled staff in these less developed countries with the Quantity Surveyor competencies where even the understanding of what the Quantity Surveying profession does is less.

Core Strength of Malaysian Consultant Quantity Surveyor in Exporting Their Services to ASEAN Countries

The Strength of Malaysian Consultant Quantity Surveyor in Exporting the Services

Experience and human capacity are identified as the core strength of Malaysian Consultant Quantity Surveyor in exporting services to ASEAN countries based on the literature review (Lynn et al., 2016). After the discussion with the respondents, they agree that the experience is the strength of the Malaysian Consultant Quantity Surveyor. Maturity of Quantity Surveying practices in Malaysia, our system of education, way of practices of Quantity Surveying, high competency level of Malaysian Quantity Surveyors, these are the trademarks of Malaysia as a market leader in providing Quantity Surveying services in the ASEAN region.

The respondents also agreed that acknowledged that human capacity is also a key strength similar to the literature by Lynn et al. (2016). They agree that with a strong team, the activity of exporting services is possible. A strong team with experienced Quantity Surveyor who has involved in almost all nature of business could handle and provide a good service to the clients.

Furthermore, the practices that we have in Malaysia help us to be more organized and systematic. With that capability, strong leadership skills, strong management command, and knowledge of how to manage the project within the timeline, the cost, and the quality.

International recognition such as being a member of the Royal Institute of Chartered Surveyors (RICS), or Australian Institute of Quantity Surveyors (AIQS) is an added strength to a Quantity Surveying firm to export their services. Most firms in Malaysia are advanced in technologies, the advancements in the measurement, the use of IT and BIM software are added strengths that we possess. These strengths allow us to outshine in the competitive market.

Weakness and Reformation Elements to Be Adopted and Opportunities Available

The Weakness Encountered in Exporting the Services

According to the findings from data analysis (Wang et al., 2017), there are three weaknesses identified in terms of firm age, firm size, and financial capacity. Surprisingly, all the respondents did not mention that firm age is considered as one of the weaknesses but agreed that the firm size to be one of the weaknesses contradicting the literature review. Wang et al (2017) mentioned that older firms have a better chance of survival than younger firms, however, this was not identified by all the respondents because it is considered irrelevant for the capability of the firm to export their services. The logarithm of years' operating in Malaysia does not certify a firm to be able to export their services successfully in the ASEAN market.

The respondent's response however, is slightly different in terms of the definition of firm size as in the literature review that mentioned the lack of funding and lack of knowledge serve as major obstacles to internationalization (Asmat-Nizam Abdul-Talib, Mohd Faisol Md Salleh, 2011). According to the respondent's opinion, firm size is closely related to the human capacity where it plays a major role as a service provider because the size of a consultant firm is the number of professionals and technical staff. Firms in Malaysia with 20 to 30 staff are considered medium however, it is not big enough, because the firms like Project Management firms or Construction Management firms or even Engineering firms in developing countries

consists of over 100 staff where they can provide Quantity Surveying services. In order to compete with these firms in the host country, Malaysian Consultant Quantity Surveyor firms should be of a certain size, however, most firms in Malaysia are considerably small. The respondents have also given a solution to counter this issue that is to collaborate either with the local firm in the host country or to form a consortium to bid the ASEAN market.

In addition, the respondent's viewpoint that the poor comprehension of the ASEAN country law, language, and market price knowledge is also a weakness of Malaysian Consultant Quantity Surveyor. Some respondents feel that our local staff are incompetent enough to handle overseas projects, especially the small firms where the directors would have to handle the projects themselves in dealing with clients where the local staffs can only assist on the groundwork such as technical support and documentation.

They also highlighted that monitoring and allocation of work with the host country staff is a hustle as well. This happens when firms helplessly rely on the local staff to handle day-to-day work while the Malaysian Consultant Quantity Surveyor only gets the opportunity to visit the site seldom or only when needed. These are the areas that need to be improved to equip for global competition.

The Opportunities Available in The ASEAN Market

Based on the literature review, having a global mindset opens up opportunity in the ASEAN market. Service Export Fund (SEF) by MATRADE also provides opportunities to Malaysian Consultant Quantity Surveyors to venture into the ASEAN market according to Wong (2012). After the discussion with the respondents, similarly, they agree that global mentality is related to the believes, behaviours, the experience of international work, and management education. The ability to understand the global economy by leaders with a global mindset who are mindful of the diversity across cultures and markets and able to adapt quickly and accurately in the rapidly evolving internationalized world.

In the context of SEF, the respondents strongly beliefs that it does provide opportunities to Malaysian Consultant Quantity Surveyor however, two of them disagrees. The respondents mentioned that MATRADE fair can be taken as a path to obtain opportunities in the ASEAN market hence the chances are quite slim.

Again, collaboration with the local industry players in the host countries and consortium provides more opportunities for the Malaysian Consultant Quantity Surveyor in venturing into the ASEAN market. According to a respondent from Cambodia, the big developers are seeking for Quantity Surveying service as it is a relatively a new profession there where currently undertaken by civil engineers, this is the best time to introduce the services and the application of a real Quantity Surveying profession in ASEAN countries to undertake the cost management of the project in developing countries.

The area of available opportunities is highlighted as in the infrastructure such as bridges, roads, connecting the villages, airports, courts, and hydroelectric dam. Affordable homes wastewater & sewerage treatment plant, water supply, and reservoir.

Reformation Elements To Be Adopted

According to the respondents, historically Malaysians should be quite well adaptable since the Quantity Surveying profession originated from the United Kingdom (UK). Malaysian Quantity Surveyors are trained through the core origination of Quantity Surveying, UK. Technically the Malaysian Quantity Surveying professionals should be well versed, however, over the years, it got too "Malaysianised" until it lost its international standard. Instead of going up, it has gone down to become very much to a domestic level. It is advised that Malaysian Quantity Surveyors get themselves to the international level of knowledge first. Familiarized with all the other forms of contracts, American AIA forms, the Singapore SIA forms, FIDIC, and also the UK new JCT forms. To be ready when the client requested to use a certain form of contract.

The attitude to change and adapt to whatever conditions as long as ways are found understanding the risk and manage to overcome the risk are elements to be adopted by Malaysian Consultant Quantity Surveyor. Further added that there is a need to change mindset when dealing with the local in host counties where the attitude and character of people in Thailand, Cambodia, Vietnam, and Laos. Based on history, Malaysia, Singapore, and Hong Kong have been colonized by the British, we have a system, we have a procedure on the discipline, cultivated by the British and we have Act. The process we are following, the Quantity Surveying system and ethics are based on the British legacy. Where else Thailand, Cambodia, Vietnam, and Laos have not been colonized by anyone, so they do not have a specific system. These are the factors to encounter adaptation is needed when working with no system countries.

According to Datuk Ir. Ahmad 'Asri Bin Abdul Hamid who is currently the Chairman of the Chief Executive Officer and Corporate Division of the Construction Industry Development Board (CIDB) (Jurutera, Eng, 2012), most of the consultant firms in Malaysia are sole proprietors which consist of Small and Mediums (SME) sized firms. The individual firms do not have the scale and resources to compete in the international market and most firms are generalists where they provide standard and basic services and are not quite specialized. The best mitigation to encounter this is through collaboration with a few consultant firms of the same nature of business for instance collaboration of Quantity Surveying firm, or to form a Multidisciplinary Practice (MDP) firms consisting of Quantity Surveying firm, Civil firms, Mechanical and Electrical Engineering and more to enter the international market as a consortium company.

According to Ling & Chan (2008), piggybacking on Malaysian clients or developers on project basis is also another way to venture. Joint ventures with the host country firms will provide more understanding of the law and regulations of the country, the work culture, language, and more. By having a host country partner, the Malaysian firms will peer to be local, and this will assist in competing with the local competition to secure continuous job opportunities.

CONCLUSION

There are three objectives in this dissertation, the first objective is to identify the core challenges and threats faced by Malaysian Consultant Quantity Surveyors in exporting

services to ASEAN countries mainly in Thailand, Cambodia, Vietnam, and Laos. In achieving this objective, the literature review is done, and through the interview process with the respondents from Malaysia, Thailand, and Cambodia. The findings of the literature review highlight contractual, technical, legal, social, protectionism of local firms and entities where similar challenges were mentioned by the respondents. Global competition, home, and host country's influences, and location factors are also the threats discussed in different angles in exporting services to ASEAN countries.

The second objective is to identify the core strengths of Malaysian Consultant Quantity Surveyors in exporting their services to ASEAN countries. This objective is achieved by the list of strengths of Malaysian Consultant Quantity Surveyors through literature review focusing on experience and human capacity. From the interview, the strengths are identified more than what was found from the literature review that is international recognition possessed, latest technology implications, and strong leadership skills.

Meanwhile for the third objective is to identify the weaknesses and reformation elements to be adopted by the Malaysian Consultant Quantity Surveyor to compete with other developing countries and to recognize the opportunities available for successful entry to the ASEAN market. There are three findings discovered, firm age, firm size, and financial capacity. On the contrary, firm age was not something mentioned through the interview hence, language proficiency, market knowledge, and work coordination were discussed. Service Export Fund (SEF) by MATRADE is found to be an opportunity to export services and collaboration with the local or international partners is also discussed as an achievement of the objective. The reformation element was highlighted by the respondents that are to possess an attitude to adopt and adapt to the changes is important to achieve the goal to be successful in exporting services in ASEAN countries.

In conclusion, the three objectives of this dissection have been achieved through qualitative research. The research aim is to analyse the challenges, strengths, weaknesses, opportunities, and threats to improving the gap of exporting local business of Consultant Quantity Surveyors to ASEAN countries mainly in Thailand, Cambodia, Vietnam, and Laos is also accomplished with the aid of the objectives.

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APPLICATION OF AGILE PROJECT MANAGEMENT AMONG CONSTRUCTION PRACTITIONERS IN THE MALAYSIAN CONSTRUCTION INDUSTRY

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Abstract
The agile project reflects, learns, and regularly adjusts throughout the project life cycle, promotes collaborative working, integrates planning with execution, and creates a working mindset that helps a team respond effectively to changing requirements. However, little research has been conducted regarding agile construction project management in the Malaysian context. Therefore, this preliminary study explores the application of agile practices by construction practitioners. Online questionnaire surveys were distributed to facilitate this study's data collection and analysis. Based on the total 210 returned responses received, a hypothesis test was conducted by using ANOVA and Tukey tests. The study hypothesized 70 agile practices among the senior manager, manager, and executive of the construction project-based companies. The result indicated statistically significant differences in the application of agile practices application according to the three main groups of designations. The analysis further revealed 16 and 11 agile practices statistically significant differences between executive with manager and senior manager groups, respectively, but only one agile practice statistically significant difference between manager and senior manager groups. It is worth noting that a significant gap exists in applying agile practices among construction practitioners, even though many agile practices are already being carried out by the industry practitioners who hold different designations in the construction project-based companies. More studies could be conducted to promote the application of agile practices to improve the construction productivity and project delivery performance.

Keywords: *Agile; Project management; Construction industry*

INTRODUCTION

As one of the world economy's largest sectors contributing 13 percent of the global GDP, construction has suffered from remarkably poor productivity relative to other sectors for decades (Barbosa et al., 2017). A variety of factors account for poor productivity: poor organization, inadequate communication, flawed performance management, contractual misunderstandings, missed connections, poor short-term planning, insufficient risk management, and limited talent management (Chang, Lee, Noh & Lee, 2021; Fateh & Sulaiman, 2021; Changali et al., 2015). The number of construction projects experiencing delay in the Malaysian construction industry due to poor project management during planning and implementation phases (Nor Aida, Syuhaida & Faizal, 2019). Construction companies are keen to advance their business performance and achieve sustainable competitive advantage in competitive markets. Hence, it is necessary to explore innovative management models that enhance their business capability. Agile project management (APM) has merits that could improve the construction companies' competency (kanbanize, 2022; KPMG, 2019; Ribeiro & Fernandes, 2010). However, very few construction companies are aware of APM (Albuquerque, Torres & Berssaneti 2020). Moreover, the total of research publications on APM specifically focused on the construction industry is limited (Albuquerque et al., 2020; Ribeiro & Fernandes, 2010).

Agile project management (APM) is becoming mainstream and a cutting-edge project management approach in fast competitive markets, with fast changing technologies, innovation-driven clients, and a high level of uncertainties (Ciric et al., 2018). APM has proven successful in increasing customer satisfaction and decreasing time and cost to market under uncertain conditions (Ribeiro & Fernandes, 2010). Key attributes of APM are transparency, customer focus, adaptability, a sense of ownership, and continuous improvement (kanbanize, 2021). Today, construction companies are surviving in an extremely competitive environment. They face more challenges such as market volatility, clients are demanding better deliverables but lower costs, shorter project delivery times, and changes to the project scope during construction (kanbanize, 2022; Ribeiro & Fernandes, 2010).

Ciric et al. (2018) discovered the benefits of APM in the construction industry. The benefits comprise a better understanding of project requirements, better collaboration between project stakeholders, higher effectiveness of project and team, fewer omissions and reworks, lesser project time and costs, and quickly switch between the construction sites teams (Olsson et al., 2015; Nowotarski & Paslawski, 2015; Chen et al., 2007; Tomek & Kalinichuk, 2015; Owen et al., 2006; Demir & Theis, 2016). Ribeiro et al. (2010) stressed that the five most important APM enablers in the construction industry were identified: people, organizational culture, collaborative work with project key stakeholders, organizational structure, and technology. An agile construction project environment requires multidisciplinary project teams formed with the most skilled, empowered and highly motivated people. Frequent and short meetings with all project stakeholders can help to increase efficiency. A simpler and more flexible organizational structure with few interconnected departments that facilitate interaction, cooperation, and communication. Construction companies need to boost speed to response to the prevalent project environment by being more adaptive to the clients' requirements. The involvement of key project stakeholders from the early project phase would expedite the project delivery. Technology is a tool to help project members to interact with each other, and to collect, store, retrieve and transfer project information (Subramaniam, Ismail, Rani & Saleh, 2021).

The aim of this paper is to explore the application of agile practices in the Malaysian construction industry as very little research has been carried out into this topic. This paper is organized by describing the importance of the construction industry and agile project management, and the main objective of this research. This is followed by a description of the Agile Manifesto, and agile practices in the construction industry. The research processes and the design of an online questionnaire survey will also be explained. The major findings of the online survey will be presented and discussed, and lastly, the conclusions of this study.

LITERATURE REVIEW

The Agile Manifesto and Agile Project Management

The origin of today's agile development could be tracked to the Agile Manifesto, which was originally cultivated in February 2001, at Snowbird ski resort in Utah. The Agile Manifesto consists of 4 value statements (SCRUMstudy, 2017; Fowler & Highsmith, 2001):

"We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:
Individuals and interactions over processes and tools;
Working software over comprehensive documentation;
Customer collaboration over contract negotiation;
Responding to change over following a plan;
That is, while there is value in the items on the right, we value the items on the left more."

The 4 value statements are supported by 12 principles of the Agile Manifesto which are (1) satisfy the customer: deliver project to the client as consistently and regularly as possible, (2) welcome change: utilise and determine change to enhance client's competitive advantage by delivering project requirements progressively, (3) deliver frequently: fast feedback-cycles to adapt changes by delivering project deliverables frequently, (4) work together: create a collaborative project environment by working together closely among the customers, stakeholders and team, (5) trust and support: empowered and motivated project people are normally to be more productive and committed, (6) face to face conversation: short, regular feedback cycles are crucial in a dynamic project environment especially through face-to-face communication, (7) practical completion: the ultimate goal of agile project is to deliver value to the client in short time cycle continuously, (8) sustainable development: maintain a delivery performance pace to avoid project people burning out, or experiencing over dense, (9) continuous attention: apply excellent technical design from the outset, to avoid any costly lesson learned, (10) maintain simplicity: concentrate on developing a solution that meets the project requirements and specification, (11) self-organizing teams: project teams know the project details very well to drive the project delivery (12) reflect and adjust: identify good practices and lesson learned throughout the project life cycle to avoid repeating same mistakes (Ciric et al., 2018; Measey, 2015; Fowler & Highsmith, 2001).

The Agile Manifesto is the statement of principles that support agile software development, agile methodologies and agile project management (Cobb, 2011). Therefore, it is generally accepted that APM has emerged from principles and values expressed in the Agile Manifesto (Ciric et al., 2018), and no discussion of APM would be complete without a discussion of the Agile Manifesto (White, 2014). Generally, APM can be defined as the work of energizing, empowering, and enabling project teams to rapidly and reliably deliver business value by engaging customers and continuously learning and adapting to their changing needs and environments (Augustine, 2005). The Project Management Institute's Agile Certified Practitioner (PMI-ACP) is the fastest growing certification. The PMI-ACP certification recognizes the need for a specialist role in agile project management to apply agile practices on specific project situations including construction projects. The PMI-ACP examination content outline is adopted for this research. It organizes the industry practitioners do when working in an agile environment into seven domains include: (1) agile principles and mindset, (2) value-driven delivery, (3) stakeholder engagement, (4) team performance, (5) adaptive planning, (6) problem detection and resolution, and (7) continuous improvement (PMI, 2014).

Agile Practices in The Construction Industry

During initiation and planning phases, client's involvement will lead to well-defined project requirements and specifications, and subsequently the accuracy of the project deliverables. Project stakeholders can provide continuous feedback to ensure higher

productivity, transparency, and lesser errors during this phase. This practice improves collaboration and removes unnecessary stress and workload from the team. Ultimately, agile practices will lead to a faster and shorter development programme, lesser mistakes or revisions, and greater client satisfaction. APM creates a set of roles, namely product owner, scrum master, and the development team, to administer the development of a project. In construction project management, the consultant team or main contractor is the scrum master, coordinating work and ensuring the team is committed to the designated activities. The product owner is responsible to prioritize the key construction work elements, making critical decisions and assigning activities to be completed aligned with the project objectives. A product owner can be the project manager or employer representative in construction. The team is merely the sub-contractors, installers or suppliers responsible for the physical implementation of the confirmed user stories or specifications or the project's scope (nTask, 2020; digital.ai, 2013; Klein, 2009).

During the execution phase, some agile practices to manage a construction project will help for continual improvement and simplify the process to complete faster, diminishing harmful errors. Moreover, the team can plan, implement, adjust, and monitor decisions sooner, leading towards cost reduction in terms of materials, resources, and overtime, better coordination with minimum argument, fewer projects overrun, and happier clients who are well-informed and involved in the process of project development (Loizou, 2021). A weekly construction work programme is like a sprint in the agile framework. It is an efficient means to begin any construction project by allocating the construction work programme into sprints with identified backlogs. It is related to the construction work activities that need to be completed within a certain limiting cycle time. It facilitates activities planning and prioritization, progress measuring and monitoring, with continual improvement for future implementation. The weekly construction work programme is similar to daily stand-up meetings and site inspection with client, which is important for contractors and sub-contractors to seek feedback simultaneously. User stories in agile can be synonymous with work packages in for measuring project completion, which can be further represented through a burndown or burnup chart, resembling the s-curve reporting in the construction industry (nTask, 2020; digital.ai, 2013; Smith, 2011).

RESEARCH METHODOLOGY

This preliminary research was based on a survey conducted using an online questionnaire. It was achieved through the following processes:

1) Population and The Sample of Respondents

The data collection exercises were held in Malaysia from July 2020 until October 2021. Stratified random sampling was used for this study as stratified sampling involves a stratum or a subset group of the target population wherein the members possess one or more common attributes. A nine-page structured questionnaire was distributed to the four target groups: developers, consultants, contractors, and suppliers through LinkedIn professional networking.

2) Questionnaire Design

This is exploratory research as a questionnaire is designed to explore the application of agile practices by Malaysian construction practitioners. Following a thorough literature search, 70 agile practices were consolidated. All these practices were then assembled into a questionnaire distributed to the construction practitioners. The respondents were required to identify, from the list to what extent they agreed to the application of agile practices in the Malaysian construction industry by responding on a five-point Likert rating scale was 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The survey instrument was divided into two main sections. The first main section comprises seventy questions on agile practices for respondents to rate the level of agreement based on construction projects completed lately or ongoing construction projects. The second section contains seven questions about the respondents' demographic information to ensure they are the targeted respondents for the research.

3) Data Analysis and Interpretation

The collected data were analysed and interpreted using quantitative analysis, in which both descriptive and inferential statistics would be used typically to draw generalization. ANOVA, which stands for Analysis of Variance, is a statistical test used to analyse the difference between the means of more than two groups. Use a one-way ANOVA when the collected data about independent and dependent variables. The independent variables should have at least three levels or three different groups or categories. The null hypothesis (H_0) of ANOVA is no difference among group means. The alternate hypothesis (H_a) is that at least one group differs significantly from the overall mean of the dependent variables (Bevans, 2021).

ANOVA determines whether the groups created by the independent variable levels are statistically different by calculating whether the means of the levels are different from the overall mean of the dependent variable. If any of the group means is significantly different from the overall mean, then the null hypothesis is rejected (Bevans, 2021). The 70 agile practices are regarded as ordinal dependent variables for this research. The three independent variables are senior manager, manager, and executive which are nominal variables. The answer from managing director and general manager were not being considered for analysis as the responses were less than 30. This is because the central limit theorem (CLT) states that the distribution of samples means approximates a normal distribution as the sample size gets bigger, regardless of the population's distribution. Sample sizes equal to or greater than 30 are often considered sufficient for the CLT to hold (Ganti, 2021).

RESULTS AND DISCUSSION

The online questionnaire was sent out to construction practitioners through LinkedIn. Only 210 respondents out of approximately 1335 construction practitioners or 15.7% answered the online questionnaire. The respondents were mainly from the companies having nature of business as contractors (102 or 48.57%), then followed by consultants (50 or 23.81%), developers (35 or 16.67%) and suppliers (23 or 10.95%). At the same time, they are holding certain designation in the companies as managing director (8 or 3.81%), general

manager (8 or 3.81%), senior manager (36 or 17.14%), manager (45 or 21.43%) and executive (113 or 53.81%). Table 1 summaries the respondents' demographics.

Table 1. Respondents' Demographics

Descriptions	Number of Respondents	Percentage
Nature of Company Business		
Construction business	102	48.57
Construction material, plant & equipment merchant	23	10.95
Consultancy	50	23.81
Property development	35	16.67
Profession		
Architecture	18	8.57
Engineering	42	20.00
Quantity Surveying	86	40.95
Project Management	45	21.43
Interior Design	13	6.19
Others	6	2.86
Construction Industry Working Experience		
Less than 2 years	52	24.76
2 – 5 years	49	23.33
6 – 10 years	44	20.95
11 – 20 years	43	20.48
More than 20 years	22	10.48
Designation		
Managing Director	8	3.81
General Manager	8	3.81
Senior Manager	36	17.14
Manager	45	21.43
Executive	113	53.81
Types of Projects Involved Mostly		
Commercial	64	30.48
Industrial	19	9.05
Infrastructure	46	21.90
Residential	64	30.48
Renovation	15	7.14
Others	2	0.95

Hypothesis Test: Application of Agile Practices in Construction Industry

Null hypothesis, P_{no}: There is no significant difference in agile practices (P_n) between the respondents who hold the designation of senior manager, manager, and executive.

Alternative hypothesis, P_{na}: There is significant difference in agile practices (P_n) between the respondents who hold the designation of senior manager, manager, and executive.

There are statistically significant differences found on 28 agile practices applications according to the senior manager, manager, and executive designations in the Malaysian construction, as shown in Table 2 below. The five agile practices that are statistically significantly higher are P_{59}, P_{58}, P_{57}, P_{55} and P_{53}; and the five statistically significantly lower are P_{70}, P_{45}, P_{41}, P_{40} and P_{12}. However, ANOVA will tell if there are differences among the levels of the groups, but not which differences are significant. To determine how the agreement levels differ from one group to another, Tukey post-hoc test needs to be performed. The Tukey post hoc test is generally preferred test for conducting post hoc tests on a one-way ANOVA (Laerd Statistics, 2021).

Table 2. Analysis of Variance (ANOVA) – Agile Domains and Practices

Agile Domains and Practices (P_n)	F	Sig.
Agile principles and mindset		
Deliver project progressively (by stage) (P_1)	0.812	0.445
Deliver project early (P_2)	0.659	0.518
Work closely with the key stakeholders (P_3)	0.907	0.406
Take advantage of changes in the project (P_4)	0.421	0.657
Support the delivery of project with shorter timescale (P_5)	1.328	0.268
Support the good technical design allowing for future changes in the project (P_6)	1.373	0.256
Communicate more often via face to face as compared to phone call or email (P_7)	0.960	0.385
Measure project progress via actual work done (P_8)	0.346	0.708
Maintain the project performance until completion (P_9)	4.311	0.015
Practise simplicity (P_{10})	0.511	0.601
Practise autonomy (P_{11})	0.155	0.856
Reflect regularly and adjust behavior accordingly (P_{12})	3.060	0.049
Support team members in getting their job done (P_{13})	2.929	0.056
Value-driven delivery		
Identify project deliverables progressively (P_{14})	2.067	0.129
Gain consensus on project acceptance criteria just-in-time (P_{15})	0.587	0.557
Tailor processes based on team experience (P_{16})	1.744	0.178
Tailor processes based on project characteristics (P_{17})	2.148	0.120
Tailor processes based on organizational characteristic (P_{18})	1.440	0.239
Follow the sequence of work (P_{19})	0.440	0.645
Limit the cycle time (P_{20})	0.436	0.647
Solicit client feedback (P_{21})	0.230	0.795
Prioritize project work through stakeholders' collaboration (P_{22})	1.784	0.171
Balance both project delivery and risk reduction works (P_{23})	1.995	0.139
Reprioritize requirements to reflect project environment changes (P_{24})	2.391	0.094
Reprioritize requirements to reflect project stakeholder needs changes (P_{25})	3.668	0.027
Conduct frequent inspections (P_{26})	5.910	0.003
Conduct frequent testing's (P_{27})	4.944	0.008
Stakeholder engagement		
Engage with project stakeholders regularly (P_{28})	0.792	0.454
Share project information frequently with all stakeholders (P_{29})	1.166	0.314
Sign contract agreement for all project involvement (P_{30})	4.352	0.014
Assess project changes to maintain stakeholder involvement (P_{31})	1.678	0.189
Promote collaborative decision making (P_{32})	2.704	0.070
Promote collaborative conflict resolution (P_{33})	4.795	0.009
Share project vision (P_{34})	5.202	0.006
Share project success criteria (P_{35})	3.251	0.041
Make project status transparent for stakeholders' decision making (P_{36})	1.425	0.243
Provide forecasts for stakeholders' planning (P_{37})	1.243	0.291
Team performance		
Develop ground rules with project members (P_{38})	3.822	0.024
Develop project members' interpersonal skills (P_{39})	2.145	0.120
Develop project members' technical skills (P_{40})	3.041	0.050
Encourage project members to become generalized specialists (P_{41})	3.074	0.049
Encourage emergent leadership (P_{42})	2.453	0.089
Understand the factors that motivate and demotivate project members (P_{43})	1.488	0.228
Encourage communication via co-location (P_{44})	1.007	0.367
Encourage communication via collaboration tools (P_{45})	3.119	0.046

Agile Domains and Practices (P_n)	F	Sig.
Reduce distractions among project members (P_{46})	5.370	0.005
Measure project team performance (P_{47})	5.110	0.007
Adaptive planning		
Do planning at multiple project stages (P_{48})	5.474	0.005
Make planning transparent (P_{49})	2.415	0.092
Increase commitments as the project progresses (P_{50})	5.105	0.007
Adjust planning rate based on project characteristics (P_{51})	0.150	0.861
Adjust planning rate based on project performance (P_{52})	4.413	0.013
Adjust project plan to reflect project changes (P_{53})	6.621	0.002
Size project elements progressively (P_{54})	2.557	0.080
Adjust capacity planning based on actual site progress (P_{55})	6.696	0.002
Create rough estimates at the beginning of project (P_{56})	2.476	0.087
Refine estimates as the project progresses (P_{57})	7.975	0.000
Evaluate the estimates for the remaining project work based on project data (P_{58})	11.322	0.000
Continuous improvement		
Perform project reviews frequently (P_{59})	8.584	0.000
Seek feedback via progressive project delivery (P_{60})	2.294	0.104
Seek feedback via site mock-up (P_{61})	2.403	0.093
Create a project environment of continuous learning (P_{62})	1.590	0.207
Reduce waste via process improvement (P_{63})	1.683	0.189
Share good practices across projects (P_{64})	4.853	0.009
Share lesson learnt across projects to avoid recurrence identified problems (P_{65})	3.654	0.028
Problem detection and resolution		
Create an open environment to reveal project problems (P_{66})	4.220	0.016
Engage project members in resolving project issues (P_{67})	2.869	0.059
Resolve issues with the assistance from pertinent project members (P_{68})	3.355	0.037
Maintain a visible list of project issues to track ownership (P_{69})	2.308	0.102
Maintain a visible list of project issues to communicate resolution status (P_{70})	3.067	0.049

The Tukey post hoc test runs pairwise comparisons among each of the groups. It uses a conservative error estimate to find the groups that are statistically different from one another on the application of agile practices in the Malaysian construction industry. As indicated in Table 3, the Tukey post hoc test revealed that: -

(i) significant pairwise differences between executive and manager groups for 16 agile practices are P_9, P_{25}, P_{26}, P_{27}, P_{34}, P_{46}, P_{48}, P_{52}, P_{53}, P_{55}, P_{57}, P_{58}, P_{59}, P_{64}, P_{65}, and P_{66}.
(ii) significant pairwise differences between executive and senior manager groups for 11 agile practices are P30, P33, P46, P47, P50, P53, P55, P57, P58, P59, and P64.
(iii) significant pairwise differences between manager and senior manager groups for only one agile practice, which is P_{12}.

Interestingly, the analysis revealed more agile practices statistically significant differences between executive and manager groups, and between executive and senior manager groups. However, only one agile practice statistically significant difference is found between manager and senior manager groups. It is apparent that the significant differences can be found between the executive level and manager level in applying the agile practices for construction projects in Malaysian context. This probably related to the degree of authority, experience, expertise, and project information accessible are higher for manager level compared to those executive level.

Table 3. Multiple Comparisons – Tukey HSD

Dependent Variable	(I) Designation	(J) Designation	Mean Difference (I-J)	Std. Error	Sig.
Maintain the project performance until completion (P_9)	Sr Mgr.	Mgr.	.25556	.18521	.354
		Exec.	-.17060	.15852	.530
	Mgr.	Sr Mgr.	-.25556	.18521	.354
		Exec.	-.42616*	.14600	.011
	Exec.	Sr Mgr.	.17060	.15852	.530
		Mgr.	.42616*	.14600	.011
Reflect regularly and adjust behavior accordingly (P_{12})	Sr Mgr.	Mgr.	.45556*	.18424	.038
		Exec.	.26303	.15769	.220
	Mgr.	Sr Mgr.	-.45556*	.18424	.038
		Exec.	-.19253	.14524	.383
	Exec.	Sr Mgr.	-.26303	.15769	.220
		Mgr.	.19253	.14524	.383
Reprioritize requirements regularly to reflect changes on project stakeholder needs (P_{25})	Sr Mgr.	Mgr.	.19444	.19188	.569
		Exec.	-.20575	.16423	.424
	Mgr.	Sr Mgr.	-.19444	.19188	.569
		Exec.	-.40020*	.15126	.024
	Exec.	Sr Mgr.	.20575	.16423	.424
		Mgr.	.40020*	.15126	.024
Conduct frequent inspections (P_{26})	Sr Mgr.	Mgr.	.24444	.18026	.366
		Exec.	-.23500	.15429	.282
	Mgr.	Sr Mgr.	-.24444	.18026	.366
		Exec.	-.47945*	.14210	.003
	Exec.	Sr Mgr.	.23500	.15429	.282
		Mgr.	.47945*	.14210	.003
Conduct frequent testings (P_{27})	Sr Mgr.	Mgr.	.31667	.18845	.215
		Exec.	-.15020	.16129	.621
	Mgr.	Sr Mgr.	-.31667	.18845	.215
		Exec.	-.46686*	.14856	.005
	Exec.	Sr Mgr.	.15020	.16129	.621
		Mgr.	.46686*	.14856	.005
Sign contract agreement for all project involvement (P_{30})	Sr Mgr.	Mgr.	-.04444	.17261	.964
		Exec.	-.35497*	.14773	.045
	Mgr.	Sr Mgr.	.04444	.17261	.964
		Exec.	-.31052	.13607	.061
	Exec.	Sr Mgr.	.35497*	.14773	.045
		Mgr.	.31052	.13607	.061
Promote collaborative conflict resolution (P_{33})	Sr Mgr.	Mgr.	-.10556	.16361	.795
		Exec.	-.38127*	.14003	.019
	Mgr.	Sr Mgr.	.10556	.16361	.795
		Exec.	-.27571	.12897	.085
	Exec.	Sr Mgr.	.38127*	.14003	.019
		Mgr.	.27571	.12897	.085
Share project vision (P_{34})	Sr Mgr.	Mgr.	.10000	.17185	.830
		Exec.	-.29941	.14708	.107
	Mgr.	Sr Mgr.	-.10000	.17185	.830
		Exec.	-.39941*	.13547	.010
	Exec.	Sr Mgr.	.29941	.14708	.107
		Mgr.	.39941*	.13547	.010
Reduce distractions among project members (P_{46})	Sr Mgr.	Mgr.	.03333	.19305	.984
		Exec.	-.39282*	.16523	.048
	Mgr.	Sr Mgr.	-.03333	.19305	.984
		Exec.	-.42616*	.15219	.015
	Exec.	Sr Mgr.	.39282*	.16523	.048
		Mgr.	.42616*	.15219	.015
Measure project team performance (P_{47})	Sr Mgr.	Mgr.	-.20000	.17590	.493
		Exec.	-.45329*	.15055	.008
	Mgr.	Sr Mgr.	.20000	.17590	.493
		Exec.	-.25329	.13866	.164
	Exec.	Sr Mgr.	.45329*	.15055	.008
		Mgr.	.25329	.13866	.164
Do planning at multiple project stages (P_{48})	Sr Mgr.	Mgr.	.13889	.19056	.747
		Exec.	-.32325	.16310	.119
	Mgr.	Sr Mgr.	-.13889	.19056	.747
		Exec.	-.46214*	.15022	.007
	Exec.	Sr Mgr.	.32325	.16310	.119
		Mgr.	.46214*	.15022	.007

Dependent Variable	(I) Designation	(J) Designation	Mean Difference (I-J)	Std. Error	Sig.
Increase commitments as the project progresses (P_{50})	Sr Mgr.	Mgr.	-.18889	.18450	.563
		Exec.	-.46853*	.15791	.009
	Mgr.	Sr Mgr.	.18889	.18450	.563
		Exec.	-.27965	.14545	.135
	Exec.	Sr Mgr.	.46853*	.15791	.009
		Mgr.	.27965	.14545	.135
Adjust planning rate based on project performance (P_{52})	Sr Mgr.	Mgr.	-.01111	.16791	.998
		Exec.	-.33088	.14371	.058
	Mgr.	Sr Mgr.	.01111	.16791	.998
		Exec.	-.31976*	.13237	.044
	Exec.	Sr Mgr.	.33088	.14371	.058
		Mgr.	.31976*	.13237	.044
Adjust project plan to reflect project changes (P_{53})	Sr Mgr.	Mgr.	-.06667	.16715	.916
		Exec.	-.43068*	.14306	.008
	Mgr.	Sr Mgr.	.06667	.16715	.916
		Exec.	-.36401*	.13177	.017
	Exec.	Sr Mgr.	.43068*	.14306	.008
		Mgr.	.36401*	.13177	.017
Adjust capacity planning based on actual site progress (P_{55})	Sr Mgr.	Mgr.	.07778	.16784	.888
		Exec.	-.35349*	.14365	.039
	Mgr.	Sr Mgr.	-.07778	.16784	.888
		Exec.	-.43127*	.13231	.004
	Exec.	Sr Mgr.	.35349*	.14365	.039
		Mgr.	.43127*	.13231	.004
Refine estimates as the project progresses (P_{57})	Sr Mgr.	Mgr.	-.05556	.15872	.935
		Exec.	-.44199*	.13585	.004
	Mgr.	Sr Mgr.	.05556	.15872	.935
		Exec.	-.38643*	.12512	.007
	Exec.	Sr Mgr.	.44199*	.13585	.004
		Mgr.	.38643*	.12512	.007
Evaluate the estimates for the remaining project work based on project data (P_{58})	Sr Mgr.	Mgr.	-.04444	.17001	.963
		Exec.	-.55064*	.14551	.001
	Mgr.	Sr Mgr.	.04444	.17001	.963
		Exec.	-.50619*	.13402	.001
	Exec.	Sr Mgr.	.55064*	.14551	.001
		Mgr.	.50619*	.13402	.001
Perform project reviews frequently (P_{59})	Sr Mgr.	Mgr.	.16111	.17381	.624
		Exec.	-.36750*	.14876	.038
	Mgr.	Sr Mgr.	-.16111	.17381	.624
		Exec.	-.52861*	.13702	.000
	Exec.	Sr Mgr.	.36750*	.14876	.038
		Mgr.	.52861*	.13702	.000
Share good practices across projects (P_{64})	Sr Mgr.	Mgr.	-.00556	.17410	.999
		Exec.	-.35619*	.14901	.047
	Mgr.	Sr Mgr.	.00556	.17410	.999
		Exec.	-.35064*	.13724	.031
	Exec.	Sr Mgr.	.35619*	.14901	.047
		Mgr.	.35064*	.13724	.031
Share lesson learnt across projects to avoid recurrence identified problems (P_{65})	Sr Mgr.	Mgr.	.05556	.19154	.955
		Exec.	-.30433	.16393	.154
	Mgr.	Sr Mgr.	-.05556	.19154	.955
		Exec.	-.35988*	.15099	.047
	Exec.	Sr Mgr.	.30433	.16393	.154
		Mgr.	.35988*	.15099	.047
Create an open environment to reveal project problems (P_{66})	Sr Mgr.	Mgr.	.09444	.17824	.857
		Exec.	-.27901	.15255	.163
	Mgr.	Sr Mgr.	-.09444	.17824	.857
		Exec.	-.37345*	.14051	.023
	Exec.	Sr Mgr.	.27901	.15255	.163
		Mgr.	.37345*	.14051	.023

CONCLUSION

This preliminary study explores the application of agile practices by the Malaysian construction practitioners. A hypothesis test was conducted based on the total 210 returned responses received. The study hypothesized 70 agile practices between the respondents who hold the designation of senior manager, manager, and executive in the construction industry. The result indicated statistically significant differences in the application of agile practices according to the three main groups of designations. The analysis further revealed more agile practices statistically significant differences between executive and manager groups compared with executive and senior manager groups. However, the least agile practices statistically significant differences are found between manager and senior manager groups. It is worth noting that a significant gap exists in applying agile practices among construction practitioners. This is proven by the responses from the executive group on agile practices application in the construction project that is significantly different with the manager and senior manager, respectively. Evidently, many of the agile practices are already being carried out by the construction industry practitioners who hold difference designations in their companies. More studies could be conducted to promote the application of agile practices to improve the construction productivity and project delivery performance.

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EMPLOYEE WILLINGNESS TO CHANGE TOWARDS THE IMPLEMENTATION OF SMART CONTRACT

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Abstract
Smart contract is one of the latest technologies in the construction industry, which can substitute the traditional contracting method. With an increasing shift towards adopting and implementing this technology into construction projects, it is essential to realize how smart contracts can be used for organizational advantages. However, the implementation of Smart Contract poses challenges, particularly among construction employees. Therefore, this paper tends to identify the resistance factors in embracing changes among construction employees and determine the factors that influence the employee willingness to implement smart construction contracts in Malaysia. The quantitative method was adopted by distributing 120 questionnaire surveys to Malaysia's construction backgrounds. A total of 60 respondents' feedback has been received. Data collected are analysed using reliability, descriptive, one-way ANOVA, and correlation analysis. The findings show that most of the respondents agree that the factors such as employee behaviour, demographics, psychology, social and culture impact employee resistance towards change. Furthermore, the finding also illustrates that all respondents strongly agreed to the factors that influence employee willingness to change towards implementing Smart Contract. The factors influencing employee willingness to change are leadership, communication and collaboration, self-efficacy, personal valence, investment, and employee engagement. In supposition, construction organization has realized the factors that influence employee resistance to change as well as the factors that can be practised to implement Smart Contract.

Keywords: *Smart Contract; Employee Behaviour; Resistance to change; willingness to change*

INTRODUCTION

The construction industry is one of the industries that play a crucial role in developing and enhancing the economy and developing one's own country. The construction industry has a duty and responsibility to establish the quality of life of today's advancement and the ambition of today's wealth are in the future (Dwikojuliardi, 2015). It is undoubtedly fair that the construction sector is favourably linked to the success of any economy. It can be described as some persuasion of the economic engine for improving and developing economies. The construction sector plays a substantial role in the production of wealth and improving the nation's quality of life, which is vital for the nation's development. It also correlates to the emergence of massive employment in the economy (Khan, Liew & Ghazali, 2014).

Aside from being a significant contribution to a country's economic development, the construction sector is becoming complex, leading to demand, design complexity, a broader spectrum of stakeholder participation, and Industrial Revolution 4.0 (IR 4.0). As a result, construction projects are represented by a substantial degree of complexity, ambiguity, exclusiveness, uncertainty and interdependency (Mazur et al., 2014). Moreover, due to the complexity of the social and environmental conditions imposed on such projects, participants' perceptions and actions might influence the project's performance (Wu et al., 2017). Fortunately, with technological advancement, the construction industry possesses even more potential to grow.

In the construction industry itself, the advancement of technology is unavoidable and should be embraced. Similar to other industries such as manufacturing, the construction industry's performance can be amplified via IR 4.0 (Alaloul et al., 2018). The adoption of IR 4.0 creates an environment in which all mechanized automation will be integrated via technology improvements to operate and communicate information without human intervention, increasing efficiency (Alaloul et al., 2020). However, these adaptations of technological advancement are not without challenges. Although with the aid of technology, circumstances such as payment issues will lead to unfavourable outcomes such as project delays, higher expenses, poor performance, conflicts, and bankruptcies, all of which might jeopardize project success (Ahmadisheykhsarmast & Sonmez, 2020). Improper payment procedures not only have a negative influence on most project stakeholders' financial status, but they may also significantly undermine relationships between partners on specific occasions (Manu et al., 2015).

Nevertheless, current advancements in blockchain technology have resulted in the emergence of smart contracts as a unique mechanism for automating the fulfilment of contract conditions. (Ahmadisheykhsarmast & Sonmez, 2020). A smart contract is a computerized machine that is automated via executable code that operates on the blockchain. Smart contracts possess authority over actual or digital resources based on the conditions of the agreement (Raskin, 2017). In addition, smart contracts can have more confidentiality than traditional signed paper contracts (digital archiving), can be modified (flexible) throughout the project and are easier to manage (diminished transaction costs) in comparison to current contracting practices (Fox, 2016). A recent study has addressed the capabilities of smart contracts for contract management, especially their efficiency to secure payments (Liu et al., 2019).

Apart from that, "change" has become regular and widespread in most organizations but is often resisted by employees leading to confrontation and decreased organizational efficiency. Therefore, the capacity of any management to optimize the benefits of change relies partly on how efficiently it establishes and maintains an environment that minimizes resistant conduct and promotes acceptance and support (Coetsee, 1999). Therefore, for construction players to continue adopting the latest technology, they must understand the effect of resistance to change among employees, which can become a significant problem in embracing the change.

PROBLEM STATEMENT

Technology is rapidly evolving, and it is very complicated to maintain the latest technological developments and be consistently aware of them. Technology is constantly changing, and corporations will constantly enhance their ability to perform tasks faster, better and cheaper all the time (Singh, 2015). The discovery of smart contracts announced the beginning of the blockchain 2.0 era, in which contract provisions may be executed on the blockchain via automated computerized procedures. Szabo first introduced the notion of incorporating contractual provisions into software as computerized transaction protocols. (Ahmadisheykhsarmast & Sonmez, 2020). Smart contracts, in addition to the features of blockchain, offer a secure and reliable service for the automated operation of contract clauses without the need for a trusted intermediary such as lawyers or banks, leading to lower

transaction fees, lower administrative costs, and faster transaction durations (Fanning & Centers, 2016).

It is crucial to understand that their terms are encoded in a computer algorithm related to smart contracts. This smart contract can be legally acknowledged if it meets the legal requirements. The Contracts Act 1950 is the essential reference for smart contracts in Malaysia. It is possible to argue that the Contracts Act of 1950 is only appropriate for traditional contracts. Regardless of how inventive a smart contract is, it must meet several essential requirements to be legitimate and lawful. Smart contracts are faster than traditional contracts because they can safeguard and record all transactions from automated execution through contract settlement (Zain et al., 2019). However, Beer and Nohria (2000) mentioned that change occurs rapidly than most workers are concerned with change or its impact. Many workers do not desire change because they believe that change will often negatively affect them (Singh, 2015).

Many who wish to maintain the styles in which things are done are usually reluctant to change (Buildingtalk, 2019). Manuela and Clara (2003) suggested that the more transformational and drastic the changes, the more excellent the resistance to such change. Introducing new mechanisms into an organization requires changing the culture of an organization that includes with it risks and obstacles that are not limited to financial considerations but can require the consistency or versatility of the people and structures of the organization (Eadie, Odeyinka, Browne, McKeown & Yohanis, 2014). This involves a significant change in culture within the company (Rowlinson et al., 2009, Watson, 2010). Employees avoid change due to their poor tolerance levels, which indicates that they cannot learn the new skills and attitudes needed in the new situations arising from the change implemented (Paul, Mike & Rodger, 2006).

Besides, sophisticated technology leads to job insecurity among construction industry workers (Mathebula et al., 2012). Within sectors, professions, and education classes, computerization reduces labour input of routine manual and routine cognitive services and increased labour input of non-routine cognitive services, as David, Levy and Murnane (2003) mentioned. Technology can never substitute man, and technology usage tends to lead to man's need to be less demanding, leading to reduced workers (Mathebulaa, Mukukab, Aigbavboac & Thwalad, 2015).

Hence, there is a need to look into the willingness of stakeholders in the construction industry to change. Highlight the importance of the industry to understand the behaviour of employees in any organization on their ability or willingness to change to become a better human capital that could bring the nation towards a developed country soon. This research tends to identify the significant factors that influence the employee resistance to adopt changes as well as the factors that influence the implementation of digital or smart Contract within Malaysian's construction industry.

SMART CONTRACT IN THE CONSTRUCTION INDUSTRY

The smart phrase contract translates to a computerized protocol that negotiates, automates and validate the contract performance. Smart contracts can offer greater security than conventional wet-signed paper contracts (digital archiving), can be updated throughout the

project (flexibility) and are convenient to manage (reduced transaction costs) compared to existing contracting procedures (Fox, 2016). In addition, smart contract is a legally binding agreement that can be automated. Although certain stages may involve individual input and control, the process may be automated with the help of a computer. Either through enforcing legal rights and responsibilities or by executing computer code in a tamper-proof manner (Zou et al., 2021).

Szabo in 1994 also highlighted that the main goals of the Smart Contract concept are to fulfil specific contractual requirements (such as payment terms), reduce expectations and reduce the need for reliable intermediaries (Mason & Escott, 2018). Clauses and instructions could be coded in the system. The software is enforced when the terms and conditions of the coded contract are fulfilled, so that smart contracts are self-enforcement. Smart contracts also provide for the integration of digital transaction information, such as payment sum, and the automatic data transmission between the contracting parties upon receipt of instructions (Crosby et al., 2016).

Furthermore, the total reimbursed amount is restricted by smart contracts so that no single entity can access money. The payment will be made to the parties' account only if the coded terms have complied. Smart contracts are definitive because of their binary logic, which indicates that inputs and outputs are similar and the contract conditions rely on the coded fulfilment of the scope (Ahmadisheykhsarmast & Sonmez, 2018).

Resistance to Change

Resistance is a condition, according to Del Val and Fuentes (2003), which influences the process of change by delaying its introduction or sabotaging its adoption, which in essence increases costs. Resistance is also characterized as a behaviour that seeks to preserve the status quo and prevent change. Resistance affects the change cycle by delaying or postponing its commencement, slowing or stopping its execution, and increasing its expenses (Amjad & Rehman, 2018). Employee strikes, arrogant attitudes, or damaging new technology or machineries are all examples of resistance that organisations encounter (Fleming & Spicer, 2003). Due to the adverse implications, resistance to organisational change should be viewed as an impediment to growth (Boohene & Williams, 2012). Resistance to change is traditionally viewed as an adversary of change that must be overcome if the change is to be accomplished (Karaxha, 2019).

Resistance to change has been viewed mainly as a desire to preserve the status quo, and study has historically seen resistance as an opposing force to be resolved (Courpasson, Dany and Clegg, 2012) and as a disruptive factor "that drives employees further from promoting changes proposed by managers" (Piderit, 2000). Resistance to the emergence of technology is "anticipated". It can be regarded as the opposite side of innovation success drivers, highlighted in information systems (IS) research on technology implementation. (Samhan and Joshi, 2015; Bintoro et al., 2015).

Factor That Influence Employee Resistance to Change

As mentioned by Strickland (2000), "People resist change due to the feeling loss of identity as well as belonging". Some more detailed factors contributing to resistance to change

were identified by Schoor (2003), which are (Alameri, 2013): Self-interest as employees see the changes as damaging in one aspect or another. Psychological effects relate to the effect of the change on the organization's job security, technical skills, and social standing. Redistributive factors when employees assume that they can lose any or all of their privileges by reallocating duties and obligations. The destabilizing impact of introducing new individuals who are not familiar with the company's culture and practices. The political influence of an organization's power relationships and the degree to which they are challenged.

As suggested by numerous researchers, other human factors influence the resistance to change. The following table shows the factors that influence the resistance to change as highlighted in their finding:

Table 1. Human Resistance Factors to Change

No.	Sources	Human Resistance Factors to Change				
		Behavioral Factors	**Demographic Factors**	**Psychological Factors**	**Social Factors**	**Cultural Factors**
1.	(Alameri, 2013)	✓	✓	✓	✓	✓
2.	(Singh, 2015)	✓	✓	✓	✓	✓
3.	(Agboola et al., 2019)	✓				
4.	(Vakola, 2012)	✓	✓	✓	✓	✓
5.	(Elgohary & Abdelazyz, 2020)	✓	✓	✓	✓	✓
6.	(Angonese & Lavarda, 2014)	✓		✓	✓	
7.	(Dibrov, 2015)	✓		✓	✓	✓
8.	(Sharma, 2019)	✓		✓	✓	
9.	(Saleemi, 2010)	✓		✓	✓	✓
10.	(Williams, n.d)	✓		✓	✓	
11.	(Tanner, 2020)	✓		✓	✓	✓
12.	(Pakdel, 2016)		✓			
13.	(Basyal & Wan, 2020)	✓		✓	✓	✓

Willingness to Change

While managing organizational change is not a simple job, it also needs an organization to understand existing policies and recognize the firm's problems since introducing current policies and procedures. Organizational change is crucial because if companies do not change their strategies based on various external changes, it is difficult for a business to thrive in today's competitive, demanding and ever-changing environment. Nevertheless, it may necessitate a firm to provide an effective training regime for their staff and motivate them to make the necessary changes. Management must express the objective towards every employee to encourage their willingness (Siddiqui, 2011).

Continuous business expansion, innovative ideas and reasonable management assistance are necessary elements for the effective implementation of the change. However, healthy organizations need to embrace all the changes, and effective organizations must educate their employees regarding the changes they will introduce. In order to achieve the willingness of the employee to embrace the new approaches of executing their responsibilities, the organizations need to address two significant issues in order to implement changes successfully; firstly, to obtain the willingness of the employees and secondly, to reduce the

resistance to change (Madsen et al., 2005). Several works of the literature suggest the factor that influences employee willingness to change as follows:

Table 2. Human Willingness Factors to Change

No.	Sources	Human Willingness Factors to Change					
		Leadership	Communication and Collaboration	Self-Efficacy	Personal Valence	Investment	Employee Engagement
1.	(Patel & Patel, 2008)		✓	✓		✓	
2.	(Appelbaum et al., 2017)	✓	✓	✓			
3.	(Siddiqui, 2011)	✓		✓	✓		
4.	(Ahmad et al., 2017)	✓	✓	✓	✓		✓
5.	(Osmundsen, Iden, & Bygstad, 2018)	✓	✓				✓
6.	(Othman et al., 2019)	✓			✓	✓	✓
7.	(Heathfield, 2019)	✓	✓				✓
8.	(Anin, Ofori & Okyere, 2015)	✓	✓	✓	✓	✓	
9.	(Brooks, 2007)			✓	✓		✓
10.	(Talukder, 2012)	✓	✓	✓	✓		
11.	(Peansupap & Walker, 2005)	✓	✓		✓	✓	✓

RESEARCH METHODOLOGY

A straightforward, organized, and systematic orientation research methodology successfully satisfies the research objectives and questions raised. This can be achieved through a well-defined research structure that will aid to establish a straightforward guide to the researcher in his findings. For this research, descriptive surveys were conducted by distributing questionnaires to the targeted respondents, which are construction personnel in Malaysia that consist of architects, engineers, and quantity surveyors. This method was chosen since the research objectives was to explain people's perceptions and behaviours using data collected at a certain point in time (Bryman & Bell, 2007). It also has the benefit of generating positive responses from a diverse group of people. It also includes the collecting of reliable and objective data in order to explain an existing occurrence. (Nwadinigwe, 2005). The list of the registered architects, engineers and quantity surveyors are derived from the official portals of the professions, which are Lembaga Arkitek Malaysia (LAM), Board of Engineer Malaysia (BEM) and Board of Quantity Surveyors Malaysia (BQSM). The collected data were analysed using the Social Sciences Statistical Package SPSS version 27 (SPSS), consisting of descriptive analysis, ANOVA, and Pearson's correlation analysis method.

RESULTS AND DISCUSSIONS

The study aims to identify the resistance factors in embracing changes among construction employees and determine the factor influencing employee willingness to implement smart construction contracts in Malaysia. Based on the Figure 1, the majority of the respondent is Quantity Surveyors with a significant percentage of 55% (33), followed by

Engineer with the percentage of 17% (10), Architect at 12% (7), Project Manager at 10% (6) and finally others at 7% (4).

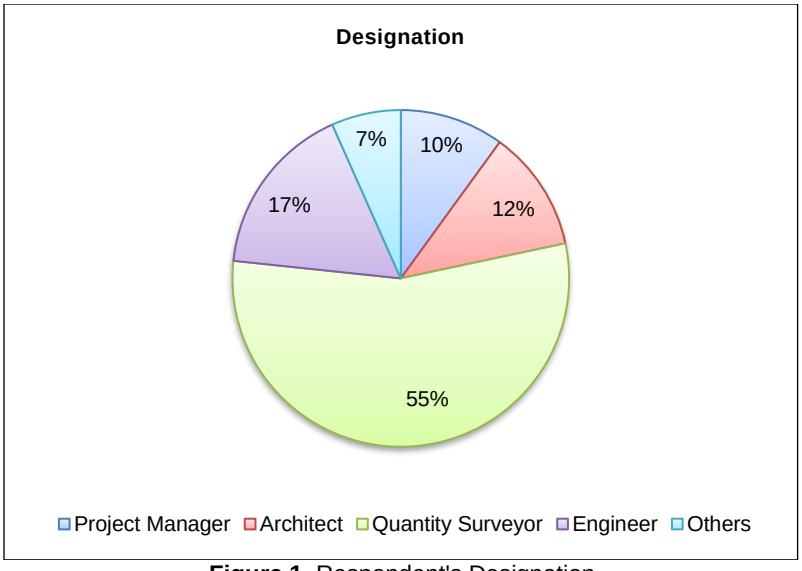

Figure 1. Respondent's Designation

Next, based on Figure 2, a significant 92% of the respondents, consisting of 55 individuals, agree that Smart Contract is necessary for the construction industry future compared to only 8% (5) of the respondents that disagree.

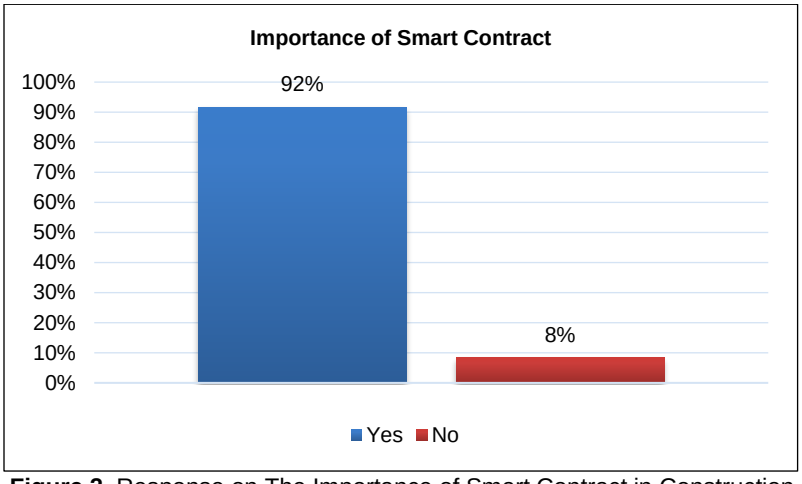

Figure 2. Response on The Importance of Smart Contract in Construction

Then, to be more precise, the mean range method is used to get the average of each question answered by the Respondent. Finally, the mean range method is used to obtain the level of resistance by the respondents toward change:

Table 3. Descriptive Statistic on Resistance Factors in Embracing Changes Among Construction Employees

Code	Description	Mean	Level of Agreement
	Behavioural Factor		
RB1	I believe that employees are comfortable with the implementation of the Smart Contract.	3.58	Moderate
RB2	I believe that employees may find the change to be stressful.	3.78	High
RB3	I believe that employees may experience the anxiety of change to Smart Contract.	3.62	Moderate
RB4	Employees may lose interest in the job upon implementing Smart Contract.	2.85	Moderate
	Demographic Factor		
RD5	I believe that the employee age may affect the implementation of the smart contracts.	4.12	High
RD6	I believe that the employee educational level may affect the change towards the smart contracts.	4.08	High
RD7	I believe that employee experience level may affect the change.	3.95	High
RD8	I believe that employee gender may affect the implementation of Smart Contract.	2.32	Low
	Psychological Factor		
RP9	I believe that employees are rewarded upon Smart Contract is successfully implemented.	3.50	Moderate
RP10	I believe that Smart Contract implementation may affect the employee's job performance.	3.87	High
RP11	I understand that employees may experience job insecurity upon implementation of Smart Contract.	3.80	High
	Social Factors		
RS12	I believe that implementing a Smart Contract may affect the communication between employees.	3.65	Moderate
RS13	I believe that the employee society may feel disinterest to embrace the change.	3.78	High
RS14	I believe that employees might feel uncomfortable towards the social-environmental change upon the implementation of Smart Contract.	3.75	High
	Cultural Factors		
RC15	I believe that the employee's culture unwillingness to change may affect the Smart Contract implementation.	4.10	High
R16	I understand that employee culture lack of approaches such as training may affect the change.	4.33	High

All of the Respondents provided positive feedback by answering all of the questions mentioned in the survey. This can be possibly due to the factors contributing to employee resistance to change. The Respondent was able to respond based on their criteria and experiences. Five (5) human factors were identified based on previous research conducted: Behavioural Factors, Demographic Factors, Psychological Factors, Social Factors and Cultural Factors.

Most respondents highly agreed that the factors mentioned influence employee resistance to change. For instance, the highest mean for the resistance factor is 4.33, which falls under cultural behaviour. In addition, the Respondent believed that the employee culture lack of approaches such as training might affect the change. Thus, eliminate or reduce the influence or impact of employee resistance towards change in the organizations; employees must promote or encourage all individuals to become more proactive in participating in the change.

The second highest mean is at 4.12, which falls under demographic factors. The Respondent believes that employee age may affect the implementation of the smart contracts. Age is one of the main obstacles for organizations to adopt change. Senior employees tend to be more resistant to learning and adopting new technology or management than younger generations.

Psychological factors highest mean is 3.87. Respondent believes that Smart Contract implementation may affect employees' job performance as they tend to become insecure and worried about not catching up with the new implementation. Therefore, employees need to solidify their psychological strength to embrace the challenges that come together with every new technology or system the organization introduces to ensure that they will maintain their work performance.

Social factor highest mean is at 3.78 which Respondent believes that employee society may feel disinterest to embrace the change. Therefore, employee society is significant to encourage all employees as a society that reacts positively to a new change will provide positive vibes and an environment to embrace the change.

Last but not least, behavioural factor's highest mean is at 3.78, which Respondent believes that employees may find the change stressful. It cannot be argued that every new system and technology introduce into an organisation will cause stress and pressure especially towards employees as they needed to learn new things and worst case scenario is that the organisation tend to implement the change immediately, making them become more stress due to learn in short period of time.

Next, six (6) factors have been identified based on previous research conducted on the factors that influence the employee willingness to implement smart construction contracts: Leadership, Communication and Collaboration, Self-Efficacy, Personal Valence, Investment, Employee Engagement. Most of the respondents highly agreed that the factors mentioned influence employee willingness to implement Smart Contract. For instance, the highest mean for leadership is at 4.38, which Respondent believes is essential to offer a leadership development program to focus on the smart contract implementation. Furthermore, to provide a smooth transition in the organization, a capable leader is needed to provide guidance and monitor the employee performance during the change.

Next, for communication and collaboration factors, the highest mean recorded is at 4.40, which suggest that the Respondent believed that the collaboration between software developer and construction employee is necessary to help with the change. Collaboration between the software developer and the user is essential. It can provide early ideas and technical knowledge of using the system, thus increasing its familiarity with the users. Next, for the self-efficacy factor, the highest mean recorded is at 4.38, which Respondent believes that employees must become more proactive and ready to learn about the Smart Contract. The Respondent believes that employees must prepare themselves with adequate knowledge and become more active in implementing the new change.

Table 4. Descriptive Statistic on Factor That Influence the Employee Willingness to Implement Construction Smart Contract in Malaysia

Code	Description	Mean	Level of Agreement
	Leadership Factor		
WL1	I believe that it is essential that the company provide a leader or manager that is experienced with Smart Contract to help with the change	4.33	High
WL2	It is essential to offer a leadership development program to focus on the smart contract change.	4.38	High
WL3	I believe that good leadership and management in the company is essential to assist other employees to embrace the change.	4.37	High
	Communication and Collaboration Factor		
WC4	I believe that it is necessary to collaborate with other construction-based companies to help with the implementation of Smart Contract.	4.22	High
WC5	I believe that communication between employees and employers is essential to increase the success rate of the change.	4.37	High
WC6	I believe that the collaboration between software developers and construction employees is necessary to help with the change.	4.40	High
	Self-Efficacy Factor		
WS7	The employees need to equip themselves with adequate knowledge and skills to embrace the Smart Contract.	4.33	High
WS8	The more the employee is confident in his knowledge and skills, the greater the chance of handling the change more effectively.	4.35	High
WS9	Employees must become more proactive and ready to learn about the Smart Contract.	4.38	High
	Personal Valence Factor		
WP10	I believe that employee interest is essential to increase the effectiveness of the implementation of Smart Contract.	4.33	High
WP11	I believe that reward is essential upon the successful implementation of Smart Contract to boost employee interest.	4.30	High
	Investment Factor		
WI12	I believe that the company's willingness to invest in the latest technology can boost the employee's confidence to embrace change.	4.22	High
WI13	I believe that it is essential for the organization to incentivize the employee to increase their interest.	4.33	High
WI14	I believe that it is essential for the organization to invest in training and development programs to increase employees' confidence levels.	4.30	High
	Employee Engagement Factor		
WE15	I understand that it is essential for the employees to participate in training and development programs to embrace the change.	4.45	High
WE16	I believe that offering programs to develop skills and training are essential among employees to implement the change.	4.43	High

Besides, 4.33 is the highest mean value recorded for personal valence factors, which suggest that employee interest is essential to increase the effectiveness of the implementation of Smart Contract. Respondent believes that one of the keys to promoting or encouraging the employee willingness to implement the smart contract is by boosting their interest to embrace the change. Furthermore, the investment factor recorded the highest mean at 4.33, which suggested that it is vital for the organization to incentivize the employee to increase their interest. Incentives and rewards are some of the vital encouragements that the organization can offer to their employee in order to boost their interest. However, incentives are restricted to monetary aspects as organizations can also boost their employee interest by offering better welfare care and investing in new technological devices.

Finally, for the employee engagement factor, the highest mean recorded is at 4.45, which suggests that the Respondent believes that it is essential for the employees to participate in training and development programs to embrace the change. Participation in the training program can boost their willingness to change and gain adequate knowledge to handle the change.

Next, the one-way ANOVA analysis is used to determine whether there are any significant differences towards Respondent's designation with the resistance factors in embracing changes among construction employees, as well as significant differences towards Respondent's designation with the factors that influence the employee willingness to implement smart construction contract in Malaysia.

Table 5. Resistance Factor's One Way Anova Analysis

Resistance Factors		Sum of Squares	df	Mean square	F	Sig.
Behavioural	Between Groups	1.395	4	0.349	0.936	0.450
	Within Groups	20.501	55	0.373		
	Total	21.896	59			
Demographic	Between Groups	1.833	4	0.458	1.014	0.408
	Within Groups	24.85	55	0.452		
	Total	26.863	59			
Psychology	Between Groups	1.435	4	0.359	0.928	0.455
	Within Groups	21.269	55	0.387		
	Total	22.704	59			
Social	Between Groups	0.294	4	0.073	0.133	0.970
	Within Groups	30.482	55	0.554		
	Total	30.776	59			
Cultural	Between Groups	1.374	4	0.344	0.493	0.741
	Within Groups	38.309	55	0.697		
	Total	39.683	59			

Based on Table 5, the ANOVA significant value for the factors is 0.450, 0.408, 0.455, 0.970 and 0.741, respectively, which indicates that there is no significant difference towards the Respondent's designation with the resistance factors in embracing changes among construction employees, due to the significant value is more than 0.05 (Pallant, 2007). Most probably, all the respondents possess similar ideas and perspectives towards the factors affecting employee resistance to change.

Based on Table 6, the ANOVA significant value for the factors is 0.536, 0.461, 0.898, 0.258, 0.834 and 0.998, respectively, which indicates that there is no significant difference towards the Construction's Personnel with factors that influence the employee willingness to implement Smart Contract, due to the significant value is more than 0.05 (Pallant, 2007). Thus, this indicates that all the approaches or strategies to boost employees' willingness to change are suitable for every construction's personnel.

Table 6. Willingness Factor's One Way Anova

Willingness Factors		Sum of Squares	df	Mean square	F	Sig.
Leadership	Between Groups	1.684	4	0.421	0.791	0.536
	Within Groups	29.270	55	0.532		
	Total	30.954	59			
Communication and Collaboration	Between Groups	1.631	4	0.408	0.916	0.461
	Within Groups	24.479	55	0.445		
	Total	26.109	59			
Self-Efficacy	Between Groups	0.427	4	0.107	0.267	0.898
	Within Groups	21.987	55	0.400		
	Total	22.415	59			
Personal Valence	Between Groups	2.574	4	0.644	1.366	0.258
	Within Groups	25.909	55	0.471		
	Total	28.483	59			
Investment	Between Groups	0.776	4	0.194	0.363	0.834
	Within Groups	29.407	55	0.535		
	Total	30.183	59			
Employee Engagement	Between Groups	0.057	4	0.014	0.030	0.998
	Within Groups	26.489	55	0.482		
	Total	26.546	59			

Last but not least is correlation analysis. Correlation analysis is a statistical instrument intended to determine the significance and strength of the relationship between two quantitative variables. A high correlation indicates that the variables possess a good relationship, whereas a weak correlation indicates that the variables are not very closely related. In other terms, it is the method of analysing the strength of such a relationship with the statistical data available. For example, Pearson Correlation analysis is used in this research to determine the relationship between the resistance factors with the willingness factors.

Table 7. Correlation Table

		Resistance	Willingness
Resistance	Pearson Correlation	1.000	0.452**
	Sig. (2-tailed)		0.000
	N	60	60
Willingness	Pearson Correlation	0.452**	1
	Sig. (2-tailed)	0.000	
	N	60	60

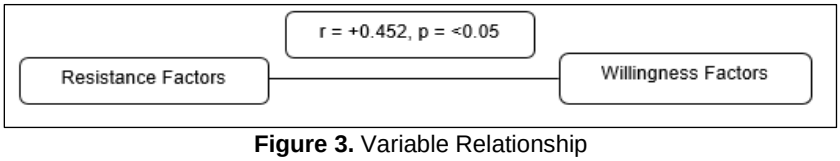

Figure 3. Variable Relationship

Table 7 and Figure 3 show the correlation and the relationship between employee resistance factor to change and employee willingness factor to implement Smart Contract. First, the Pearson Correlation values were recorded at a positive 0.452 (r = +0.452) indicate that the resistance factors and factors that influence employee willingness to change possess a positive relationship and medium correlation. Next, the significant values of the variables are 0.000. Finally, the traditional alpha value is 0.05. Therefore, the correlation is significant.

CONCLUSION

This research implies that hopefully, it can provide knowledge and exposure, especially towards employers, that employee resistance to change is crucial to overcome in order to implement change. I firmly believe that it is essential to overcome the human factors first as the employee is the user of the new technology. What is the point of investing in new sophisticated technology, but at the end of the day, the user, an employee, tends to neglect the system as they were comfortable with the old system? Besides, this research also had identified the factors that influence employee willingness to implement smart contracts. Therefore, organizations can adopt the factors to introduce smart contract, or any other system change in the future.

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CHALLENGES IN DIGITALISATION OF BUILT HERITAGE IN MALAYSIA: A FOCUS GROUP PERSPECTIVE

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Abstract
In recent years, the digital heritage sector has experienced gradual expansion and development within worldwide industry. Concurrently, the utilisation of digital tools linked with software and hardware has emerged as a viable solution in the preservation and management of built heritage, promising enhanced efficiency in conservation and operational processes. While the digitalisation approach has gained widespread recognition and adoption globally, its implementation within the Malaysian industry remains limited. This limitation can be attributed to the slow uptake of new skill sets, particularly proficiency in 3D modelling and understanding the digital approach. In order to cope with the challenges, deeper insights are required; thus, this paper presents findings from a qualitative study conducted through focus group interviews with stakeholders and conservation experts held on the 20th of September 2023. The primary objective of this study is to identify the current challenges encountered in the practice and implementation of digitalisation of heritage information systems for built heritage in Malaysia, utilising digital tools. This study identifies several obstacles to the implementation of digital heritage information systems in Malaysia, which can be classified into four main categories which are people, encompassing training, education, attitude, and management efforts; process, including modelling and integration; technology, encompassing software, hardware, and compatibility; and policy, encompassing guidelines, contracts, procurement, and legislation.

Keywords: *Digital Heritage; Digital Tools; Digitalisation; Challenges; Heritage Information System; Heritage Data Documentation*

INTRODUCTION

Heritage is considered an integral component of national identity that links people to the past, demonstrating the value of history, and stands as a tradition for future generations (Khan et al., 2022); heritage buildings, on the other hand, are unique landmarks around the world and hold great cultural significance. Heritage buildings, famous for cultural, historical, economic, and political value, are essential and have global significance. They should be protected and valued as they are bound to be valuable to future generations (Adegoriola et al., 2021). Heritage data can be categorised into two main groups: manual and digital. Heritage documentation typically involves a combination of manual and digital methods. This manual approach necessitates substantial manual effort, is time-consuming, and may be prone to human errors, posing challenges for organisation and administration. Digital heritage data utilises digital technologies to record and document cultural material, providing a contemporary alternative to conventional manual recording techniques (Letellier, 2007).

The development of digital tools aimed to provide a new medium capable of interpreting and managing many data kinds that were previously restricted by their specific forms; it became a solution for integrating, interpreting, and managing disparate data, leading to the integration of several disciplinary processes on one platform (Khalil & Stravoravdis, 2022). Digital tools are considered a new architectural heritage paradigm that can be utilised for developing, saving, documenting, and managing entire engineering drawings and information (Megahed, 2015). It provides highly adaptable solutions for modelling and overseeing information related to existing and historical buildings. It can serve as a record for conservation work, retrofitting, renovations, and building study. It can be used as a research tool for documenting and interpreting historic buildings and representing changes to the building throughout time (Fai et al., 2011; Khalil & Stravoravdis, 2019). Digital tools can serve in integrating and managing a building through its design, construction, and operation. Since different professionals need different data, information flows through various stages and levels. It's crucial to keep this information accurate and relevant for effective future decision-making, (Azmi et al., 2023) including for heritage data. The application of electronic submission includes the electronic uploading of data files for the purpose of obtaining permission, making revisions or renewals by submitting digital building or development plans to a regulatory body, which then performs automated checks to ensure compliance with building codes and regulations. These checks are required for all buildings within a jurisdiction since manually checking building designs against national codes is complex and prone to human error (Harun et al., 2018).

However, challenges may develop while digitally documenting heritage buildings' data and information (Khalil & Stravoravdis, 2022). This paper provides insights from stakeholders, relevant parties, and experts on the challenges in the current practice and implementation of digitalising heritage information systems for built heritage in Malaysia by collecting data from (N=16) focus group interview sessions.

DIGITALISATION OF HERITAGE INFORMATION SYSTEM

Historical building records typically contain a substantial amount of complex information and data. Figuring out complex settings with multiple layers can be challenging, especially when there are unknown entities due to gaps in knowledge, making it hard to understand the technical components of the work (Woodward & Heesom, 2021). Recording and analysing decisions are crucial in conservation efforts to facilitate the ongoing assessment and observation of the lasting effects of change (Woodward & Heesom, 2021). A heritage information system is necessary for conservation projects to enable informed management of historic buildings and places. It assists in understanding the significance and heritage values, fostering public interest and involvement, and ensuring these sites' long-term maintenance, repair, and restoration (Hafez, 2019). According to the Merriam-Webster Dictionary, the verb digitise was first used in 1953. The current definition of digitisation is converting analogue information into digital form using electronic devices like scanners and cameras, enabling the information to be processed, stored, and sent over digital circuits, equipment, and networks. The other definition is incorporating digital technologies into daily life by digitising all possible items. The second concept is broader and relates explicitly to cultural heritage (Ivanova et al., 2012).

The digital technological boom has improved the methods for documenting, conserving, and preserving architectural heritage. Digital heritage involves utilising digital technologies to conserve cultural or natural heritage. The UNESCO Charter 2003 defines digital heritage as unique human knowledge and expression resources. The database includes cultural, educational, scientific, and administrative resources, along with technical, legal, medical, and other information that are either developed digitally or transferred from analogue resources into digital format. Digital architectural heritage involves employing digital technologies to preserve cultural history by maintaining the integrity and beauty of the built environment (Khalid, 2021). Digital heritage data offers superior visualisation and analysis capabilities compared to manual methods (Santana Quintero et al., 2020).

Furthermore, information and data from heritage buildings may be easily kept, shared, and accessed remotely via digital methods, removing the need for physical storage and transit of manual heritage data. Digitisation procedures vary depending on the object type (writing, photograph, architecture, audio, video and other). Digitisation technology consists of specialised hardware, software, and networks; technical infrastructure includes protocols, standards, and policies and procedures (for workflow, maintenance, security, upgrades and others) (Ivanova et al., 2012).

BENEFIT OF DIGITALISING HERITAGE DATA DOCUMENTATION AND INFORMATION SYSTEM

Documentation is essential in the conservation process as it enables conservation professionals to record current conditions, evaluate suitable conservation solutions strategies, and oversee the plan's execution (Leblanc & Eppich, 2005). Heritage documentation is the organised collection and archiving of physical and non-physical elements of historic buildings and surroundings. The objective is to provide precise information to facilitate proper conservation, monitoring, and maintenance for the building's survival (Dore & Murphy, 2017; Khalil & Stravoravdis, 2019; Letellier, 2007). According to Ahmad (2021), heritage documentation is vital in conservation initiatives as it captures architectural styles, building elements, conditions, repairs, materials, and other relevant information. It creates precise drawings and assists in identifying building defects to determine appropriate conservation techniques. Conservation projects in Malaysia involve various stages that necessitate extensive data documentation and heritage information, such as evaluation, survey, historical research, planning, execution, and monitoring. Digital tools like software and hardware integrate multi-dimensional visualisation with extensive, parametric databases. It enables the integration of graphical and informational data flow management to enhance collaborative development of the strategy for designing, constructing, and managing building projects among project partners (Fai et al., 2011; Khalil & Stravoravdis, 2019).

Meanwhile, the digital model serves as a centralised information repository for collaborative efforts across the whole lifespan of a facility. It helps various design team members work together more effectively than conventional methods (Malagnino et al., 2018). The applications can significantly enhance the heritage buildings sector by supporting the management of conserving, renovating, retrofitting, and managing heritage buildings (Khalil & Stravoravdis, 2022). The advantage of implementing digital models in heritage architecture is that it allows for the creating of comprehensive digital documentation that integrates many forms of information inside a single building database (Fai et al., 2011; Megahed, 2015).

Digitalising heritage data, documentation, and information systems offers numerous benefits for historic buildings, including design integrity, visualisation, cost estimation, conflict identification, planning implementation, and enhanced engagement of stakeholders. It can assist in automatically measuring, identifying, and modelling damaged or missing architectural parts during documentation. It can show the historical evolution of the structure over time. It can contribute to energy, economic, and multi-thematic sustainability analysis (Khalil & Stravoravdis, 2022). All the elements of a heritage building throughout its existence are digitally documented, thus providing valuable potential for preserving information (Khalil & Stravoravdis, 2019). A wide range of data can be helpful in the process of documenting, modelling, and visualising heritage buildings; these data (whether tangible, such as geometry, materials, and structural systems, or intangible, such as the building's historical record, cultural assets, and performance) can vary in scope, purpose, and investigation tools (Khalil & Stravoravdis, 2019). These data include archaeological, historical, geometry, pathology and performance.

- Archaeological and historical data include archaeological investigations, historical records, and building morphology across time.
- Geometry: analysis survey and visually represent the heritage building's current condition to determine the position, size, shape, and identity of its outside skin components.
- Pathology involves examining the potential harm or deterioration of the historic building's structure and investigating the underlying properties of its materials and structural systems.
- Performance: This refers to the building's present operational status and efficiency across many elements.

FRAMEWORK OF DIGITALISATION IMPLEMENTATION

Adopting digitalisation involves three interconnected pillars: process, technology, and people. Digitalisation encompasses not just technology but also people and processes. It is essential to set standards for the content and format of data transmission among these components. The mentioned variables enable all decision-making elements to access information effectively (Megahed, 2015).

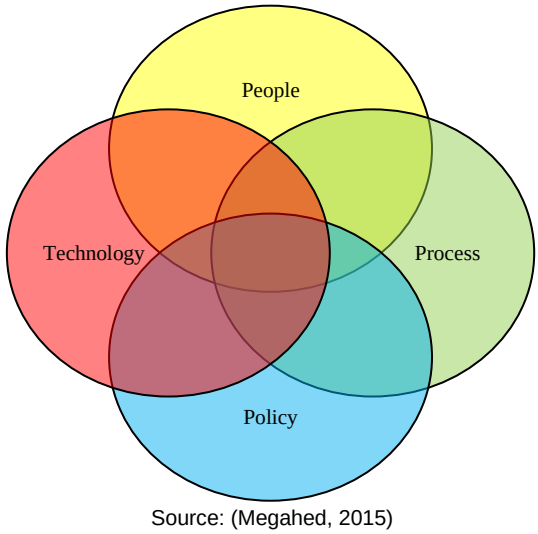
- The first pillar addresses people, whether they are specialists or not. Their duties include inserting, extracting, and updating or modifying information inside the building model. Therefore, to foster a digital culture that encourages innovation, learning, and feedback, adopting a bottom-up approach that involves everyone in the decision-making process (Megahed, 2015; Succar, 2009; Succar & Kassem, 2015). In addition, education and formal training will enhance the basis of digitisation. The readiness to incorporate digital heritage can be ensured by the correct mindset of the individuals (Haron, 2013).

- The second pillar presents technology, either hardware or software. A wide range of devices used on surveying and representation methods offer a high level of accuracy and reliability while capturing the details of an architectural form. On the other component, due to the complexity of gathering all the relevant information when working with digital tools, some companies have developed software designed

specifically to work in a digital framework. These packages differ from architectural drafting tools by adding further information (analysis, project schedule, estimating, sustainability and maintenance information, others.) to the building model (Megahed, 2015; Succar, 2009; Succar & Kassem, 2015). Technology enables data aggregation from several sources into a model, simulating building data for multiple purposes during the building's lifespan (Hussain, 2016).

- The third pillar supports a process that involves modelling and integration. These procedures collect and provide information to assist the creation and use of knowledge in different scenarios, following the guidance of the specified policy pillar in a coordinated manner (Megahed, 2015; Succar, 2009; Succar & Kassem, 2015). One of the clear objectives and benefits of digitalisation is to establish an accurate model that streamlines communication, coordinates workflow, and effectively manages information related to heritage buildings (Hussain, 2016).

- The fourth pillar focuses on formulating policies to facilitate in-depth analysis, efficient management, and effective control. Therefore, to satisfy the preservation objectives stated by project stakeholders, the policy components must be precise by incorporating information into digital models via embedding formats, standards, codes, manuals, criteria, and recommendations. These rules prioritise the management process and can establish, arrange, enhance, and oversee the entire digital implementation (Megahed, 2015; Succar, 2009; Succar & Kassem, 2015).



Source: (Megahed, 2015)

Figure 1. Pillar Concept of The Digital Framework

The pillars link together to create a comprehensive framework for digitalisation. The philosophy is rooted in these pillars, which support the proposed framework's structure. From this comprehensive perspective, it is evident that the framework consists of four interrelated pillars: people, technology, process, and policy. These pillars are bound together without any defined boundaries, and each one is crucial to the functioning of the others (Megahed, 2015; Succar, 2009).

CHALLENGES IN THE IMPLEMENTATION OF DIGITAL HERITAGE

Despite acknowledging its benefits, the conservation industry has yet to embrace digital tools fully. There is currently no clear consensus on implementing or using digital software and hardware (Azhar, 2011; Hussain, 2016). Despite the enormous benefits of the adoption, only a few contractor and consultant firms have successfully applied it in the actual industry (Hussain, 2016). The most difficult challenge with the digital approach is that it must begin at an intermediate point in the asset's life cycle, which can be far more complicated than the relatively simple cradle-to-grave model that describes new-build construction (Antonopoulou & Historic England, 2017; Khalil & Stravoravdis, 2019). Given the scarcity of scientific knowledge, the issues that clients face remain mostly unclear. Although many digital tools have been around in the worldwide construction and conservation sector, they have sparked little interest in Malaysia, which is so entrenched that many are hesitant to change.

- People - The lack of knowledge, skills, and experience among construction professionals is considered the critical obstacle preventing many construction firms from adopting digital technology, as highlighted by (Bryde et al., 2013; Hussain, 2016) and according to a study conducted by Azhar (2011), revealed that construction professionals had lacked a comprehensive understanding of digital technology, leading to their reluctance in using it. Due to these problems, the top management at the organisational level may face challenges with staff members who are sceptical about adopting it and are, therefore, hesitant to change their working methods (Dowsett & Harty, 2013).

- Process – Organisations should allocate funds for training and consider purchasing digital tools (hardware and software) to deploy a digital approach (Eadie et al., 2013). It is commonly believed that organisations do not use a formal approach and conduct cost-benefit assessments before adopting digital tools in order to evaluate the benefits of their investment (Hussain, 2016). Based on the discussion, (Hussain, 2016) believes that for businesses to integrate BIM into their existing operations successfully, they must first overcome obstacles related to organisational culture and behaviour, which impede the capability of organisations to institutionalise digital processes with current business processes rather than technical concerns. The following challenges are identified: benefits from the adoption do not outweigh the costs of implementing it and are not tangible enough to warrant digital technology uses.

- Technology - The investment in the purchase of digital technology and the related integrated process presents several challenges that must be addressed before adoption (Bricogne et al., 2011; Ho et al., 2013). The acquisition process encompasses evaluations based on anticipated utilisation and investment capacity, including initial investment, learning curve, and maintenance expenses (Ho et al., 2013; Sebastian & van Berlo, 2010). Adopting digital technology necessitates significant changes in the management process (Abrishami et al., 2013; Langroodi & Staub-French, 2012). To make the necessary changes using digital implementation, the initial costs and expenditure for the adoption can be hefty. Aside from that, the literature also reveals that the users also faced issues with the interoperability and compatibility of the digital tools (Talebi, 2014). Olatunji (2011) found that interoperability between

different software providers is a "major issue that the adoption has got to deal with" (Olatunji, 2011; Talebi, 2014).

- Policy - The successful launch and adoption of digital technology require the government's leadership and reasonable policies. Several studies have emphasised the need for the government to be involved and lead the market in effectively accommodating the digital change management process (Dim & Okoro, 2015; Wang & Chong, 2015). (Alfred (2011) emphasised that creating strong guidelines and standard procedures for collaboration among different disciplines is a critical strategy for organisations to respond to digitalisation. According to Hussain (2016), the progress of digitalisation development is limited by the absence of a specific clause in government contract agreements and policies, and the difficulties in adopting digital technology are caused by the insufficiency of the contractual framework. The digital sector is also seeing a deficiency in guidance and industry benchmarks.

RESEARCH METHODOLOGY

This study aims to identify challenges currently being faced in the practice and implementation of digitisation of heritage information systems for built heritage in Malaysia. In order to study the challenges that were experienced by associated participants, such as stakeholders and experts in the conservation industry, an interview with focus groups was used as the study approach. These interviews were conducted by assembling a small group of experts and stakeholders who have participated in managing heritage data conservation practices. The group was divided up into four, with a total of sixteen participants in all of them. The groups were classified according to the digitalisation framework's four pillars: people, process, technology, and policy. Two moderators were present during the interview session, which took place on the 20th of September, 2023. This group brainstorming was conducted in collaboration with the National Heritage Department, Ministry of Tourism and Culture. Each of the interview sessions consisted of four main questions, the sessions were recorded, and the duration of each session ranged from forty-five minutes to one hour.

RESULT AND DISCUSSION

Five primary transcript analyses were carried out based on the interview sessions conducted. These analyses included demographic information of individuals who participated in the focus group, an acknowledgement of the current implementation of digitalisation of heritage information systems, respondents' perceptions of using digital tools for conservation and heritage data information, as well as challenges that they experienced in the process of digitalising heritage information systems, and suggestions on how to overcome those challenges.

Demographic Information of Respondents

The participants consisted of the participants were academicians (n=3), registered conservators (n=4), consultants (n=4), B03 contractors (n=4), and government agencies (n=5), as shown in Table 1. Based on the table, five participants have between 10 and 15 years of experience in heritage conservation, two participants have over 20 years of conservation experience, and five participants have 5 to 10 years of experience. Each of the 20 participants

has been involved in fewer than five projects using digital tools to collect heritage data information during conservation projects.

Table 1. Demographic Information

Group	Position	Years of Experience in The Heritage Conservation Project	Numbers of Involvement Using Digital Tools for Heritage Data Documentations
Group 1	(R1) Academician	5 to 10 Years	< 5
	(R2) Consultant	15 to 20 Years	< 5
	(R3) Conservator	10 to 15 Years	< 5
	(R4) Government Agency -JWN	5 to 10 Years	< 5
	(R5) Academician	10 to 15 Years	< 5
Group 2	(R1) Government Agency -JKR	10 to 15 Years	< 5
	(R2) Conservator	15 to 20 Years	< 5
	(R3) Contractor	15 to 20 Years	< 5
	(R4) Consultant	15 to 20 Years	< 5
	(R5) Consultant	15 to 20 Years	< 5
Group 3	(R1) Consultant	5 to 10 Years	< 5
	(R2) Government Agency -JWN	15 to 20 Years	< 5
	(R3) Contractor	20 to 25 Years	< 5
	(R4) Conservator	25 to 30 Years	< 5
	(R5) Government Agency -JWN	5 to 10 Years	< 5
Group 4	(R1) Academician	10 to 15 Years	< 5
	(R2) Contractor	15 to 20 Years	< 5
	(R3) Government Agency -JWN	5 to 10 Years	< 5
	(R4) Government Agency -JWN	10 to 15 Years	< 5
	(R5) Conservator	25 to 30 Years	< 5

Opinion on Current Practice and Implementation of Digital Heritage Information System

Four participants in a small group were given questions on their opinions on the challenges in current practices and the implementation of digitalising heritage information systems. The micro-groups are categorised under four pillars of the framework: people, process, technology, and policy. Based on the following results, most participants acknowledge their challenges in existing digitalisation practices and implementations.

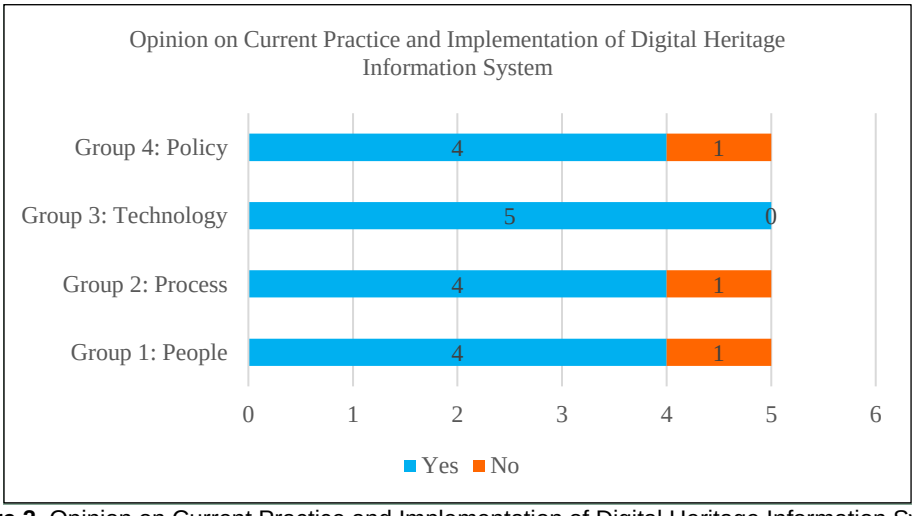


Figure 2. Opinion on Current Practice and Implementation of Digital Heritage Information System

Perception on Using Digitalising Tools for Heritage Information System

A question was posed to each participant in the group, seeking whether they agreed with the application of digital tools to replace the conventional method in heritage information systems. As can be seen in the results presented below, most participants favour digital tools and believe that digitalising heritage information systems for conservation projects is a trustworthy instrument.

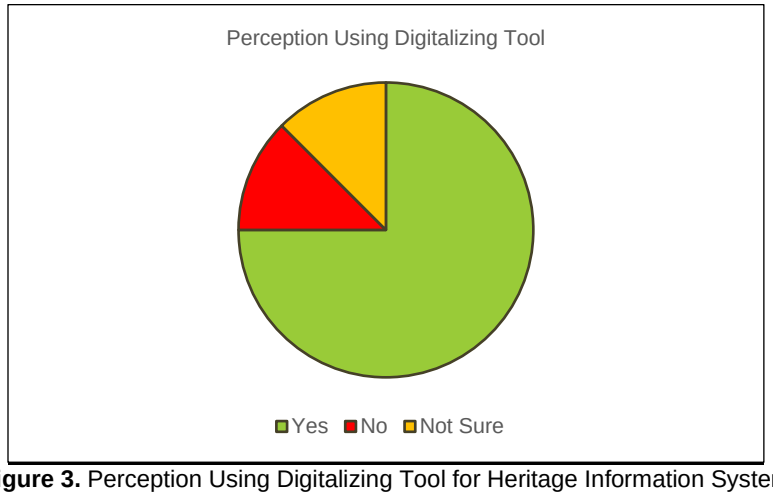


Figure 3. Perception Using Digitalizing Tool for Heritage Information System

Challenges in Current Practice and Implementation of Digital Heritage Information System

Each group member is asked questions concerning the challenges encountered in the existing practice and implementation of digital heritage information systems. The groups are classified based on the pillar concept in the digitalisation framework, which includes **people, processes, technology, and policy**. All answers from interview sessions are transcribed according to themes, as shown in Table 2.

Table 2 shows all the responses from interview sessions regarding the challenges in current practice and implementation of heritage data information systems. The responses are divided into four main categories of digital heritage framework: people, process, technology and policy. Based on the responses, twenty challenges were identified and transcribed into an analysis using thematic answers. Every key factor of digital tools is confronted with its obstacles, regardless of whether those challenges originate from people, processes, policies, or even the technology itself. When adapting and implementing digital technology for heritage information systems, the primary challenges are primarily caused by a lack of expertise and knowledge on digitalisation and digital tools. In addition, the process is considered difficult and unstandardised, which can lead to interoperability and incompatibility and may cause the project to take longer to complete. As an additional point of interest, these digital technologies are expensive and require enormous investment to acquire software and hardware. There is a lack of guidance, standards, and policy from the government, which causes digital innovations to be slow in their adaptation. Finally, it is said that the lack of government involvement is another factor that makes it difficult to fully adopt digitalisation in heritage conservation.

Table 2. Challenges in Current Practice and Implementation of Digital Heritage Information System: People Factor

Group	Answer	Themes (Based on Answer)
Group 1 (People)	R1 – "Many professionals in the field are highly skilled in traditional methods but may not have the technical skills needed for digital tools and software."	Lack of expertise
	R2 – "Another issue is the lack of awareness among stakeholders about the importance of digital conservation…the top management to the operational staff…not fully understand how digital approaches can enhance their work."	Lack of stakeholder awareness
	R3 – "Many companies do not offer comprehensive programs or workshops to upskill their staff in the latest digital technologies and methods."	Lack of education and training in adopting digital conservation
	R4 – "A rigid attitude and fear of new and advanced technology…hinder the adoption of digital conservation methods…comfortable with their current practices and wary of changing established routines."	Rigid attitude and fear of new and advanced technology
	R2 – "In addition…top management sometimes fails to provide adequate incentives or rewards to motivate staff to embrace digital approaches. Without encouragement and recognition, staff may not see the value in investing time and effort into learning new technologies."	Incentives and rewards from management
Group 2 (Process)	R1 – "…the difficulty in collaboration and standardisation leads to interoperability issues. Different stakeholders often use various systems and formats, making it hard to integrate and standardise data across the board…many stakeholders operate in silos, with isolated and fragmented processes…each stakeholder works independently."	Isolated and fragmented process
	R2 – "…stakeholders still rely on manual or conventional submissions, with only a few adopting digital documentation processes. This slow transition creates a mixed environment where digital and manual methods coexist."	Manual or conventional submission
	R3 – "There is a noticeable lack of standard operating procedures (SOPs) in digital processes. Many conservation stakeholders still focus on manual submissions, as the Jabatan Warisan Negara (JWN) dictates, instead of digital ones, creating a disconnect and lack of uniformity in processes."	Lack of standard operating procedure (SOP) in the digitalisation process
	R4 – "This lack of standardised formatting leads to compatibility issues…difficult for all users to access and utilise the data effectively."	Unstandardised and incompatible data formats
	R1 – "There is often no central data repository or shared library encompassing the entire building lifecycle, including operation and maintenance. This absence of a centralised system hinders efficient data management and access."	No central data repository
	R2 – "…. the lack of management support. Many top managements are reluctant to embrace change…to implement digital conservation methods. Without their backing, driving the necessary changes and securing the required resources is hard."	Lack of top management support
	R3 – "Errors in budgeting are also a concern, particularly during dilapidation surveys…due to the occupied status of buildings, leading to incomplete data and subsequent budgeting errors."	Lack of knowledge and limitations during the dilapidation survey

Group	Answer	Themes (Based on Answer)
Group 3 (Technology)	R1 – "…. the high cost associated with purchasing the necessary software. Conservation software tends to be specialised and, therefore, quite expensive. The initial investment…major barrier for many organisations"	High-cost software
	R2 – "Similarly, the tools required for digital conservation, such as advanced imaging devices, sensors, and other technological equipment, are often costly. Adopting equipment adds to the financial burden, especially for smaller organisations or those with limited budgets."	High-cost hardware
	R3 – "The technology used in digital conservation can be highly complex and difficult to implement. Ensuring compatibility across the entire team can be challenging, as different team members may have varying technological expertise and access to different systems."	Complex technology and incompatible
	R4 – "…absence of a single repository platform that can integrate all tangible and intangible information in a standardised format. Without a unified system, managing and accessing data becomes complex."	Complex technology and incompatible
Group 4 (Policy)	R1 – "… lack of clear government policy initiatives, protocols, mandates and direction regarding digital transformation. Without strong policy support, it is difficult for organisations to prioritise and align their efforts towards digital conservation."	Lack of direction of conservation efforts – policy, protocol and mandates
	R2 – "…the lack of standard guides and authoritative training programs on implementing digital heritage. Without these, many organisations are unsure how to begin and sustain their digital conservation efforts."	Lack of guides and training from authority
	R3 – "The industry often lacks clear direction or requirements regarding digital heritage…absence of requirements from the government for purchasing the necessary hardware and software within existing procurement and contract processes."	There is no requirement to purchase hardware and software in the existing contract.
	R4 – "Legal issues surrounding the use and management of digital data (softcopies)…There are often concerns about data security, authenticity, and intellectual property rights, which can hinder the adoption of digital methods."	No preparation of legal issues on softcopy data
	R1 – "…lack of benchmarks or pilot projects means there are few examples to follow, leading to low adoption rates. Organisations may hesitate to invest in digital conservation without successful case studies or pilot projects to demonstrate the benefits."	No benchmarks or pilot projects

CONCLUSION

The results of this study have contributed to the knowledge of the challenges encountered in Malaysia's conservation industry regarding the digitalisation of built heritage based on the perspective of focus groups. Consequently, the study reveals some challenges that are listed in the Table 3.

Therefore, it is possible to overcome these challenges by boosting the degree of understanding, awareness, and exposure among stakeholders. In addition, it is also possible to improve the motivation and positive attitude of conservation stakeholders to embrace a digital heritage strategy. Creating a comprehensive digital dataset, also known as a digital repository, is recommended by collecting, digitising, and keeping original documentation that

includes both graphical and non-graphical data. The new digital working environment may initially present specific difficulties; however, it will provide more advantages compared to the traditional approach. Furthermore, given the high cost of software, it is recommended that businesses set aside a sizeable amount of money and resources to improve their software's capabilities. All parties, whether the government or stakeholders, must acknowledge and support the actions to conserve digital heritage. Thus, it will increase the demand for digital heritage and its increasing adoption. Building a project for reference or pilot initiatives is also necessary as a baseline for future projects. This benchmark may assist users and practitioners in gaining confidence and understanding of digitalisation (Haron, 2013; Latiffi et al., 2016; Megahed, 2015; Yaakob et al., 2016). By conducting interview sessions with the focus group participants, the challenges in the current practice of digital heritage information systems in Malaysia's industry were identified, through these challenges, it can contribute towards the awareness and exposure of digital heritage.

Table 3. Challenges in The Current Practice of Digital Heritage Information Systems Based on Interview Sessions with Stakeholders

CHALLENGES IN CURRENT PRACTICE TO ADOPT DIGITAL HERITAGE INFORMATION SYSTEM		
PILLAR	***SUB-PILLAR***	***CRITICAL CHALLENGE (S)***
PEOPLE	Training and Education	PE 1: Lack of expertise
		PE 2: Lack of education and training in adopting digital conservation
	Attitude	PE 3: Rigid attitude and afraid of new and advanced technology
	Management Efforts	PE 4: Lack of stakeholder awareness
		PE 5: Incentives and rewards from management
PROCESS	Modelling	PR 1: Isolated and fragmented process
		PR 2: Manual or conventional submission
		PR 3: Lack of standard operating procedure (SOP) in the digitalisation process
		PR 4: Unstandardised and incompatible data formats
	Integrated	PR 5: No central data repository
		PR 6: Lack of top management support
		PR 7: Lack of knowledge and limitations during the dilapidation survey
TECHNOLOGY	Software	TE 1: High-cost software
	Hardware	TE 2: High-cost hardware
	Compatibility	TE 3: Complex technology and incompatible
POLICY	Policy and Guideline	PO 1: Lack of direction of conservation efforts – policy, protocol and mandates
		PO 2: Lack of guides and training from authority
		A3: No benchmarks or pilot projects
	Contract and Procurement	A4: No requirement to purchase hardware and software in existing contract
	Legislation	A5: No preparation of legal issues on softcopy data

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IMPACT OF HOT GULF CLIMATES ON THE CURING AND EARLY STRENGTH OF UHPFRC

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Abstract
This study investigates the effect of diverse curing regimes on the early-age mechanical properties of ultra-high performance fiber reinforced concrete (UHPFRC). Specimens composed of a standard UHPFRC mix design underwent water curing for 7 days under three distinct conditions: 1) room temperature, 2) simulated Gulf climate temperatures, 3) high-heat treatment. Results implied that the apparent densities of the UHPFRC specimens displayed minimal sensitivity to the curing techniques. However, the specimens subjected to Gulf climate curing were able to obtain a 7-day compressive and flexural strengths of 95.4 MPa and 20.7 MPa, respectively, surpassing the strengths achieved under room temperature conditions by at least 10% and remaining within a 20% margin of high-heat treated strengths. It was further noted that the international EC2 and ACI 363R standards, which yields predictions for high strength concrete, underestimates the actual early-strength of UHPFRC. Load-deflection curves suggested that curing under Gulf climate conditions can improve the ductility and long-term performance of UHPFRC. It was also deduced that curing under Gulf climate can lead to higher first-crack strengths and improved toughness and resistance to progressive failure. In summation, the outcomes from this study support that in-situ production of UHPFRC in the Gulf can potentially achieve formidable mechanical properties without necessitating high-heat treatments.

Keywords: *Hot gulf; concrete curing; curing regimes; durability; ductility; early strength*

INTRODUCTION

Concrete is the most widely used construction material, with its applications ranging from residential structures to highways and offshore infrastructures. Concrete possesses numerous characteristics that make it a versatile material, including high compressive strength, strong fire resistance, low cost, and the ability to be easily moulded into almost any desired shape (Aram, 2013). Some of the drawbacks of concrete, however, include its low tensile strength, brittleness, and a high degree of variability in terms of mechanical properties due to the quality of the constituent materials (Shaikh et al., 2020). To address these limitations, a new form of concrete known as Ultra-high performance fiber reinforced concrete (UHPFRC) emerged in the 1990s. UHPFRC was developed to meet the growing demands of modern construction by incorporating fibers and advanced mix designs that enhance the mechanical and durability performance that conventional concrete can no longer satisfy, making it a promising solution for various structural applications. UHPFRC typically consists of a significant amount of cement, small size aggregates, fibers, cementitious supplements such as fly ash, silica fume, and ground granulated blast furnace slag, and an extremely low water-cement (w/c) ratio of approximately 0.2 (Zahid et al., 2020). The result of this mix design is a highly dense and tightly interconnected product that is homogenous and possesses a porosity lower than 1.5%, tensile strength of above 7 MPa, superior ductility, enhanced flexural strength, and a compression strength higher than 150 MPa, while weighing one third to one half as much as ordinary concrete under the same loading conditions (Benthia et al., 2016). However, due to the high production cost of UHPFRC, which is mainly driven by the heat treatment, steel fibers and reactive powders (Yoo et al., 2016), it is not commonly used in situations where conventional concrete meets the required performance criteria. Its mechanical properties are

also affected by a several factors such as the curing conditions, size of aggregates, specimens' size and shape, and the rate of loading. As aforementioned, heat treatment is a fundamental process in the production of UHPFRC, as it initiates an intense pozzolanic activity within the mixture constituents, resulting in a denser composite material and superior mechanical properties (Richard et al., 1995). Also, heat treatment of UHPC alone can often result in a brittle material with limited ductility, similar to normal concrete. To rectify this issue, steel fibers are introduced to the mix, which improves both the ductility and tensile capacity of UHPFRC and increases it deformability under loading (Buttignol et al., 2017). Controlling the temperature and humidity without the specialized and expensive equipment, however, restricts UHPFRC production primarily to the precast sector (Shaikh et al., 2020). Furthermore, curing UHPFRC members under standard conditions for 24-48 hours and at temperatures ranging from 60-90°C (von Werder et al., 2021) requires a lot of energy and produces a large carbon footprint (Shaikh et al., 2020).

A few recent studies, however, have suggested that heat treatment of UHPFRC at lower temperatures of around 40°C, which is prevalent in hot climatic countries, can result in mechanical properties similar to, and in some cases superior to, those acquired under standard 60-90°C steam or hot water curing (Park et al., 2015). While this area is yet to be extensively studied (Hassan, 2013), this finding would then render it feasible to cast and cure UHPFRC in-situ at construction sites, and further reduce the environmental impacts and high production costs. According to climate statistics, the temperature in the Arabian Gulf region exceeds 40°C several months a year, with summer temperatures even reaching up to 50°C in countries like Oman, Kuwait and the United Arab Emirates (Meteoblue, 2021). Given these high ambient temperatures, the application of heat treatments in the production process of UHPFRC may not be necessary in such countries. This reduction in production cost will not only greatly encourage the use of UHPFRC for construction in these regions, but also generate an increased interest in research studies focusing on the use of UHPFRC in hot weather countries.

In line with the above perspective, the objective of this study is to investigate the impact of varying heat treatment methods on the early-age mechanical properties of UHPFRC. Evaluating the early-age strength of concrete is crucial multiple reasons, including meeting construction schedules, ensuring the safety of workers and the public, resisting long-term environmental factors, and maintaining quality control of materials. Specifically, the study aims to subject UHPFRC specimens to three different water curing regimes over a period of 7 days. The first regime involves curing at room temperature, the second at temperatures that simulate the average climate of a region in the Gulf, and third under the standard temperature of 60-90°C. The experimental investigation will focus on key mechanical attributes of UHPFRC, including the monitoring of the variation in curing temperature over time, hardened apparent density, compressive strength, flexural strength, load-deflection behaviour in bending, crack development, first-crack strength, and deflections under flexure. The outcomes of this study are expected to provide valuable insights into the potential of utilizing the available climatic conditions in hot countries as a method of heat treatment for UHPFRC, which may facilitate the widespread adoption of this type of concrete in countries like Oman.

EXPERIMENTAL WORK

The experimental work in this study was conducted in the Materials Laboratory of the School of Civil Engineering & Surveying, University of Portsmouth. The materials, mix design, casting technique, and curing regimes employed for developing the ultra-high performance fiber reinforced concrete (UHPFRC) were adopted from Muqaibal (2020).

Materials and Mix Design

To date, various UHPFRC mixes have been documented in the literature in which each mix varies in proportions and strength (Zahid et al., 2020). Table 1 below outlines the UHPFRC mix design used in this study, which was originally implemented in the study of Harkin et al. (2016) and has been proven to be successful, however without the involvement of heat treatment in the curing process. A brief description of each material used in the mix design is given in Table 1.

The cement was of high strength Portland cement type CEM1 with a strength class of 52.5 N. This type is known to promote rapid strength development at early age. The dry silica fume powder used in this study acts physically to optimize particle packing of the mixture due to its highly reactive pozzolan. The silca fume had an average particle size of 0.1µm and a bulk density of 250 to 300 kg/m^3, while the silica sand in this mix had an average particle size of 270µm. The utilized AURACAST 200 superplasticizer is a unique combination of the latest generation of polycarboxylate polymers which act synergistically to outperform conventional superplasticizers (FOSROC, 2020). The steel fiber was made of carbon steel with dimensions of 13 mm in length and 0.2 mm in diameter and exhibited a high tensile strength of 2750 N/mm^2. For all specimens produced in this study, the steel fiber inclusion was limited to 2.0% by volume.

Table 1. Mix Proportions of the UHPFRC

Material	(Kg/m^3)
Cement	1075
Silica fume	119
Silica sand	1050
Steel fibers (2%)	157
Superplasticisers	40
Water	173 (1.61 %)

Specimen Preparation

Zahid et al. (2020) noted that the mixing procedure for UHPFRC has a significant effect on the quality of the concrete produced. The study also reported that, to promote homogeneity and prevent agglomeration, dry particles should be blended before the addition of water and superplasticizers, which was also consistent with the findings of Maca et al. (2013) and Prem et al. (2015) Therefore, the same approach was adopted in this study during the mixing stage. The materials were initially weighed to the targeted proportions using an electronic scale. The dry particles (except for the steel fibers) were then added to the mixer and mixed for 2-3 minutes until they reached a fine, lump-free consistency. Subsequently, the specified quantity of water was added while mixing. Following this, the superplasticizer was gradually

introduced to mixture while mixing until the dry powder mix had transformed into a wet paste concrete, typically taking about 5-10 minutes (Figure 1). In the final step, steel fibers were gradually incorporated into the mixture, and the mixing continued for an additional 5 minutes. The gradual addition of steel fibers towards the end of the mixing process was intended to minimize coagulation of fibers in the mixture, which could lead to the formation of voids in the mixture and potentially reduce the compressive strength of concrete (Zahid et al., 2020).

(a) (b)

Figure 1. (a) Flowable UHPFRC Mix; (b) UHPFRC Specimens Water Cured at Room Temperature

Following the mixing stage, the concrete mix was manually casted using scoops into 18 molds: nine 100mm × 100mm cubes with accordance to BS EN 12390-1:2000; and nine 100mm × 100mm × 500mm prismatic beams in line with ASTM C1609. Prior to pouring the concrete, the inside walls of the molds were lightly coated with a mold releasing agent to prevent the concrete from sticking to the internal surfaces and ease the de-molding process. Furthermore, when casting the beams, the concrete was poured from one end and allowed to flow to the other end. This was done to ensure the alignment of fibers parallel to the direction of flow, as this has been shown to enhance the flexural performance of beams (Kwon et al., 2012 and Yang et al., 2010). After casting, the molds were then compacted for 90 seconds on a vibrating table in accordance to BS EN 12390-2:2009 and left to set for 24 hours before de-molding.

Curing Regimes

To align with the objectives of this research, three distinct water curing methods for the UHPFRC specimens were investigated after de-molding. The general procedures were adopted from Hassan (2013) and Park et al. (2015). These are outlined as follows:

1) The first six specimens, comprising of 3 cubes and 3 beams, underwent a conventional concrete curing process. After de-molding, they were immersed in water at room temperature (20°C) for a duration of 7 days (Figure 1b), before testing.

2) To gain insights into the expected temperatures within the hot desert climates, this study analysed weather data from one particularly country in the Gulf region, Oman, spanning the past three decades, as shown in Figure 2 (Meteoblue, 2021). The figure indicates that the average daytime temperature in exceeds 40°C from April to September (6 months). On the other hand, the average night temperature at these months was 27°C, which is still higher than the room temperature used in previous

studies (around 20°C) (Shaikh et al., 2020). Accordingly, another six specimens (3 cubes and 3 beams) were placed in a plastic box containing sufficient water to immerse the samples. The box was then sealed and placed inside an oven temperature controlled over a 24-hour period (Figure 3a). The temperature inside the oven was initially set to 40°C for a duration of 8-9 hours, to represent the daytime temperature expected in a Gulf region. Following this, the oven switch was turned off, such that the temperature in the oven would gradually decline over the remainder 24-hour period to cooler temperatures in the range representing night-time temperatures in a Gulf region. The process was repeated for 7 days, while the temperature was monitored hourly throughout these days using thermocouples (Figure 3b), after which the relevant tests were carried out.

3) The standard heat treatment of UHPFRC typically involves exposing the specimens to steam or water curing at temperatures ranging from 60-90°C for 48 hours (von Werder et al., 2021). In this study, a standard temperature of 70°C was opted for the heat treatment due to the limited heat resistance of the plastic boxes used to contain the six specimens. The box was initially filled with water to completely immerse the six samples, and then sealed to prevent water evaporation. The box was then placed inside the oven set at a temperature of 70°C for 48 hours (Figure 3a), throughout which period the temperature was monitored using thermocouples (Figure 3b). After this period, the box was removed from the oven and placed at room temperature for a duration of 5 days, prior to the testing phase.

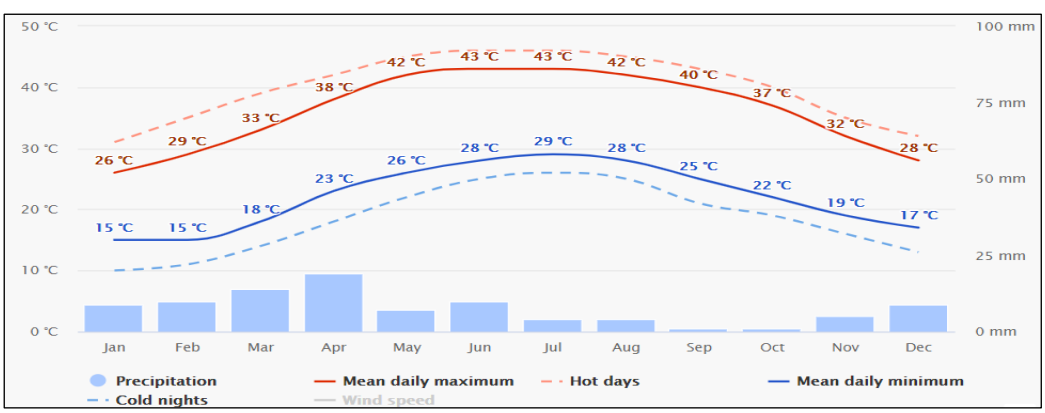

Figure 2. Average Monthly Temperature in Oman Over a 30-Year Period (Meteoblue, 2021)

Figure 3. a) UHPFRC Specimens Placed in Oven for Heat Treatment; and b) Thermocouples Attached to The Boxes

Testing Apparatus and Procedure

Upon the completion of the 7-day curing period, the UHPFRC specimens were then subjected to a number of mechanical tests in order to evaluate the early-age performance of the concrete. Each of the three aforementioned curing regimes was subjected to three 100 mm cubes and three 100 mm x 100 mm x 500 mm prisms, resulting in a total of nine cubic specimens and nine prismatic specimens that were tested. The specific tests are outlined below.

Hardened Apparent Density

The 7-day apparent density of the UHPFRC specimens were determined in accordance to BS EN 12390-7:2009. Each specimen was firstly dried using an oven at 100°C for a period of 24 hours, then cooled to room temperature, after which the dried mass of the specimen (M_1) was measured using a PGW precision balance. The specimen was then placed inside a hooked stirrup (for grip) that was suspended from beneath the balance, following which the stirrup and specimen were fully immersed in water. The mass of the fully immersed and suspended specimen was then measured (M_2). After removing the specimen from the water and stirrup, the surplus water from the surfaces of the specimen were wiped off using a moist cloth. The mass of the specimen in air was subsequently measured using the balance (M_3). The apparent density of the concrete (ρ_c) was then determined by Equation (1):

$$\rho_c = \frac{M_1}{M_3 - M_2}\rho_w \tag{1}$$

Figure 4. Cube Compression Test

Compressive Strength

The 7-day compressive strength development was obtained using the standard 100 mm cube specimens in accordance with BS EN 12390-3:2009. All 9 cubes were loaded on the face perpendicular to the casting face using an ELE ADR Touch Compression Machine that has a force capacity of 2000 kN and complies with BS EN ISO 7500-1 (Figure 4). The compression machine exerted a progressive force at a constant rate of 4 kN/s on the cube until failure occurred by crushing. The reading on the machine at failure (in MPa) was taken as the maximum compressive strength of the concrete (f_{ck}) with accordance to BS EN 12390-2: 2009 / BS EN 12390-3:2009.

Flexural Strength

The flexural strength is another important property that is a measure of the tensile strength of concrete beams and slabs, as well its resistance to bending and transverse loads. The development of the flexural strength of the UHPFRC specimens was examined using a four-point bending test as per the guidelines of ASTM C78/C78M-10. This test is widely employed to measure the indirect tensile strength of concrete, due to the complexities associated with performing direct uniaxial tensile tests (Hassan et al., 2021). A total of 9 prismatic beams (100 x 100 x 500 mm) were subjected to a four-point bending test using a Zwick/ Roell Z250 Universal testing machine (Figure 5a-b), which has a load capacity of 250 KN. As shown in the apparatus of Figure 5a, the loading points and supports of the beam were symmetrically positioned at distances of 150 mm and 450 mm, respectively. Loading was applied at a constant rate of 2 kN/min at the two points on the beam simultaneously until the beam failed by rupture (Figure 5b). The flexural strength was then calculated using the Equation (2), which is based on elastic beam theory that assumes a linear elastic stress-strain behaviour until failure:

$$f_{ct,fl} = \frac{P_u L}{W d^2} \tag{2}$$

where σ is the flexural strength (MPa), P_u is the maximum force applied (N), L is the length of the sample (mm), W is the average width of the sample (mm), and d is the average depth of the sample (mm).

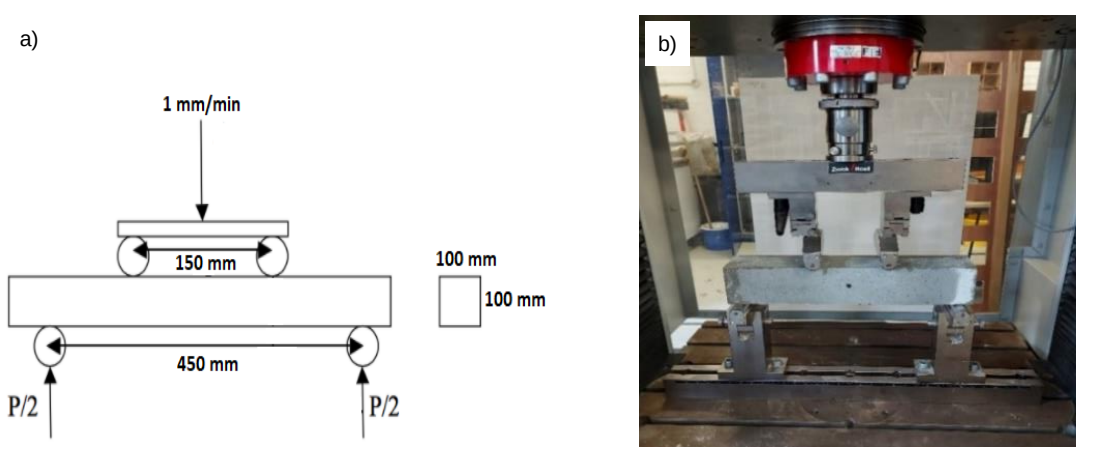

Figure 5. a) Four-Point Bending Test Setup (ASTM C78-10); and b) UHPFRC Beam in Zwick/ Roell Z250

First-Crack Strength

The first cracking strength is another important parameter that has been recommended for assessing tensile performance of UHPFRC in the absence of a direct tensile test (Hassan, 2013). By definition, first crack occurs when the maximum tensile stress in concrete reaches the rupture modulus of the concrete (ASTM C1018-97). Furthermore, according to the ASTM C78-10:2010, the first-crack strength is calculated using Equation (3):

$$f_{cr} = n\frac{P_y L}{Wd^2} \tag{3}$$

where P_y is the load at first crack (N), L is the span length, W is the width of the specimen (mm), d is the depth of the specimen (mm) and n is a variable depending on the loading configurations and equals 1 herein. The load at first-crack (P_y) was obtained from the load deflection curve produced by the Zwick/Roell Z250 Universal testing machine, which corresponded to the point where the curve's shape first changes from linear to non-linear (Moreillon et al., 2012).

Load-Deflection Measurement

The load-deflection curve serves as a valuable tool for interpreting the deformation behaviour of concrete elements subjected to transverse loads. It is also essential for determining the toughness, toughness factor, and flexural toughness indexes of concrete beams. The load-deflection characteristics of the 100 mm x 100 mm x 500 mm beams were determined in accordance with the guideline of ASTM C1609. The testing apparatus was similar to four-point test aforementioned using the Zwick/Roell Z250 machine (Figure 5b). Additionally, a rectangular jig was set up around the specimen and clamped to the specimen at mid-height directly over the supports (Figure 6). Two electronic displacement transducers, with a recording accuracy of 0.001 mm, were then mounted at the mid-span of the beam (on either side) with support brackets and connected to a data recording system. Due to the sensitivity of the transducers, they were positioned vertically and gently in contact with the metal supporting brackets. The loading on the beam was applied at a rate of 0.1 mm/min until an end-point deflection of L/150 was reached. The in-built data acquisition system (testXpert) was capable of recording the load and deflection data at sampling frequency of 450 kHz.

Figure 6. Rectangular Jig Surrounding the Specimen with Two Displacement Transducers Mounted at Mid-Span (ASTM C1609)

RESULTS AND DISSCSSION

Curing Temperature

Figure 7 shows the recorded temperatures for specimens cured under the simulated gulf climate conditions over a 7-day period. Notably, during the 9-hour daily period when the oven was operational, the maximum simulated temperatures that the UHPFRC specimens

experienced ranged from 36.5°C to 38.5°C. As expected, this temperature range reached its peak just prior to the oven being turned off. Furthermore, this range was within acceptable limits of representing the average 40°C day-time temperature in one of the Gulf regions (Figure 2). On the other hand, the minimum temperature ranged from 27.8°C to 30.6°C, which was also an accurate representation of night-time conditions (Figure 2).

The temperature variation of the UHPFRC specimens cured under standard heat treatment over a 48-hour period is displayed in Figure 8. Based on the data, the curing temperature reached a peak value of 60°C approximately 18 hours after the oven was turned on, following which this temperature was maintained for the remainder of the curing time. Consequently, the specimens were subjected to elevated heat treatment for about 30 hours. For future reference, it may have been optimal to pre-heat the water to the standard temperature range of 60-90°C (von Werder et al., 2021) prior to exposing the specimens to the water. Nevertheless, the current heat treatment method is still expected to yield significant results.

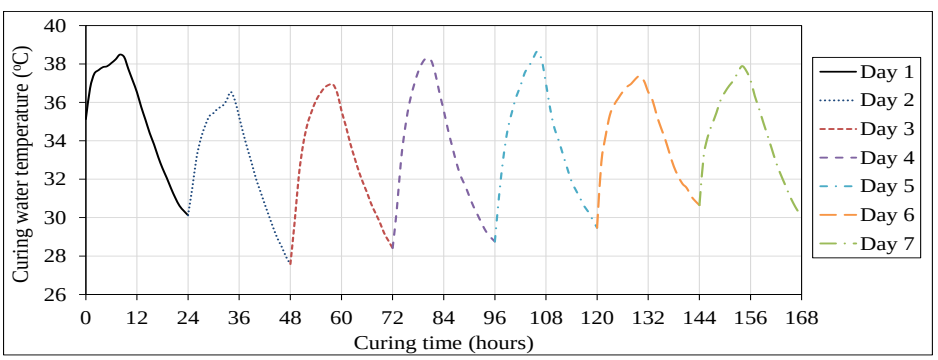

Figure 7. Variation In Temperature of UHPFRC Samples Cured Under Simulated Gulf Climate

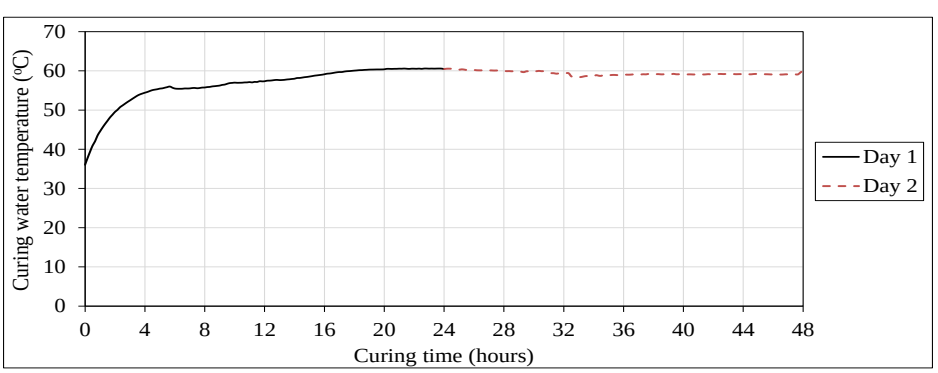

Figure 8. Variation In Temperature of UHPFRC Samples Cured Under Standard Heat Treatment

Apparent Hardened Density

Prior to testing, the apparent density of all the UHPFRC cubes were measured for all the different curing regimes, as shown in Figure 9 below. The cubes that were cured at room temperature consisted of a density between 2289 – 2304 kg/m^3, while the cubes that were cured under gulf simulated climate and standard heat treatment exhibited densities in between 2293 – 2322 kg/m^3 and 2295 – 2317 kg/m^3, respectively. Hence, the overall densities of the cubes was within a narrow range of about 2289 – 2322 kg/m^3, indicating that the method of curing did not have a significant impact on the overall density of the UHPFRC material. In

other words, the method of curing did not cause substantial changes in the compactness or porosity of the UHPFRC material. This also suggests that the different curing methods may not have induced significant variations in the distribution of the constituents of the concrete matrix, resulting in a relatively stable microstructure. The similarity in apparent density values could also indicate that all three curing methods were effective in promoting proper hydration and achieving a relatively uniform concrete structure.

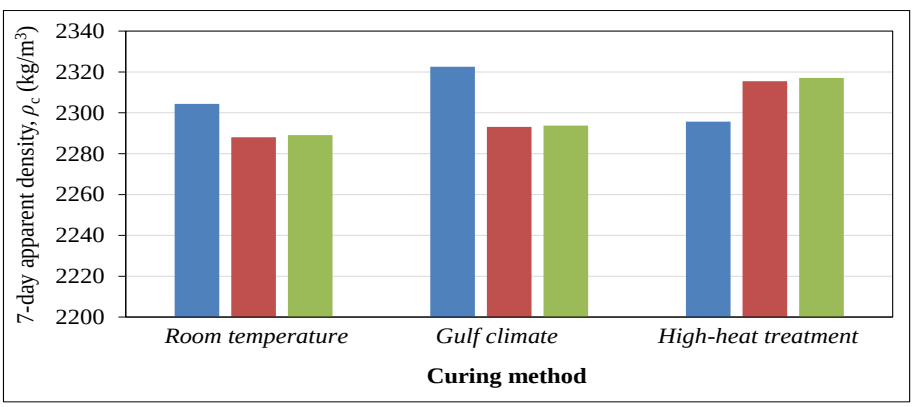

Figure 9. Values of Apparent Density for UHPFRC Samples Under Varying Curing Methods

Compressive Strength

Figure 10 depicts the 7-day compressive strength (f_{ck}) of the UHPFRC cubes under three different curing conditions. The graph demonstrates some interesting correlations between curing temperature and compressive strength. Firstly, the compressive strength of UHPFRC increases with respect to increasing curing temperature. This trend aligns with the known behavior of UHPFRC and their response to temperature variations during the early curing period, and further suggests that higher temperatures during the curing process are advantages for accelerated strength gain in UHPFRC. The conventional concrete curing method showed the lowest strength, which was expected as low temperature causes a lower rate of cement hydration and hence requires a longer period to reach full hydration. Figure 11 shows one of the UHPFRC samples after compression test failure, where it can be noticed that there is less observable damage compared to normal concrete. This is due to the steel fibers keeping the sample intact to sustain load even though it has already failed (Harkin et al., 2016).

The average compressive strength of specimens cured under simulated Gulf temperature was approximately 95.4 MPa, which was 18 % greater than the conventionally cured UHPFRC specimens, and about 16 % lower than that of the specimens subjected to high heat treatment. Higher strengths of the specimens are also expected the curing period had been extended up to 28, 90, or 360 days, as reported in previous studies (Hassan, 2013 and Hassan et al., 2021). Nevertheless, the specimens cured under Gulf temperatures showed a considerable early age compressive strength development and proved to be better than room temperature curing, which is very promising for cast in-situ application in countries where high ambient temperatures are common. In addition, the higher compressive strengths implies that construction projects in Gulf countries could potentially benefit from accelerated construction schedules. However, practical applications should also take into account the quality of material properties, construction practices, and the long-term durability performance.

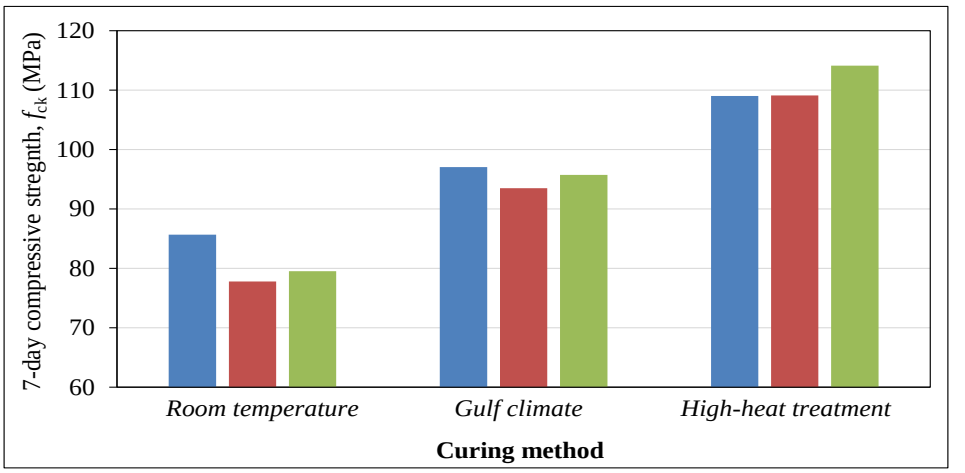

Figure 10. Compressive Strengths of The UHPFRC Samples Under Varying Curing Methods

Figure 11. UHPFRC Cube After Failure

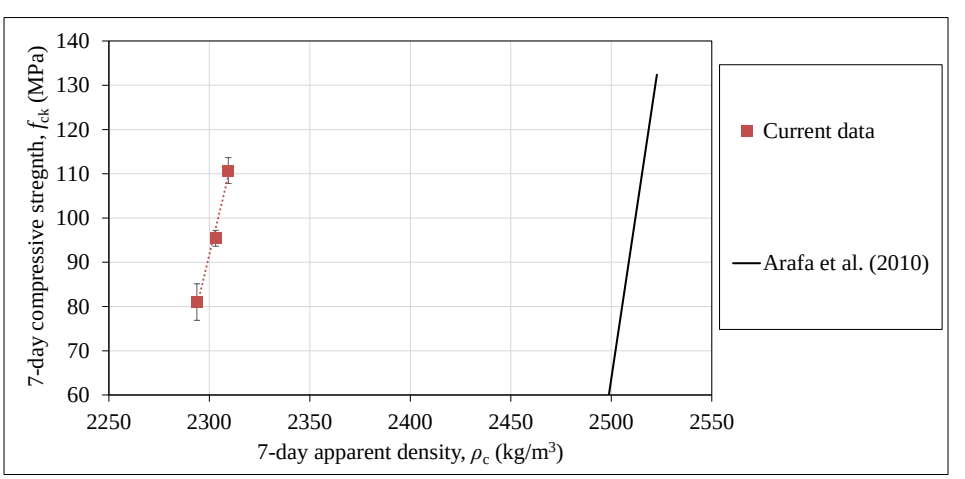

Figure 12. Relation Between Compressive Strength and Density of UHPFRC

Figure 12 illustrates the relationship between the 7-day compressive strength and apparent density for the UHPFRC specimens. It appears that both the current data and the findings of Arafa et al. (2010), where the results of UHPFRC produced from local market materials in the Ghaza strip are presented, form a roughly linear relationship between the two variables. The spread between the two sets of data also indicates the different types or grades of UHPFRC with varying properties, potentially due to variations in materials, mixing procedures, curing conditions, and testing methods. Another intriguing note to make is that at the lower densities, there seems to be a steep rise in the compressive strength corresponding to slight change in the density. This could suggest that optimizing the UHPFRC mix to achieve higher densities in this range may result in significant improvements in compressive strength. However, as the density continues to increase, the rate of increase in compressive strength is expected diminish, naturally, owing to the inherent limitations of how dense the particles can pack together without negatively affecting other material properties. Hence, higher density gains may yield smaller increases in compressive strength.

Flexural Strength

Figure 13 displays the influence of the different curing methods on the 7-day flexural strength of the UHPFRC specimens. Similar to the compressive strength, the figure indicates that higher curing temperatures leads to increased early flexural strengths, resulting from accelerated chemical reactions and improved cement hydration rates at elevated temperatures. The UHPFRC specimens cured under Gulf climate conditions exhibits an average early flexural strength of 20.7 MPa, which is an 11% improvement compared to specimens cured under room temperature, and 18% lower than that of the specimens cured under high heat treatment. Again, the figure highlights the importance of selecting an appropriate curing method for UHPFRC based on the project requirements and existing ambient conditions. While the conventional high heat treatment can accelerate the early strength development, this method raises awareness on the energy consumption and environmental impact, as well as resulting in increased carbon emissions. Based on the figure, however, harnessing the hot climate of Gulf countries as a curing method for UHPFRC can be beneficial, and can facilitate rapid construction progress. Particularly, in construction projects where time constraints are a significant factor, contractors can achieve target flexural strengths within a shorter timeframe, enabling faster formwork removal and subsequent construction phases.

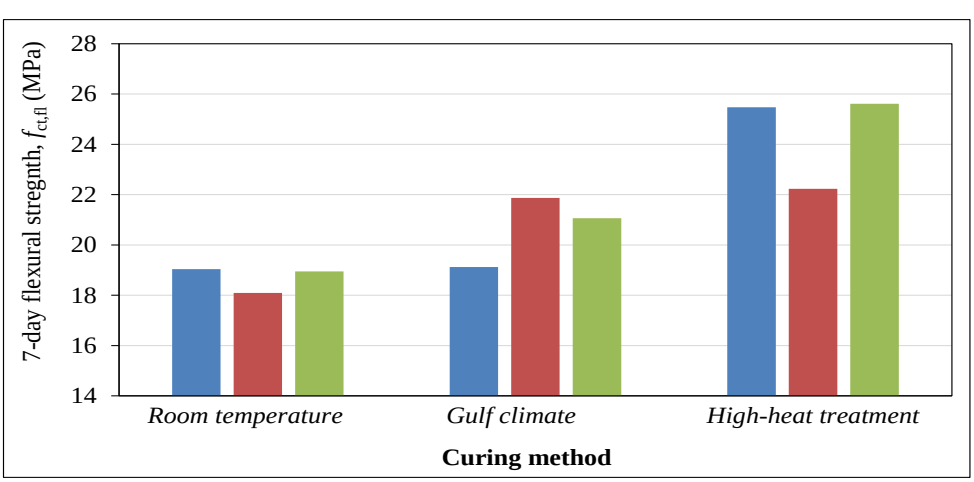

Figure 13. Flexural Strengths of The UHPFRC Samples Under Varying Curing Methods

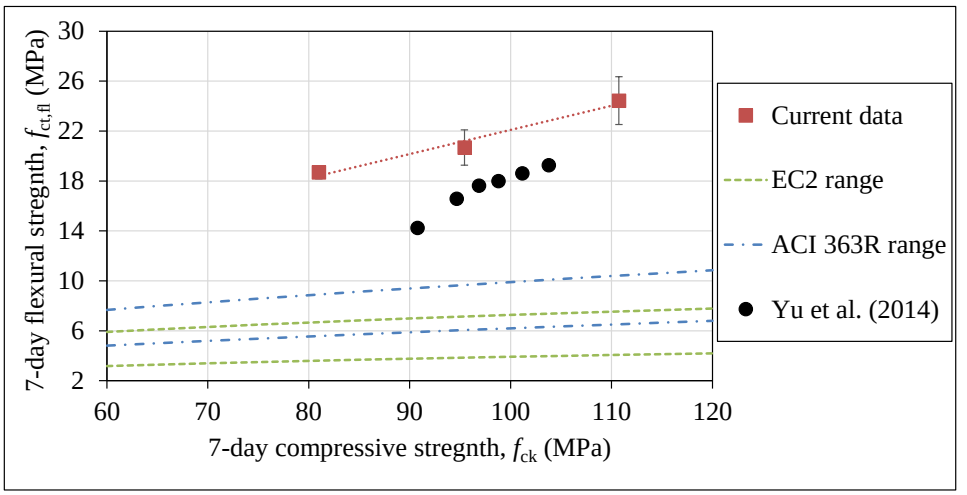

Figure 14. Relation Between Compressive and Flexural Strength of UHPFRC

The relationship between the 7-day flexural and compressive strengths of the UHPFRC specimens is demonstrated in Figure 14. The figure compares the current data with that of Yu et al. (2014), where the effect of nano-silica on the hydration and microstructure development of UHPFRC was investigated. In addition, the figure shows the predictions of the standards Eurocode 2 (EC2) and American Concrete Institute (ACI 363R) pertaining to high strength concrete behaviour, represented by Equations (4) and (5), respectively. It is interesting to firstly note that the trend between the flexural and compressive strengths is found to be relatively linear. Furthermore, the current data and the results of Yu et al. (2014) are closely aligned, with the discrepancies possibly resulting from specific mix design or material choices. Both of the former results also indicate a higher flexural strength corresponding to a specific compressive strength, as compared to the EC2 or ACI 363R. Moreover, the deviation from the predicted relationships in EC2 and ACI 363R implies that UHPFRC possesses distinct mechanical properties that set it apart from even traditional high strength concrete. It further highlights the applications of UHPFRC where flexural strength is more critical in design than the compressive strength, such as members subjected to high lateral loads, bridges, or columns subjected to eccentric loading. Furthermore, the predictions of EC2 and ACI 363R, which were originally developed for conventional high strength concrete, might underestimate the actual flexural strength of UHPFRC. Hence, this observed divergence could motivate the relevant standards to revise their guidelines to better accommodate the distinctive characteristics of UHPFRC.

$$\text{EC2}: f_{ct,fl} = \begin{cases} 0.62\sqrt{f_{ck}}; \text{ lower bound} \\ 0.99\sqrt{f_{ck}}; \text{ upper bound} \end{cases} \tag{4}$$

$$\text{ACI 363R}: f_{ct,fl} = \begin{cases} 0.7 \times 1.1 \times 2.12 \ln\left(1 + f_{ck}/10\right); \text{ lower bound} \\ 1.3 \times 1.1 \times 2.12 \ln\left(1 + f_{ck}/10\right); \text{ upper bound} \end{cases} \tag{5}$$

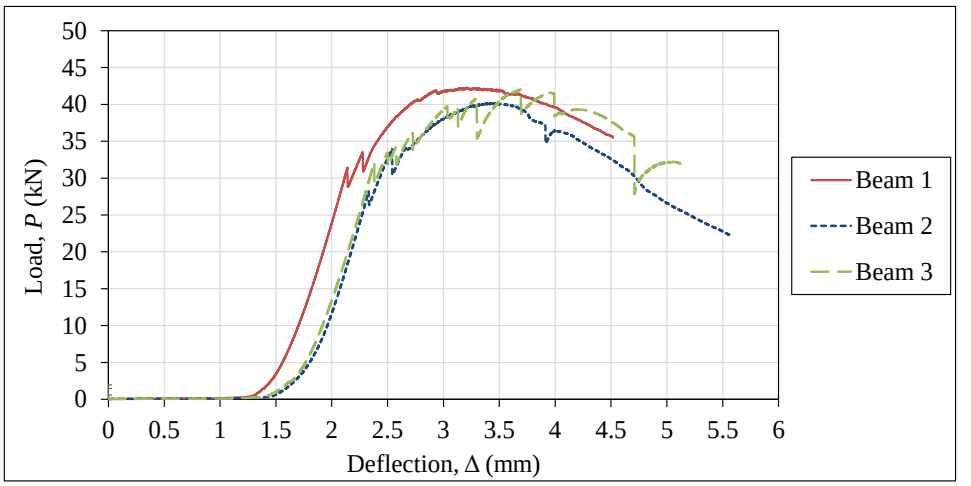

Figure 15. Load Deflection Curve of 7-Day Aged UHPFRC Beams Cured at Room Temperature

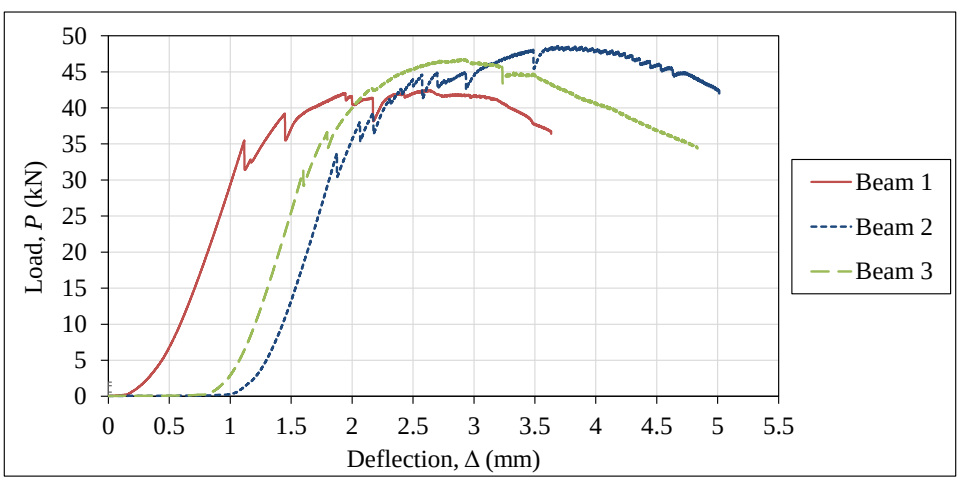

Figure 16. Load Deflection Curve of 7-Day Aged UHPFRC Beams Cured Under Simulate Gulf Climate Temperatures

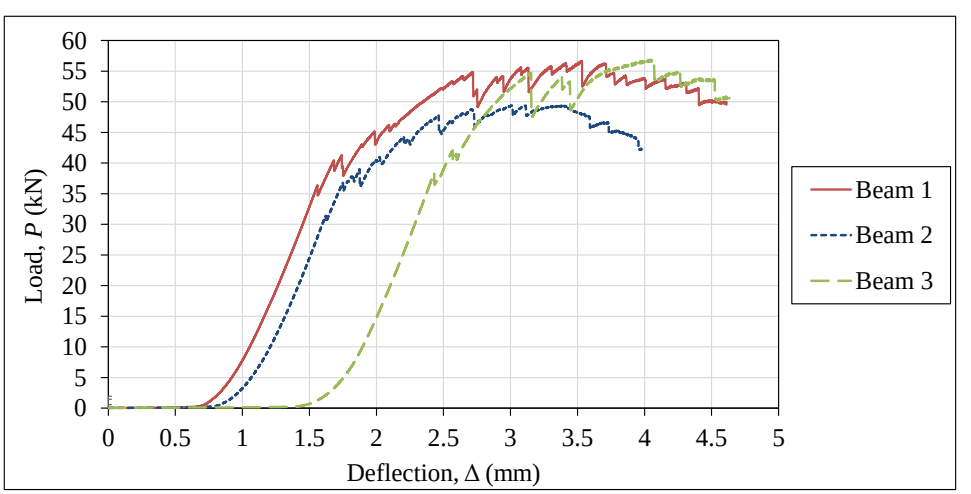

Figure 17. Load Deflection Curve of 7-Day Aged UHPFRC Beams Cured Under Standard Heat Treatment

Load-Deflection Behaviour

Figures 15-17 displays the load-deflection curves of the UHPFRC beam samples corresponding to the three different curing regimes after 7 days of casting, i.e. at room temperature, under Gulf climate and standard high heat treatment. It is apparent that, regardless of the curing temperature, all of the curves of the UHPFRC beams behave linearly within the first phase of the load cycle, which is consistent with recent literature (Hassan, 2013; Meng and Khayat, 2016; Guo et al., 2022).

The UHPFRC beams that were cured at room temperature exhibited a good initial stiffness and underwent predictable deformation characteristics (Figure 15). The curves corresponding to the beams cured under simulated Gulf climate temperatures displayed an initial stiffness that was quite comparable to the room temperature cured beams, indicating that the elevated curing temperature did not compromise the material's stiffness (Figure 16). However, there is a definite increase in load-carrying capacity prior to the non-linear behaviour. This is further indicative that simulated Gulf temperatures contribute to enhanced early strengths as well as improved load-bearing capabilities. In addition, the distinguishable non-linear deformation beyond the linear phase suggests that the increased temperature could also lead to internal material changes that affect its ductility and long-term performance. With regards to the load-deflection curves of the beams cured under standard high heat treatment, a notably higher initial stiffness is evident when compared to the previous two curing methods (Figure 17). This observation aligns with the accelerated advancement in strength within the UHPFRC material, which was previously addressed in the context of both compressive and flexural strengths. Moreover, the gradient of the curves changes much more gradually throughout the load cycle, indicating a more controlled transition from the linear to non-linear phase. This pattern also implies a more predictable and controlled deformation in response to applied loads. The absence of any significant downward trend in the curves, even at higher loads, suggests that the high heat treatment may have effectively mitigated the onset of brittle failure, possibly through improved fiber-matrix interaction or reduced porosity.

Crack Development

In addition to the flexural strength, the first cracking strength was investigated herein to further understand the tensile behaviour of UHPFRC. Upon further examination of Figures 15-17, prior to formation of the first crack, the UHPFRC beams strained but without any observable damage. After the development of the first crack, a sharp drop is noticed in the curve, indicating the point of the first-crack load. As the load continued to increase, a number of microcracks and fiber bridging effects began to appear on the beams, indicating the on-set of non-linear behaviour of the material. At this stage, the flexural load carrying capacity was primarily dependent on the steel fibers content in the mix and its distribution along the fracture plane. In addition, the microcracks' opening, and propagation was controlled by the fibers. This part of the curve is known as the pseudo strain hardening stage (Hassan, 2013). After that, the spacing between microcracks reduced as additional cracks formed toward the end of the hardening stage, until several microcracks joined to form a macrocrack. Following the formation of macrocracks, the samples flexural load resistance quickly deteriorated, resulting in failure, which is also known as pseudo strain softening stage (Hassan, 2013). Figures 18a and 18b display the bending test resistance and failure mechanism of a UHPFRC beam specimen, including the development of microcracks and macrocracks. The beams were

examined after failure, and the tests showed that fiber pull-out is the reason of failure in all cases.

While this study did not include numerical values for crack widths, it was designed to observe the qualitative progression of crack formation and its implications on the material's performance in harsh environmental conditions. The primary focus was on examining the influence of hot Gulf climates on the curing process and early strength development of UHPFRC, with crack formation serving as a critical indicator of the material's response to these conditions. Therefore, while specific numerical values for crack widths are not provided, the qualitative observations offer valuable insights into the behavior of UHPFRC in real-world applications.

(a) (b)

Figure 18. (a) Microcracks in The UHPFRC Beam; (b) Macrocrack in The UHPFRC Beam

Table 2. Four-Point Bending Test Results

Sample	First Crack Load, P_y (KN)	Deflection at First Crack, Δ_y (mm)	Maximum Flexural Load, P_u (KN)	Deflection at Maximum Load, Δ_u (mm)	First Crack Strength (MPa)	Flexural Strength (MPa)
Conventional Curing (Room Temperature)						
Beam 1	31.40	2.14	42.30	3.2	14.13	19.04
Beam 2	28.20	2.33	40.20	3.5	12.69	18.09
Beam 3	32.17	2.38	42.10	3.7	14.48	18.95
Average	30.59	2.28	41.53	3.5	13.77	18.69
Simulated Gulf Temperature						
Beam 1	35.45	1.12	42.49	2.63	15.95	19.12
Beam 2	33.70	1.88	48.60	3.70	15.17	21.87
Beam 3	31.31	1.60	46.80	2.9	14.10	21.06
Average	34.15	1.53	45.96	3.1	15.07	20.68
High-Heat Treatment						
Beam 1	36.34	1.56	56.60	3.5	16.35	25.47
Beam 2	31.40	1.62	49.40	3.0	14.13	22.23
Beam 3	38.44	2.43	56.90	4.1	17.30	25.61
Average	35.39	1.87	54.30	3.53	15.93	24.44

First-Crack Strength

Based on the results of Figures 15-17, a summary of the values of the first-crack load and maximum flexural load, the corresponding deflections, as well as the calculated first-crack and flexural strengths of the UHPFRC beams are given in Table 2. Similar to the compressive strengths, both the first-crack strength and flexural strength were observed to increase as the curing temperature increased. However, only a small variation was seen in the first-crack load under all curing regimes, while a more pronounced increase was observed in maximum flexural load. Specifically, the highest mean values of the first-crack strength and flexural strength were recorded at 15.93 MPa and 24.44 MPa, respectively, attributing to the beams subjected to high heat treatment. In contrast, the lowest values were 13.77 MPa for first-crack strength and 18.69 MPa for flexural strength, corresponding to the beams cured at room temperature.

The beams cured under simulated Gulf temperature exhibited an average first-crack strength of 15.07 MPa, almost equal to the beams under high heat treatment that displayed an average strength of 15.93 MPa. Conversely, the flexural strength of the high heat-treated samples surpassed that of the specimens cured under simulated Gulf temperature by 18.2%, and those achieved approximately twice as much strength as the beams cured under room temperature. Furthermore, according to previous studies (Hassan et al, 2021 and Ashkezari et al., 2020), heated samples usually achieve the maximum flexural strength within the first 7 days. Hence, it may be possible that beams exposed to curing under Gulf simulated temperatures will reach similar strengths if subjected to extended curing durations.

The tensile performance of the UHPFRC beams are further analysed in Figure 19, which illustrates a comparison between the 7-day first-crack load and the 7-day ultimate flexural load. The correlation between these critical loads is important for understanding the ability of UHPFRC to withstand initial cracking and its overall load-carrying capacity. The graph reveals a relatively linear relationship between the two parameters, i.e. by increasing the curing temperature of the UHPFRC, both the first-crack load and ultimate flexural load are expected to increase. The inclusion of the reference data from Hassan (2013), where UHPFRC for highway bridge applications was studied, provided a benchmark for comparison. It is apparent that the results of Hassan (2013) exhibit a wider range of first-crack load and ultimate flexural load values when compared to the current data, which is mainly attributed to a wider variation in curing temperatures that was tested, but also the mix design, modifications in material composition and testing methodologies. However, the overall linear trend seems to be in good in agreement between the two sets of results. Both studies indicate that beams with higher first-crack loads might have a greater capacity to carry loads beyond their initial cracking point, which could reflect improved toughness and resistance to progressive failure. Particularly, this characteristic is preferred for projects where load-bearing capacity and resistance to cracking are critical, such as in high-stress zones or seismic regions. Designers can use such information to enhance the durability of structures by selecting UHPFRC mixes that exhibit higher first-crack loads and ultimate flexural loads, ensuring that they can withstand both initial cracking and subsequent loading conditions.

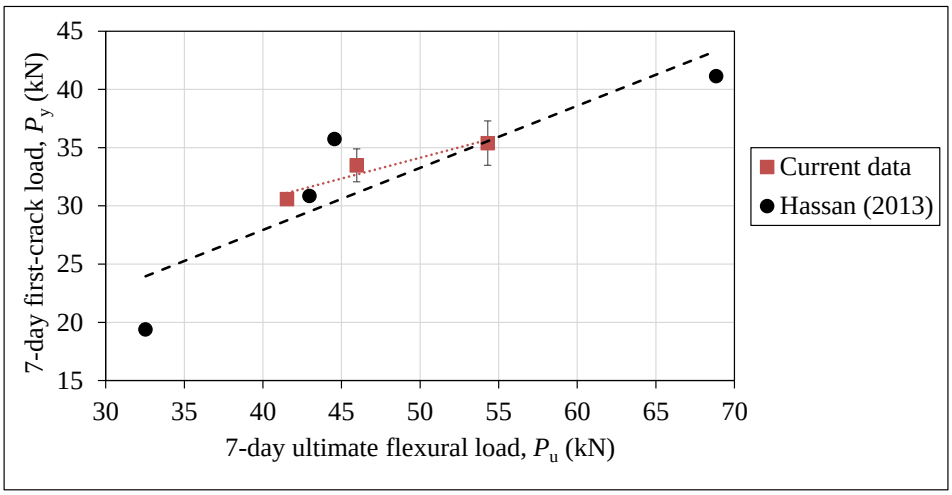

Figure 19. Relation Between First-Crack Load and Ultimate Flexural Load of UHPFRC Beams

Flexural Deflections

As outlined in Table 2, the beams cured at room temperature displayed the highest average deflection at the point of the first crack, reaching 2.28 mm. Subsequently, the high heat treated samples followed with an average deflection of 1.87 mm, while those exposed to simulated Gulf temperatures showed a value of 1.53 mm. This outcome might be explained by the occurrence of shrinkage shock when the beams undergo an abrupt transition from room temperature conditions during hardening phase to elevated temperatures. Such an abrupt thermal shift may induce the expulsion of free water content from the concrete, thereby resulting in crack formation at the materials weak zones (Hassan, 2013). At the point of maximum flexural load, however, the beams cured at room temperature and those under standard high heat treatment displayed very similar deformations of with 3.50 mm and 3.53 mm, respectively. In contrast, the simulated Gulf temperature conditions showcased an adverse effect on the ductility of the beans, with a lesser deflection of 3.1 mm at maximum load. This outcome is unlike that of the findings of Zahid et al. (2020), which suggests that elevated temperature enhances ductility properties of UHPFRC.

Figure 20 further establishes a direct correlation between the deflection at the initial cracking point and the deflection at ultimate failure. This relation is essential for understanding how UHPFRC beams respond to loading conditions, progressing from its earliest stages of deformation to its final failure state. As evident in the figure, the current data indicates a slight but gradual increase in the ultimate load deflection with respect to the first-crack deflection. On the contrary, the results of Hassan (2013) suggest a more steep increase in the relationship, which could be described by the variations in UHPFRC formulation. Nevertheless, this trend signifies that UHPFRC beams subjected to higher curing temperatures can accommodate further deformation beyond its first-crack point before reaching failure, enhancing the ductility, toughness, and the ability to absorb energy through plastic deformation. In addition, designing UHPFRC mixes to exhibit higher deflection at ultimate failure, while maintaining a reasonable deflection at first-crack, allows structures to undergo significant deformation while still retaining load-carrying capacity. This characteristic is particularly beneficial in earthquake-prone regions, where structures are required to demonstrate resilience against seismic forces.

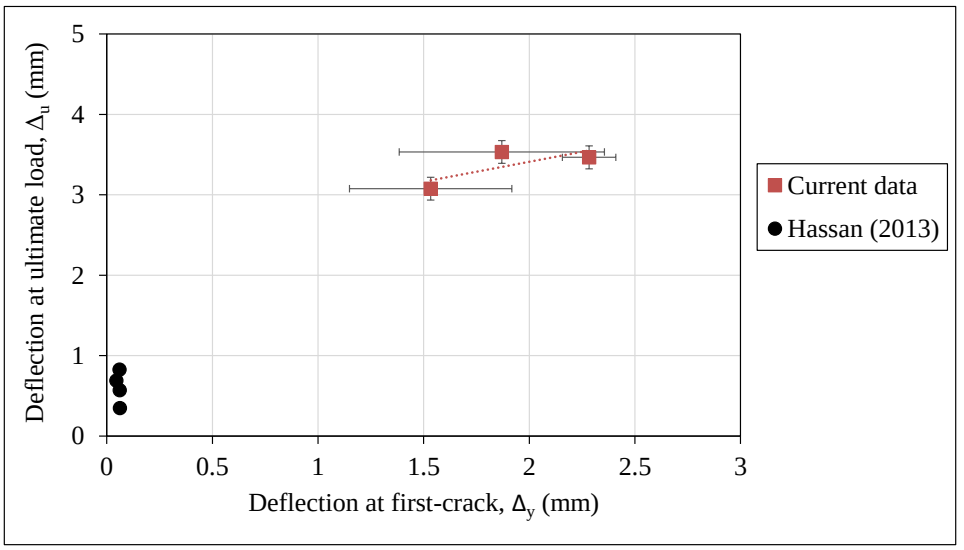

Figure 20. Relation Between Deflections at First-Crack and Ultimate Load of UHPFRC Beams

CONCLUSIONS

Ultra-high performance fiber reinforced concrete (UHPFRC) is renowned for its remarkable mechanical and durability properties, owing to a precise combination of cementitious materials, fine aggregates, steel fibers, and superplasticizers. However, its high cost and energy intensive production, predominantly due the complex mix design and high-heat treatment, limits its application globally, particularly for in-situ construction. The objective of this study was to explore the potential of utilizing the hot climatic conditions pre-existing in Gulf countries as a curing technique for UHPFRC. Following the curing of UHPFRC specimens under the conditions room temperature, Gulf climate and standard high-heat treatment, several experiments were conducted to examine its early-age mechanical characteristics. The following conclusions are drawn from the outcomes of these experiments:

- In order to simulate Gulf climate conditions on a daily basis, the UHPFRC specimens were cured under continuously rising temperatures in an oven for a duration of 9 hours, reaching a maximum 36.5°C to 38.5°C, while the remainder of the period temperatures were allowed to drop to a minimum of 27.8°C to 30.6°C.
- Different curing methods, including Gulf climate simulation, resulted in similar 7-day apparent densities of the UHPFRC specimens, indicating that the curing regimes did not significantly affect the overall density, compactness, or porosity of the material at the early age.
- The average 7-day compressive and flexural strengths achieved by the UHPFRC specimens were 95.4 MPa and 20.7 MPa, respectively, which were close to at least 80% of the strengths resulting from high-heat treatment.
- At lower densities, a slight change leads to a steep rise in compressive strength, indicating potential for optimizing mixtures in that density range, while higher densities exhibit diminishing strength gains due to particle packing limitations.

- The predictions of Eurocode 2 (EC2) and American Concrete Institute (ACI 363R), originally designed for high strength concretes, seem to be conservative in representing the relationship between flexural and compressive strength of UHPFRC, highlighting the need to perhaps revise these codes to better accommodate the mechanical behaviour of UHPFRC.
- Curing under Gulf simulated temperatures contributes to improved load-bearing capabilities and enhanced early strengths in UHPFRC beams without compromising its stiffness.
- The correlation between first-crack load and ultimate flexural load of UHPFRC is linear, both of which can be improved with by curing under Gulf simulated temperatures, resulting in enhanced toughness and resistance to progressive failure.
- The relationship between the deflection at initial cracking and the deflection at ultimate failure of UHPFRC beams indicates that curing under Gulf simulated temperatures could improve the ductility, toughness, and energy absorption through plastic deformation.
- While our study primarily focuses on the early-age development and the impact of hot Gulf climates on the curing and early strength of UHPFRC, certain aspects such as crack width measurements were not within the scope of this study. Our qualitative observations on crack formation, although not accompanied by numerical values, provide insights into the material's response to harsh environmental conditions and its tensile behavior under such circumstances.

The findings presented in this study hold significant promise for the in-situ application of UHPFRC in hot weather countries like those in the Gulf region, potentially eliminating the need for costly heat treatments and reducing production expenses. However, it is important to note that while this research examines early-age development, further investigation into the long-term evolution of UHPFRC's mechanical properties under these curing conditions is warranted. Additionally, future research should focus on real-site curing to overcome the limitations of temperature simulation highlighted in this study. Furthermore, workability values and precise crack width measurements, must be taken into consideration to fully understand the effect of such curing regimes. Exploring the use of different types of steel fibers, such as hook end and twisted fibers, as documented in the literature, could also enhance the mechanical performance of UHPFRC members.

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THE THEMATIC REVIEW ON THE CAUSES OF ACCIDENTS IN THE CONSTRUCTION SECTOR

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Abstract
The construction industry made a substantial economic contribution worldwide, and this industry has greater safety issues than others. An accident can cause loss of life, damage to property, depletion of resources, and pollution of the natural environment. To date, no scholarly work has yet synthesised construction accident causes. This thematic review paper intended to examine the causes of accidents in the construction industry from 2018–2022. This paper used three databases from SCOPUS, Web of Science, and Google Scholar for article searching using specified keywords resulting 39 to be analysed using the ATLAS.ti 9 software. 13 primary codes were developed and categorised to human, managerial and material factors. The results are consistent with Sustainable Development Goals 2030, which aim to ensure that all workers have safe and healthy workplaces and contribute to studies on safety and health measures. The study highlights the need for better safety and health measures in the construction industry and points out gaps in current knowledge. Adhering to standards can reduce insurance claims and payouts, improve productivity, quality, and project timelines, and reduce non-conformance. This is the first publication to consolidate and review research on the causes of accidents in the industry.

Keywords: *accident; hazard; fatality; construction; ATLAS.Ti*

INTRODUCTION

Over the past decade, the construction industry worldwide has expanded at an unprecedented rate (Abukhashabah et al., 2019). The International Labor Organization (ILO) reported that there are 317 million workplace accidents, and over 2.3 million worker deaths occur every year globally (Oza, 2017). There is a significantly higher incidence of work-related injuries and accidents in the construction industry than in any other sector (Elsebaei et al., 2020). Since its inception, the construction industry has been recognised as one of the most dangerous or hazardous industries (Abdullah & Wern, 2011) and the construction industry accounts for 30% of all workplace fatalities (Bilim et al., 2018; OSHA, 2018). Even though there has been a lot of progress in occupational safety, it is still difficult to manage and control the risks associated with specific tasks (Sousa et al., 2014). In general, there is widespread fear among safety professionals and concerned parties due to the rising frequency of accidents and the high death rate in construction sites (Lee Chia-Kuang & Yusmin Jaafar, 2012).

The term "hazard" is used to describe any situation that poses a potential danger to people, their possessions, the environment, and other resources. Considering how closely linked hazards and accidents are, they pose a significant threat to workers in this sector (Sousa et al., 2014). There were a total of seven major causes of workplace accidents, including environmental, service and protection, mechanical, other work equipment, material and agent, organisational, procedural, personal, and other (Carrillo-Castrillo et al., 2017). Accidents involving machinery are far more common than any other type of workplace injury. Direct contact with machinery and powered machinery is a leading source of severe injury or death in the construction industry, yet this equipment is essential to the completion of any building or infrastructure project. When

things fail suddenly, it can cause severe problems, including property damage, higher costs, halted project execution, lost productivity, and even fatality.

LITERATURE REVIEW

Nature of The Construction Industry

Due to the nature and intrinsic danger of the task being done, construction is seen as perilous, thus leading to accidents, which can have serious repercussions for businesses, their workers, and their families financially and socially. Accidents involving cranes and heavy-lifting machinery falls from heights, amputations from mishandling heavy equipment, falling objects, receiving electric shocks from cables, injuries during demolition, and having an excavation collapse are all possible hazards on construction sites (Hughes & Ferrett, 2005). In light of this, Health and Safety regulations are being implemented on a global scale with the aim of eliminating the causes of accidents and their subsequent effects. Many nations, unfortunately, appear to ignore and fail to apply these norms and procedures. The people who can be held accountable for incidents in the job place are diverse. First, workers' lack of competence, discipline, and awareness all fall squarely on their shoulders when an accident occurs on the job. Second, management is often held accountable for accidents that occur on the job site. This is the case for a variety of reasons, including but not limited to inadequate training and the absence of Personal Protective Equipment (PPE). As a result of lax inspections and rules, governments were held liable for workplace accidents (Othman, 2012).

When it comes to construction accidents, developing countries are hit the hardest because of lax regulations and practises, where authorities and workers alike are often unaware of the dangers they face on the job (Biswas et al., 2017; Kalatpour & Khavaji, 2016; Roudsari & Ghodsi, 2005; Tam et al., 2004). However, most developed nations are working on ways to lessen the devastating effects of construction accidents by means of preventing, eliminating, and evading mishaps. Consequences from construction site mishaps can be devastating for everyone involved. The fatality rate in this industry is frequently six times greater than the national average, and the percentage of workers who sustain a permanent disability is twice as high (Kalatpour & Khavaji, 2016). It also brings severe consequences for both workers and the public (Pinto et al., 2011).

Studies have looked further into what factors lead to accidents happening on construction sites. More than 35% of the published research on the subject of construction safety management over the past 30 years has been devoted to studying accident statistics, determining their causes, and evaluating associated risks (Liang et al., 2020). Accident analysis is the primary method used in studies of construction site accidents (Betsis et al., 2019; Carrillo-Castrillo et al., 2017; Cheng et al., 2010; Suraji et al., 2001; Zhong et al., 2020). Besides the existence of scholarly papers discussed on the factor or causes of the accident, to date, there is no single paper discussing the latest trend in construction accidents around the world. This research aims to answer this question by a systematic review of literature covering the period from 2018 to 2022 and focusing on studies that investigate what causes accidents in the construction sector around the world. Here is a research issue that we hope to address in this study.

Research Question: What is the discussion on causes of accidents in the construction sector discussed in the literature from 2018 to 2022?

MATERIAL AND METHOD

Table 1. Search Strings from Scopus, Web of Science and Google Scholar

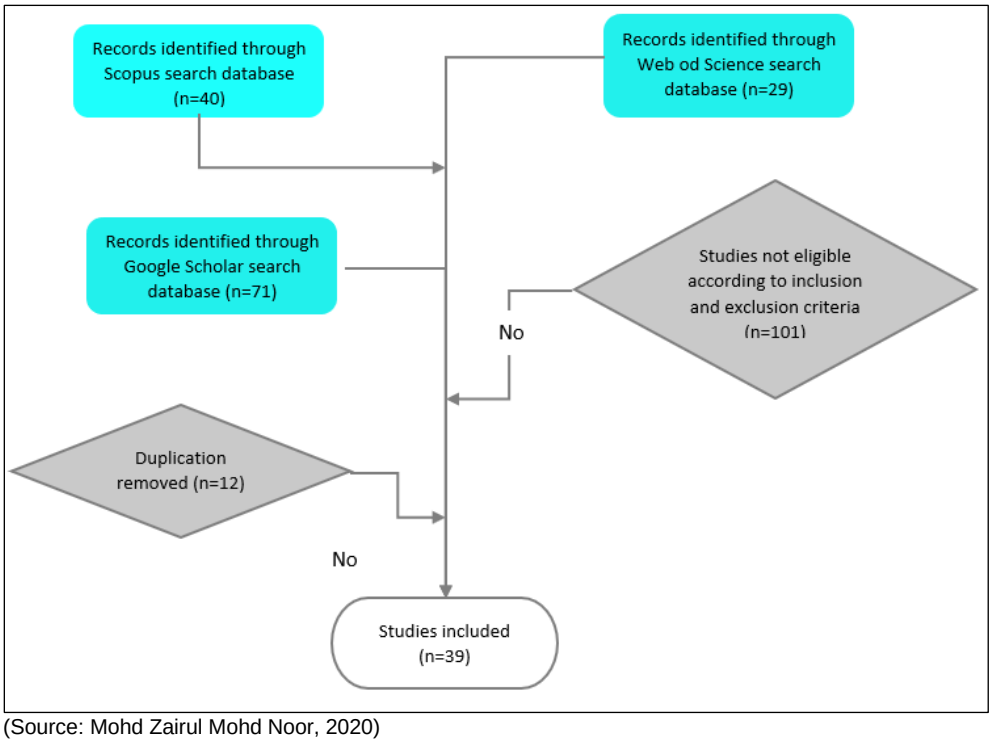
SCOPUS	TITLE-ABS-KEY (("cause" OR "causes" OR "factor" OR "factors" OR "contribute" OR "contributes" AND "accident" OR "accidents" OR "mishap" OR "mishaps" OR "fatality" OR "death" AND "construction")) AND (LIMIT-TO (O.A., "all")) AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "ARTS")) AND (LIMIT-TO (EXACTKEYWORD , "Construction Industry"))	40 results
Web of Science	TS=(("cause" OR "causes" OR "factor" OR "factors" OR "contribute" OR "contributes" AND "accident" OR "accidents" OR "mishap" OR "mishaps" OR "fatality" OR "death" AND "construction")) Refined By: Web of Science Categories: Law Web of Science Categories: Law Publication Years: 2022 or 2021 or 2020 or 2019 or 2018 Web of Science Categories: Law Languages: English Open Access Document Types: Retracted Publications or Corrections or Books or Book Reviews or Book Chapters or Editorial Materials or Review Articles or Early Access or Proceedings Papers	29 results
Google Scholar	alintitle: (("cause" OR "causes" OR "factor" OR "factors" OR "contribute" OR "contributes" AND "accident" OR "accidents" OR "mishap" OR "mishaps" OR "fatality" OR "death" AND "construction"))	71 results

Incorporating theme analysis into a literature review, as proposed by Ong and Bista (2015) and Mohd Zairul Mohd Noor (2020) led to the decision to use the term "thematic review" and the ATLAS.ti 9 software as the instrument for this research. The term "thematic analysis" refers to the process of developing an understanding of a topic through reading extensively on the subject and drawing out common threads. Thematic analysis is a qualitative research method that means being familiar with the data, creating a code to identify specific themes related to significant aspects, identifying categories, reviewing these categories, selecting the ultimate theme, and documenting the findings. Researchers are required to carefully examine and record initial information, combine prefix codes to create new clusters, and evaluate categories to verify they are relevant to the extracted data and the entire dataset. They have the option of merging or breaking down themes or eliminating the starting theme in order to initiate the process of theme generation once more. The ultimate theme is established and documented, presenting a parallel narrative and substantiating the material in accordance with the prevailing context (Clarke & Braun, 2013). The next step is to investigate the causes of the worldwide construction industry's alarmingly high accident rate by classifying recurring patterns and types of construction. The study's fundamental purpose is to analyse and evaluate existing data in order to make recommendations for improving the management of research safety in the future. The following standards were applied to our literary selection: Two requirements must be met for inclusion: 1) publication between 2018 and 2022, and 2) inclusion of at least one of the following keywords: “causes or factors or contribute or accident or mishaps or fatality or death and construction” (3) focusing in on the construction sector globally. The reviewed data will be organised into a planned theme for subsequent discussion, with the goals of the supported investigations serving as the guiding framework. As a further aid in evaluating qualitative data, we also provide a visual

representation of the theme generated from the literature (Talib, 2019). Table 1 above is the search string used in the different databases. The researcher used Boolean Operator OR and AND to help wider the search scope.

Scopus, Web of Science, and Google Scholar were three databases used in which the researcher used to search for the phrases (("cause" OR "causes" OR "factor" OR "factors" OR "contribute" OR "contributes" AND "accident" OR "accidents" OR "mishap" OR "mishaps" OR "fatality" OR "death" AND "construction") to provide a thorough overview of the existing literature on the causes of the accident.

The inclusion criteria of the selected article are based on several factors; 1) only review open access journals 2) focus on article journals 3) the language selected is only English 4) papers published for the duration of 5 years and 5) included any publication across the world.



(Source: Mohd Zairul Mohd Noor, 2020)

Figure 1. The Inclusion and Exclusion Criteria of The Search

Figure 1 further provides an overview of the criteria used for inclusion and exclusion. The initial search in Scopus yielded 40 articles, 29 articles from the Web of Science, and 71 articles from Google Scholar, making for a total of 140 articles to be examined. Some articles lack full-text access, or the link is broken or duplicated, or are written in a language other than English, or lack necessary metadata, or are irrelevant to the subject at hand. After selection, only 39 articles remained, and another 12 were omitted due to duplicate content. Articles were imported into ATLAS.ti 9 software as primary documents and organised by author, issue number, periodical, publisher, volume, and publication year. The publication timeline of the articles and the developing discourse pattern over the course of those five years were analysed.

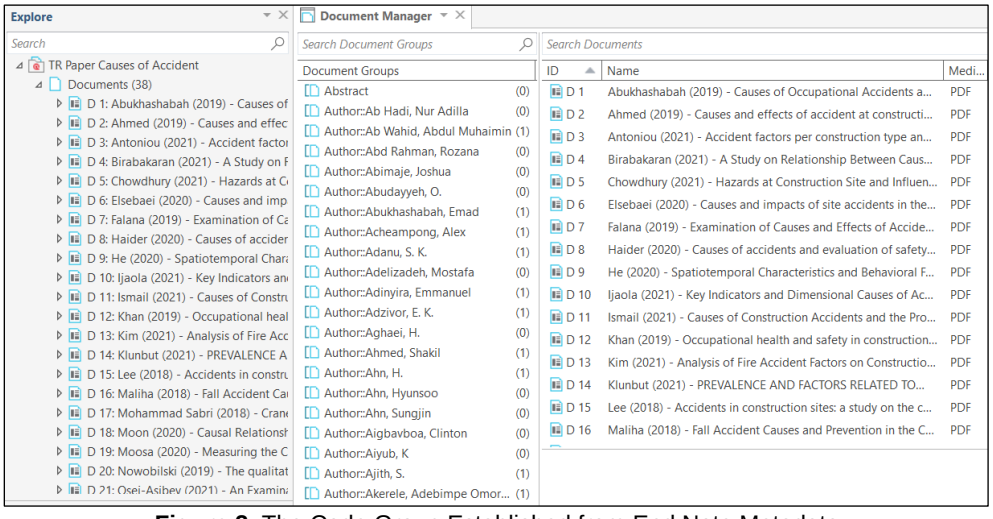


Figure 2. The Code Group Established from End Note Metadata

As can be seen in Figure 2, ATLAS.ti 9's primary documents are metadata records for a total of 39 files. The categorization tools in ATLAS.ti 9 have made the sorting process much easier and faster. After the initial round of coding, 95 unique codes were generated. A total of 37 codes remains after merging related or similar codes. Next, the codes were organised into groups before generating the theme. In this research, three final themes are generated and used to answer the research question on the causes of construction accidents as they have been discussed in the literature between the years of 2018 and 2022. The themes are a human factor, management factor and material factor. In this analysis, the research separates findings into quantitative and qualitative categories.

ANALYSIS AND DISCUSSION

The analysis of this thematic review is presented in quantitative and qualitative findings.

Quantitative Findings

The geographic dispersion of the paper was discussed, as illustrated in Figure 3. In total, 24 countries around the globe discussed the causes of construction accidents, for example, Malaysia, China, Turkey, Ghana, Italy and many more.

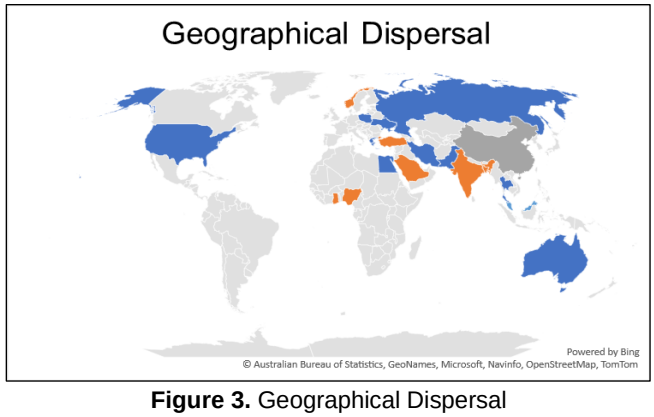


Figure 3. Geographical Dispersal

On the other note, the Sankey Diagram in Figure 4 demonstrates the frequency of countries that discussed the causes of accidents in the construction sector. Authors from Malaysia dominated the scale with five papers, followed by China (4 papers), Korea (3 papers), Nigeria, Ghana, Norway, India, Bangladesh, Iran, Saudi and Turkey (2 from each country). The remaining country has the least paper that discussed the issue under study.

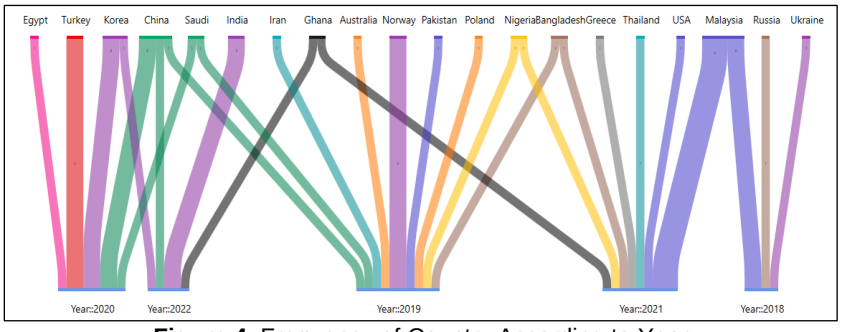


Figure 4. Frequency of Country According to Year

The word cloud displayed in Figure 5 below was constructed using all chosen articles, proving that they are all pertinent to the subject at hand. Table 2 below organises authors into the three categories derived from ATLAS coding. Most scholars denote that human factors are the main source of the accident, followed by management factors and equipment or material factors.

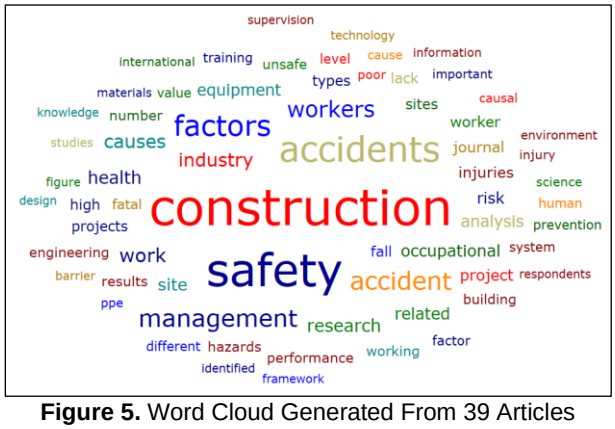


Figure 5. Word Cloud Generated From 39 Articles

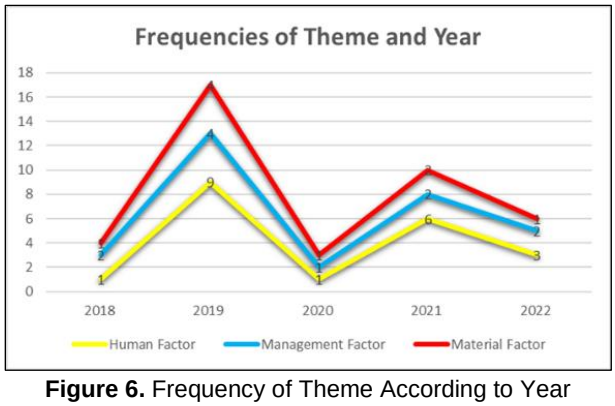


Figure 6. Frequency of Theme According to Year

In addition, Figure 6 demonstrates the frequency of themes according to year. The chart shows that the human factor scored the highest, particularly in 2019 and 2021. The decline in research frequency in the construction sector since 2019 can mostly be linked to the COVID-19 pandemic, which resulted in substantial disruptions to corporate operations and research efforts. This trajectory is consistent with the overall influence of the pandemic on global industries, including the construction sector, which had a recovery starting in 2023 when enterprises resumed their activities (International Labour Organization, 2021; Mohsen et al., 2021). Moreover, Table 2 discusses the author according to the year. From the table, it is evident that most of the authors discussed in their paper all three factors that contributed to the accident, while only a few authors denote certain factors. The human factor theme scored the highest frequency (41) followed by the management factor (37) and the material factor (20).

Table 2. List of Authors According to The Year

Author	Human Factor	Management Factor	Material Factor
Abukhashabah (2019)	2	-	-
Ahmed (2019)	1	1	2
Antoniou (2021)	-	1	-
Birabakaran (2021)	2	2	1
Chowdhury (2021)	3	1	-
Elsebaei (2020)	-	3	1
Falana (2019)	4	3	2
Haider (2020)	1	1	-
He (2020)	-	-	-
Ijaola (2021)	3	-	1
Ismail (2021)	1	-	1
Khan (2019)	1	-	3
Kim (2021)	1	1	-
Klunbut (2021)	2	-	-
Lee (2018)	1	-	-
Maliha (2018)	-	-	2
Mohammad Sabri (2018)	-	1	-
Moon (2020)	-	4	1
Moosa (2020)	1	1	0
Nowobilski (2019)	1	0	1
Osei-Asibey (2021)	2	2	1
Pichugin (2018)	2	5	-
Rafindadi (2021)	-	1	-
Song (2020)	-	-	-
Tomakov (2018)	2	-	2
Vosoughi (2019)	1	1	-
Winge (2019)	1	3	-
Winge (2019)	1	2	-
Woolley (2019)	1	-	-
Xuefei (2019)	1	1	1
Zhang (2020)	3	-	-
Ahn (2022)	-	1	-
Ajith (2022)	1	-	-
Almuder (2020)	-	-	-
Boakye (2022)	-	-	1
Deng (2022)	2	-	-
Edwards (2022)	-	1	-
Hoła (2022)	-	1	-
Totals	41	37	20

Qualitative Findings

Below is an explanation of the qualitative results obtained in response to the following research question.

What is The Discussion on Causes of Accidents in The Construction Sector Discussed in The Literature from 2018 to 2022?

It took 95 different codes generated after the first round of coding. After combining similar codes, 37 are still usable. After categorising the codes, the researcher begins to generate themes, and the final three themes will be utilised to answer the research question. There are five categories of coding related to the human factor, six codes group related to management and two codes group under the equipment or material used in the construction industry. Detailed discussion on each theme is deliberated in the below network.

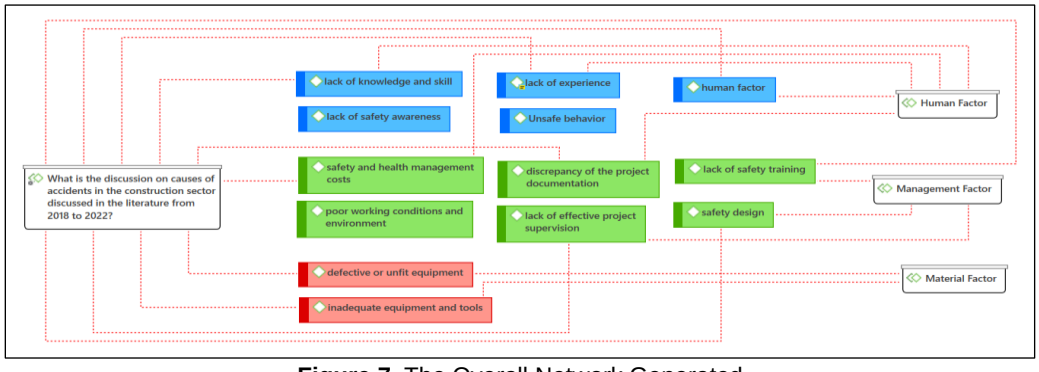


Figure 7. The Overall Network Generated

Theme 1: Human Factor

The first coding as depicted in Figure 8 is under human factors in which it is concerned with human error (Birabakaran & Nagapan, 2021; Lee et al., 2018; Nowobilski & Hoła, 2019; Tomakov et al., 2018). Next is the lack of knowledge and skills. This includes low general knowledge and skills (Osei-Asibey et al., 2021; Xuefei et al., 2019; Zhang et al., 2020), technological knowledge (Tomakov et al., 2018), lack of training that results in a lack of knowledge of the instrument (Ahmed, 2019; Chowdhury et al., 2021) and eventually resulted to improper use of the PPE (Chowdhury et al., 2021; Ijaola et al., 2021; Khan et al., 2019). The third human factor is lack of experience (Abukhashabah et al., 2019; Ijaola et al., 2021). In addition, employee behaviour also causes an accident. Since construction work is highly hazardous and prone to danger, workers must carry out their work with due diligence. Unsafe behaviour can be deliberated as an unsafe act (Ajith et al., 2022; Deng et al., 2022; Haider, 2020; Ismail & Othman, 2021; Klunbut et al., 2021), unsafe method (Birabakaran & Nagapan, 2021; Falana & Ghazaly, 2019), bad attitude (Osei-Asibey et al., 2021) negligent, careless and reckless (Falana & Ghazaly, 2019; Moosa et al., 2020), non-compliance with construction norm (Pichugin & Dmytrenko, 2018), and disobedient with work discipline (Ijaola et al., 2021). The last human factor is the lack of safety awareness (Abukhashabah et al., 2019; Deng et al., 2022; Zhang et al., 2020) and lack of compliance with the safety and health plan (Winge, 2019), safety regulations(Falana & Ghazaly, 2019), and safety codes (Chowdhury et al., 2021).

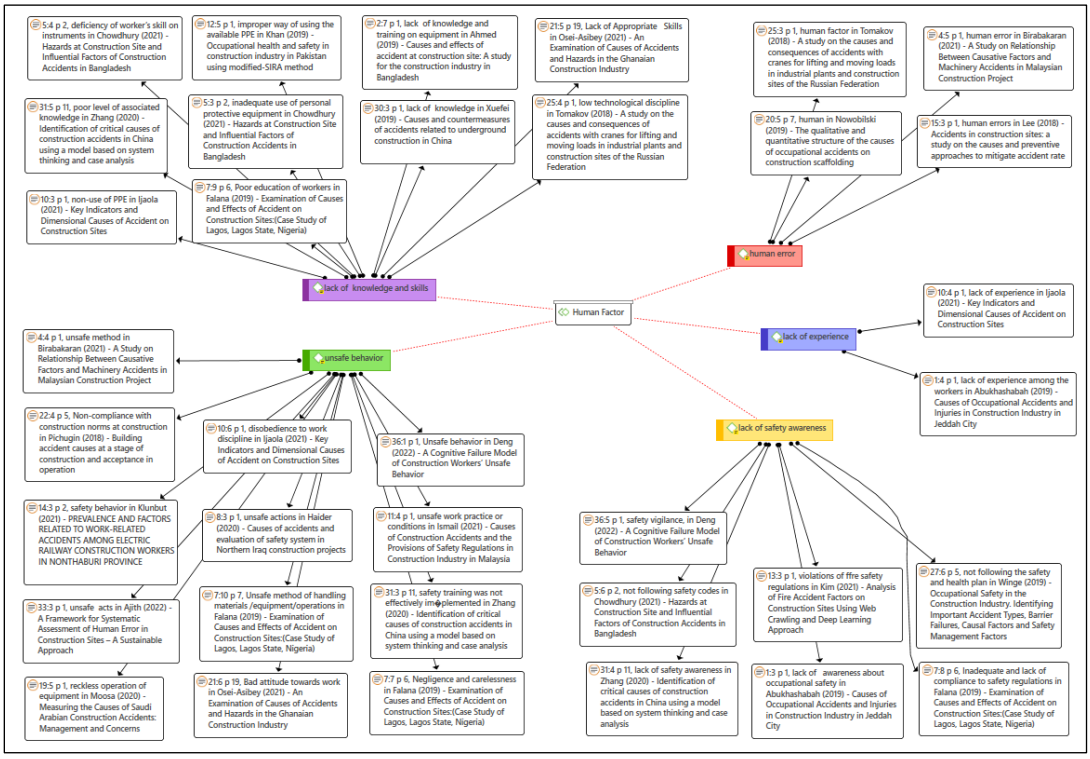


Figure 8. The Human Factor Network

Since most of the accident are related to behaviour of employee the management should implement strategies that utilise positive reinforcement. Rewarding workers for safe actions and following safety procedures is also a good idea that should be encouraged in the workplace. The performance of an organisation's safety measures should be evaluated on a regular basis, and data should be used to determine where enhancements are needed. Safety risks and improvement opportunities can be better understood with the support of routine audits and inspections. Accident rates can be lowered by encouraging employees to adopt a safety-first mentality and fostering a culture where safety is prioritised.

Theme 2: Management Factor

The second theme as demonstrate in Figure 9 was under the management factor. In construction work, the management plays an important role in making sure that the project that they undertook is safe. Before the execution of any construction work employee must first be sent for training as a lack of training related to safety can have an adverse effect on the employee (Antoniou & Merkouri, 2021; Birabakaran & Nagapan, 2021; Falana & Ghazaly, 2019; Moosa et al., 2020; Osei-Asibey et al., 2021; Rafindadi et al., 2022). The employer must ensure that the documentations are in order (Moon & Kong, 2020; Pichugin & Dmytrenko, 2018), besides paying serious attention to safety design since safety design is a contributory factor of the accident. Safety elimination design must be the top priority (Ahmed, 2019). There must also be an accurate design prediction (Xuefei et al., 2019), with no mistakes in the design (Pichugin & Dmytrenko, 2018). In maximising profit, certain employers are reluctant to provide resources for safety or strive for cost-saving (Ahn et al., 2021; Elsebaei et al., 2020; Pichugin & Dmytrenko, 2018).

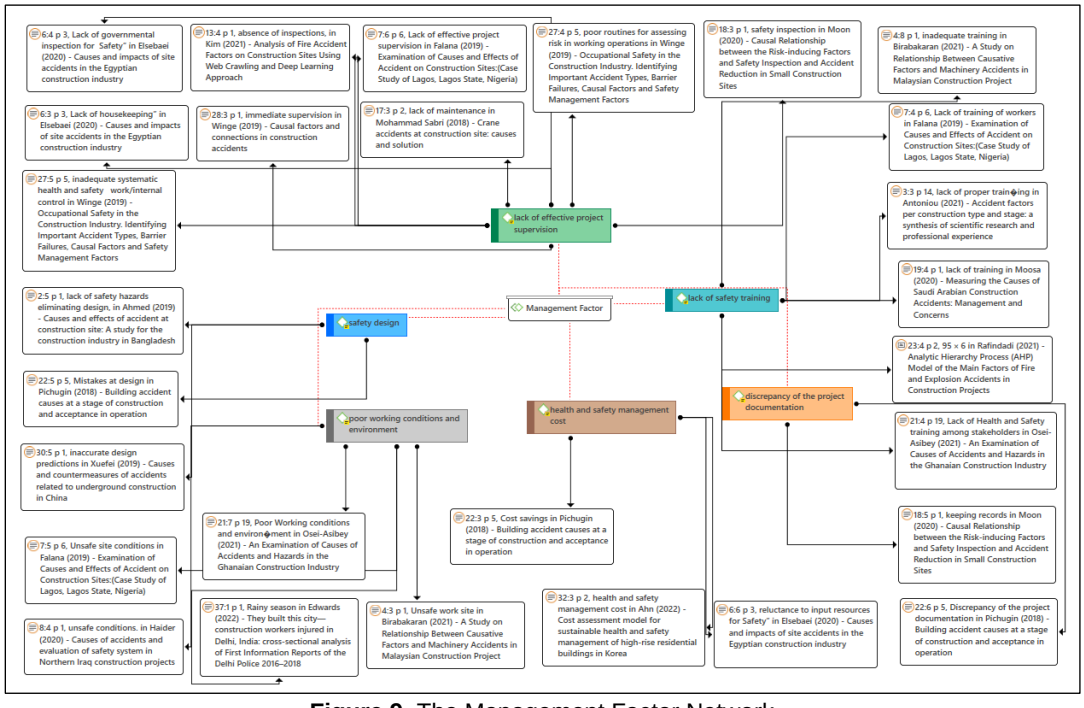


Figure 9. The Management Factor Network

After the commencement of the construction project, the management should conduct the regular inspection (Kim et al., 2021; Moon & Kong, 2020) and supervision (Falana & Ghazaly, 2019; Winge et al., 2019) as a poor routine of risk assessing operation is the cause of an accident (Winge, 2019). Besides employer, the government also play a role in mitigating accident since the absence of government supervision contributed to the accident (Elsebaei et al., 2020). The last factor under this theme is poor working conditions and environment, such as unsafe site conditions (Birabakaran & Nagapan, 2021; Falana & Ghazaly, 2019; Haider, 2020; Osei-Asibey et al., 2021).

The article highlights the importance of construction project management in ensuring safety. Prior to starting the project, employees should undergo safety training, and accurate design predictions must be made to eliminate safety risks. Employers should prioritise safety design and ensure proper documentation. Regular inspections and supervision should also be conducted to prevent accidents, and the government should provide supervision as well. Poor working conditions and environments, such as unsafe site conditions, can contribute to accidents. Some employers prioritise profit over safety, which can lead to inadequate resources for safety.

Theme 3: Material Factors

The material factor in Figure 10 is segregated into two categories: inadequate equipment and defective or unfit equipment. PPE is the most common type used in the construction sector. Several authors agreed that the lack of equipment particularly the PPE contributed to the accident (Ahmed, 2019; Boakye et al., 2022; Falana & Ghazaly, 2019; Osei-Asibey et al., 2021). Besides PPE, Maliha (2018) contended that inadequate fencing, particularly for working at height, also contributed to the accident.

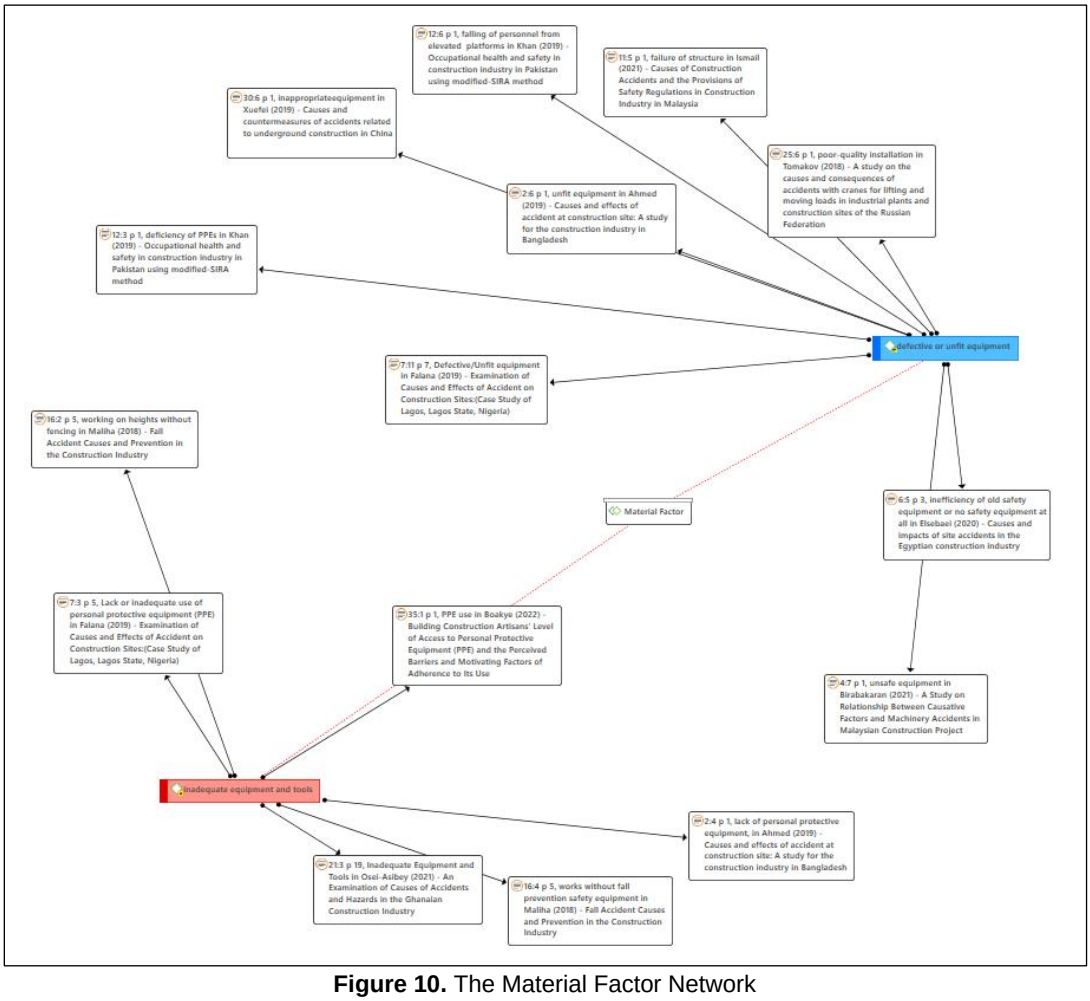


Figure 10. The Material Factor Network

The other causes of the accident are defective and unsafe equipment (Ahmed, 2019; Birabakaran & Nagapan, 2021; Falana & Ghazaly, 2019; Khan et al., 2019; Xuefei et al., 2019). In construction work, it is quite common for the contractor to use the same equipment from the previous project. This recycling or old safety equipment also contributed to the accident (Elsebaei et al., 2020). In addition, Tomakov et al. (2018) asserted that poor quality installation includes things like broken cargo ropes, a broken lifting mechanism, lifting a load at an angle, improperly executed slinging loads, and containers that are overloaded or tipped over. Besides, the failure of structure (Ismail & Othman, 2021) and elevated platform (Khan et al., 2019) both played a role in the accident.

Inadequate or broken equipment is a major source of delays and safety hazards on building sites. Many authors have pointed to the widespread usage of personal protection equipment (PPE) in the business as a solution to the problem of preventable injuries. Work at height fence that was inadequate was also cited as a cause. Other studies have found that accidents occurred due to the usage of faulty or unsafe equipment, such as that which was too old or repurposed, improperly installed, or caused by the collapse of a building's structure or an elevated platform.

DISCUSSION AND RECOMENDATIONS

Based on all three themes generated from the study, all factors are interrelated with each other. Poor management is a common root cause of mishaps. Worker safety begins at the design stage, and management should recommend adjustments to the project's safety at the design stage (Hardison et al., 2014). This is coherent with our current study by Pichugin and Dmytrenko (2018), Xuefei et al. (2019) and Ahmed (2019). Unfortunately, employers are reluctant to spend their resources since it involves huge costs (Ahn et al., 2021; Elsebaei et al., 2020; Pichugin & Dmytrenko, 2018). Lack of safety sensitivity among top management, lack of safety inputs, lack of strict safety enforcement, lack of organisational participation, and lack of PPE was identified as root causes of work-related accidents (Tam et al., 2004). Because of this, it is clear that inadequate management facilities could be at the heart of a catastrophe.

On the other note, solutions that reduce the likelihood of mistakes made by humans should be given equal weight. Besides human behaviour that is beyond the management's control, accidents might also be caused by insufficient training. Injuries of a serious kind may be avoided if only the workers were properly trained (Antoniou & Merkouri, 2021; Birabakaran & Nagapan, 2021; Falana & Ghazaly, 2019; Moosa et al., 2020; Osei-Asibey et al., 2021; Rafindadi et al., 2022). Even the most sophisticated tools are useless in the hands of an inexperienced user. Employees lack the ability to anticipate future danger and the knowledge of how to prevent accidents because of a lack of safety and technical skills training (Chen & Wu, 2010). Employers are responsible for ensuring their staff members receive the following training. Any business that aspires to meet these criteria may be held liable for any injuries sustained as a result of inadequate training. Employees should be accountable for their own education and development. If they want to advance in their careers, they should seriously consider taking advantage of short-term classes or online programmes. Employees should not assume that their superiors always know what they need(Hardison et al., 2014).

Making workers adhere to the safety and health standards is one way to address the issue of inadequate training, and controlling people's actions is a herculean task, but the management should not get away with the safety onsite. Safety monitoring tools provide for easy enforcement of preventative measures and monitoring and evaluating the factors contributing to human error. According to recent research, this is consistent with the idea that the accident was caused by inadequate oversight on the part of the employer (Falana & Ghazaly, 2019; Kim et al., 2020; Moon & Kong, 2020; Winge, 2019; Winge et al., 2019). In fact, workers who make mistakes frequently could benefit from greater preparation and training if the causes of those mistakes were identified (Hardison et al., 2014). The execution of safety programmes requires training, regular inspection, adherence to safety policy, proper management, and, most importantly, safety awareness. Consequently, potential hazards and fatal construction accidents can be greatly reduced. Even though construction companies strive for cost reduction and profit orientation, employee safety must be a top priority since all lives matter.

CONCLUSION

To summarise, the interconnectedness of several elements in ensuring workplace safety underscores the pivotal responsibility of management in averting accidents. Inadequate management frequently acts as the primary catalyst for accidents, especially when safety measures are not incorporated during the design phase. The issue is worsened by employers' hesitance to invest in safety measures due to cost considerations, resulting in a deficiency of safety awareness, enforcement, and engagement. Moreover, inadequate training plays a key role in workplace accidents, as untrained employees lack the ability to foresee and avert potential dangers. Hence, it is imperative for employers to give utmost importance to safety by providing comprehensive training, conducting routine inspections, and strictly enforcing safety standards. By effectively tackling these concerns, the probability of accidents can be significantly diminished, guaranteeing that safety remains a paramount concern despite the urge to save expenses.

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GUIDE TO AUTHORS

Aims and Scope:

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

Articles submitted will be reviewed and accepted on the understanding that they have not been published elsewhere. The authors have to fill out the **Declaration of the Authors** form and return the form via fax/email to the secretariat. The length of articles should be **between 3,500 and 8,000 words** or **approximately 8 – 15 printed pages (final version)**. **The similarity index must be lower than 20% and proofread in UK English.** The Similarity Report and summary of the article (less than 250 words) for editorial must be submitted together with the manuscript.

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CODIFICATION AND APPLICATION OF SEMI-LOOF ELEMENTS FOR COMPLEX STRUCTURES

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

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

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

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

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

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

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

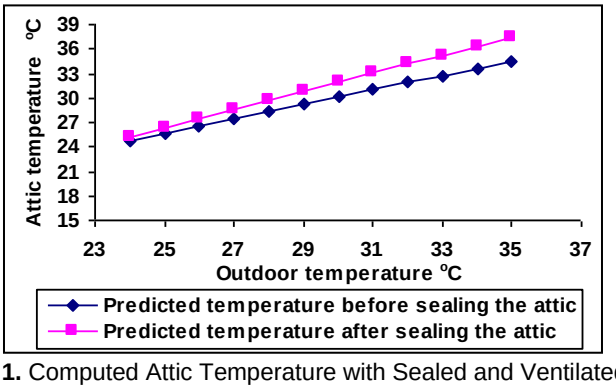

Figure 1. Computed Attic Temperature with Sealed and Ventilated Attic

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

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

Table Line: 0.5pt.

Table 1. Recommended/Acceptable Physical Water Quality Criteria

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

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

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

Citation:

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

(Source: UPSI, 2019)

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

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

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

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

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

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

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

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