Universiti Malaysia PAHANG

JABATAN PENYELIDIKAN & INOVASI
NO BORANG : UMP/JPI/REPORT
KUATKUASA: 01/06/2020

RESEARCH PROJECT REPORT FORM

Final	✓	Progress		*Progress Period : Project Started Year Since 2017*	*√ Please tick*

PROJECT DETAILS *(Keterangan Projek)*

A

Grant No	**RDU 1703296**
Faculty/CoE	**Faculty of Industrial Management**
Project Title	**DEVELOPING AN INTEGRATED INDUSTRIALISED BUILDING SYSTEM (IBS) MATURITY MODEL: A HYBRID MODEL WITH RIGGS'S OMAX**
Project Leader	**DR. LEE CHIA KUANG**
Project Member	**1. KHAIRUL FIRDAUS BIN ANUAR** **2. MUHAMMAD WARIS ALI KHAN** **3. AZI IZWANI BINTI NOR HAMZAH** **4. IRENE TING WEI KIONG**

PROJECT ACHIEVEMENT *(Pencapaian Projek)*

B

ACHIEVEMENT PERCENTAGE				
Project progress according to milestones achieved up to this period	**0 - 25%**	**26 - 50%**	**51 - 75%**	**76 - 100%**
Percentage (please state %)				**100%**

EXPENDITURE *(Perbelanjaan)*

C

Budget Approved *Peruntukan diluluskan*	**Amount Spent** *Jumlah Perbelanjaan*	**Balance** *Baki*	**% of Amount Spent** *Peratusan Belanja*
RM 25,300.00	**RM 17,938.75**	**RM 7,361.55**	**% 71**

RESEARCH OUTPUT *(Output Penyelidikan)*

D

NO OF PUBLICATION

KPI FOR NO OF PUBLICATION

	ISI	Scopus	Index Proceedings	Others
KPI	**3**	**-**	**-**	**-**
Achievement	**1 (ONE) Full WoS/ISI paper.** **2 (TWO) ESCI (WoS/ISI) papers,**	**-**	**2 papers.**	**1 indexed peer review journal.**

	with full scopus status.			

The contribution of funder (UMP, MOHE, MOSTI, Industry etc.) as the fund provider must be acknowledged at all times in all forms of publications. Please state the grant number (RDU/UIC) and grant name.

	ISI	**Scopus**
Number of articles/ manuscripts/books *(Please attach the **full paper** of Publication)*	1. Using Mediation in Project Disputes Based on Theory of Planned Behavior and Technology Acceptance Model, J. Leg. Aff. Dispute Resolut. Eng. Constr., 2020, 12(1): 04519044. (ISI & Scopus) 2. Risk attitudes and the big five personality traits:a study on construction project practitioners in Malaysia. International Journal of Construction Management, DOI: 10.1080/15623599.2020.1793506. **ESCI (WoS/ISI) papers, with full scopus status.** 3. Predicting intention to use alternative dispute resolution (ADR): an empirical test of theory of planned behaviour (TPB) model. International Journal of Construction Management, DOI: 10.1080/15623599.2018.1505026. **ESCI (WoS/ISI) papers, with full scopus status.**	
	International	**National**
Conference Proceeding *(Please attach the **full paper** of Publication)*	1. Scopus Proceedings – Published 1 in E3S Web of Comference 65, 03001 (2018), title **"Understanding Decisions to Suspend Works: When Employers Do Not Pay".** 2. Scopus Proceedings – Accepted for the FGIC 2nd Conference on Governance and Integrity 2019, title **"Status and Barriers Impeding Utilization of Project Management Tools: Epidemic for Tripartite Construction Parties in Malaysia".**	1. 2.

HUMAN CAPITAL DEVELOPMENT

KPI FOR HUMAN CAPITAL DEVELOPMENT

	PhD Student	Master Student
KPI		**1**
Achievement		**2 (TWO) On Going Master students (Proposal Defense Complete).**

Human Capital Development	Number				Others (please specify)
	On-going		Graduated		
Citizen	Malaysian	Non Malaysian	Malaysian	Non Malaysian	
PhD Student					
Masters Student	2				
Undergraduate Student					
Total	2				

Name of Student: **ID Matric No:** **Faculty:** **Thesis title:** **Graduation Year:**	Master Student (1): Yusmin Bin Jaffar MPM18001 Faculty of Industrial Management **On Going** since 12 February 2018
Name of Student: **ID Matric No:** **Faculty:** **Thesis title:** **Graduation Year:** *** enter for more space*	Master Student (2): Siti Maharah Binti Abdul Khalim MPM18003 Faculty of Industrial Management **On Going** since 5th December 2018
INTELECTUAL PROPERTIES	
KPI FOR INTELECTUAL PROPERTIES Patent, Copyright, Trademark,Industrial Design: _____	
Patent, Copyright, Trademark, Industrial Design ect	Copyright for : (1) Safety Assessment for Electronic Manufacturers (SAEM) (**LY2018005803**) (2) GCPM Modular: Global Certified Project Management Modular Based on Risk Simulator. (**LY2019002344**)
OTHERS	
KPI FOR OTHERS Prototype, Technology,Collaborations etc: _____	
Prototype, Technology, Collaborations etc	**None**

ASSET *(Aset)*

E

Bil	Peralatan *(Equipment)*	Model	No Daftar Aset *(Asset Tagging No)*	Amount (RM)	Lokasi *(Location)*
	None				

PRODUCT DESCRIPTION FOR UMP R&D DIRECTORY (SHORT & BRIEF) *Only for Final Report*

F **None**

PRODUCT PICTURE FOR UMP R&D DIRECTORY *Only for Final Report*

G	**None**

SUMMARY OF RESEARCH FINDINGS (*Ringkasan Penemuan Projek Penyelidikan*)

H	The systematic review on past and future on Industrialized Building System (IBS) has been formulated. The factors influencing IBS performances have been done and identified. These factors constitute as the corenerstone of the model influencing IBS performances and maturity.

PROBLEMS / CONSTRAINTS IF ANY (*Masalah/ Kekangan sekiranya ada*)

I	Due to current pandemic, the remaining budget allocation could not be fully utilized. However, the research itself has been successfully performed and completed.

Date : 24th August 2020
Tarikh

Project Leader's Signature:
Tandatangan Ketua Projek

DR. LEE CHIA KUANG
SENIOR LECTURER
FACULTY OF INDUSTRIAL MANAGEMENT
UNIVERSITI MALAYSIA PAHANG
LEBUHRAYA TUN RAZAK
26300 GAMBANG KUANTAN
TEL: 013-7023668 FAX: 09-5492167

COMMENTS, IF ANY/ ENDORSEMENT BY FACULTY (*Komen, sekiranya ada / Pengesahan oleh Fakulti*)

J	**Recommend / ~~Not Recommend~~ / ~~KIV / Need Ammendment~~**

Approved according to the justification stated.

Name:
Nama:
DR. PUTERI FADZLINE BINTI MUHAMAD TAMYEZ
DEPUTY DEAN (RESEARCH & POSTGRADUATE STUDIES)
FACULTY OF INDUSTRIAL MANAGEMENT
UNIVERSITI MALAYSIA PAHANG
LEBUHRAYA TUN RAZAK
26300 GAMBANG, KUANTAN
TEL : 09 - 549 2445 FAX 09 - 549 2167

Signature:
Tandatangan:

Date:
Tarikh:

** Dean/TDR/Director/Deputy Director

COMMENTS, IF ANY/ ENDORSEMENT BY RMC PNI (*Komen, sekiranya ada / Pengesahan oleh RMC PNI*)

K	**Recommend / Not Recommend / KIV / Need Ammendment** .... **Name:** **Signature:** *Nama:* *Tandatangan:* **Date:** *Tarikh:*

TEMPLATE OF FINAL REPORT
PROFILE BOOK
INTERNAL GRANT & SHORT TERM GRANT

DEVELOPING AN INTEGRATED INDUSTRIALISED BUILDING SYSTEM (IBS) MATURITY MODEL: A HYBRID MODEL WITH RIGGS OMAX.

Project Leader: Dr. Lee Chia Kuang

Co-researchers
1. KHAIRUL FIRDAUS BIN ANUAR
2. Dr. MUHAMMAD WARIS ALI KHAN
3. AZI IZWANI BINTI NOR HAMZAH
4. Dr. IRENE TING WEI KIONG

Faculty of Industrial Management, Universiti Malaysia Pahang.
E-mail: chia@ump.edu.my
Field: Project Management

ABSTRACT

Industrialized Building System (IBS) is a form of construction with focused processes comprise of methods, products and a set of connected components which works together to achieve objectives. Malaysian construction industry is among the main contributor towards the development of the country. To ensure vitality of construction performance, utilization and application of IBS is the right system to shift to from current conventional construction method. Adaptability of IBS in Malaysian's construction industry is very low due to various limitations and barriers. From a total of 110 articles reviewed in this paper, 8 factors were highly mentioned which are reduced workplace accidents, transportation and logistics, adequate knowledge and expertise, reduction in environmental degradation, management factor, integration of process and training, communication and financial status. These are all the barriers and limitations that impede the development and adaptability of IBS in Malaysia's construction industry that can also be used as crucial factors that can also significantly influence IBS project performance.

1. INTRODUCTION

The application of IBS in Malaysia had started from 1963 but still, participation and adoption of IBS among local construction industry is still relatively low compared to other developed countries (Nawi, Shaharanee, Hashim, Azman, & Ibrahim, 2015). Malaysian

government sees IBS as a new way to revolutionize its construction industry and in 1999, The IBS Strategic Plan was launched and the IBS Roadmap 2003-2010 was introduced in 2003 to support development and towards more IBS implementation among construction projects in Malaysia. Malaysia houses a very competitive construction environment as well as being very labour intensive which made the Malaysian Government continuously encourage application of modern method construction to achieve a healthy and sustainable construction industry environment (Nawi, Shaharanee, et al., 2015). Malaysia as well as other companies grew tremendously in its construction industry and continuously benefits through the returns contributed by the industry itself as identified through Malaysia's Gross Domestic Product (GDP) (Nasir, Nawi, Rahim, Bahaudin, & Tapa, 2016). Being among the main contributor towards the development of the country, the construction industry in Malaysia need to ensure that the performance of the industry itself meets the minimum standards as well as client requirements. To ensure vitality of performance within the construction industry, construction players are encouraged to shift towards modern method of construction through the utilization and application of Industrialized Building System (IBS) (Yunus, Abdullah, Yasin, Masrom, & Hanipah, 2016). One of the main benefits from implementation of IBS is that process of construction that usually occurs on site can be transferred out from construction site into a more controlled environment and condition. In conventional method of construction, components of building are prefabricated on site and requires intense labour routine as well as involved much more cost including raw material, transportation and low speed of construction time (Rubio-Romero, Suárez-Cebador, & Abad, 2014). As generally known, intense activities is the most natural aspects of conventional on-site work which can cause disorganized environment such as traffic chaos, noise and air pollution, towards local communities (Akmam Syed Zakaria, Gajendran, Rose, & Brewer, 2018). By removing some or most of the work off-site, it will greatly contribute towards harmonization of development with surrounding environment. This is where IBS attain its importance as a role player in a modern method construction within the industry. The application of off-site prefabrication and modularization can also significantly contribute towards productivity gains, decreasing labour requirements, as well as improving working condition not just among workers who directly involved in project processes but also its surrounding environment (Akmam Syed Zakaria, Gajendran, Rose, et al., 2018). However different IBS being defined, the root idea of IBS is still the same where IBS is a system or a technique to manufacture components for construction of structures in a controlled environment.The objective of this study is to develop an integrated industrialized building system (IBS) Maturity Model.

2. LITERATURE REVIEW

Industrialized Building System (IBS)

Industrialized Building System (IBS) is the term to represent the prefabrication concept in the Malaysian construction industry. IBS is a construction process that uses standardized building components mass produced in a factory or on the site. Then the IBS is transported and assembled into a structure or building using suitable machinery and equipment with minimal workers on site with proper preparation and integration (Musa et al., 2016). A factory production environment usually provides higher technological efficiency, better working conditions and more rigorously enforced quality control (Dawood, 1999).

IBS is acknowledged as an on-site construction process comprises of methods, products and a set of connected component which work together to achieve an objective in construction project (Nasir et al., 2016). Industrialized building systems (IBS) can also be referred to as off-site construction, off-site production, pre-assembled building, automated construction, off-site manufacturing, prefabricated building, precast building, precast construction, non-traditional

building, and also modern method construction (Akmam Syed Zakaria, Gajendran, Rose, et al., 2018). It is of importance to choose the right option of whether to utilize conventional building method or implement modern industrialized construction method. According to Akmam et. al (2018), industrialization of a construction method essentially has three general key characteristics;

1. A generic organization
2. Based on production quantity
3. Offers an individualized finished product.

Nasir et al (2016) categorized the general IBS system in Malaysia into five which are precast concrete system, steel formwork, steel framing system, prefabricated timber framing system and block work system. IBS has been proved as a main key to boost up the productivity in construction industry by reducing time consumed to complete construction project, extremely high durability and less employed people (Nasir et al., 2016). These beneficial of IBS is very useful to ensure project achieve its objective in term of time and cost.

Reduced Workplace Accidents

Traditional on-site production activities for building components of a particular structure can be done in a low risk environment as well as time-saving through IBS application (Rubio-Romero et al., 2014). Application of IBS in a particular project will shift most work routine out of the site which will result in less activities on-site and less activities means less workplace accidents as suggested from a study conducted by Rubio-Romero et. al (2014). Transfer of labor activities from construction site will significantly reduce workplace accidents as implementation of IBS will greatly induce a safer working environment. As a result from the implementation of IBS in a particular project, the rate of workplace accident will see a great reduce rather than implementation of conventional method of construction. Rubio-Romero et. al (2014) in their study also found out that construction method with the lowest accident rate is certainly IBS and IBS can efficiently contribute to a reduction in the number of accidents due to the resulting shorter time spent working on site. This can also be explained through reduction of on-site execution time where it should be considered as an important trait to support effort at minimizing accident rates, which can be achieved efficiently by implementing IBS as construction method.

Transportation and Logistics

Transportation can significantly boost successfulness and maturity of a particular IBS project (Baharuddin, Bahardin, Zaidi, Lokman, & Nawi, 2016). Transportation plays a big role in facilitating manufacturing processes of IBS implementation. High cost of transportation can cause big difference in project efficiency whether in terms of cost itself as well as quality and time. IBS involves off-site manufacturing of components which gives transportation a star role in ensuring that all projected tasks and processes are achieved. Higher cost of transportation plus high cost of manufacturing can significantly affect performance of IBS project both in short and long-term period. One of the main trait of IBS taking most of on-site work out of the construction area into a safer and controlled environment to boost efficiency. This effort requires efficient logistics and transportation management. From the very beginning until completion of construction, logistics plays a very important role in managing and controlling material as well as information flow (Asri, Nawi, Saad, Osman, & Anuar, 2016). IBS facilitates great attention towards logistic management to harvest benefits of materials arriving just in time to prevent materials become obsolete, stolen or damaged which will result in significant influence towards successfulness of a particular construction project. Asri et. al (2016) highlighted in their study 11 criteria that can be used to define successful transportation and logistics implementation:

1. Reduced share of non-value adding activities
2. Increase output value through systematic consideration of customer requirement
3. Variability reduction
4. Cycle time reduction
5. Simplification through minimized number of steps and parts
6. Increased output flexibility
7. Increased process transparency
8. Focused control on the complete process
9. Continuous improvement into the process
10. Balanced flow improvement with conversion improvement

11. Benchmark

Key success factors for offsite construction projects lies in good management for both on-site and off-site processes as well as planning and control of the overall project life-cycle (Rashidi & Ibrahim, 2017). The Malaysian construction industry needs to learn about effective logistics management to include the management and sustained improvement of the production process in order to eliminate waste and to ensure the right components are produced and transported at the right time, in the right order, and without defects (Rashidi & Ibrahim, 2017). The supply chain as well as logistics management is crucial in all stages of IBS project processes including initial works, components production at factory, transported to construction site, installation and finishing ensuring successful IBS project implementation. The implementation of logistics management with just-in-time (JIT) delivery may also be useful in reducing warehouse and storage cost, reducing lead time, improving productivity, and improving quality.

Adequate Knowledge and Expertise

Nawi et. al (2015) conducted a study and found out that sufficient knowledge and expertise of the IBS method especially among designers and contractors can greatly influence towards a successful implementation and delivery of an IBS project. The implementation of IBS needs an expertise to delegate and creating an attitude of cooperation and good relations between participants of the project to ensure main objective of IBS implementation is well achieved (Nasir et al., 2016). Nasir et al (2016) further stated that the introduction of IBS is not so widespread because IBS level of understanding among the participants of the project are so superficial, resulting in difficulty in adapting these systems in construction projects. Therefore, the probability of making mistakes or negligence in the performance of the system is high. Architects and engineers are still unaware of the fundamentals of design process to fabricate, connect and to install (Nawi, Shaharanee, et al., 2015). Most undergraduate engineers in Malaysia concentrate more on conventional construction processes and routine rather than giving focus towards IBS. This is also the main reason why most designers and contractors are reluctant to implement IBS in their project due to the lack of capability in terms of knowledge and expertise. Adequate knowledge and expertise can also translated from the differences of design specifications between IBS and non-IBS or conventional system especially in terms of the requirements for shop and mould drawings for the prefabrication process (Nawi, Shaharanee, et al., 2015). Nawi et. al (2015) their findings also suggested that most architects and engineers are still unaware of the basic design process to fabricate, connect and install the elements of IBS resulting in unsuccessful implementation of IBS towards achieving construction objectives.

Reduction in Environmental Degradation

Advanced manufacturing uses emerging technologies to critically enhance not only the economic competitiveness of individual manufacturers but also the sustainability of the whole industrial sector. New materials and technologies require new manufacturing processes and novel analytical models for process controls and parameter optimization regarding cost, reliability, quality, product flexibility, and energy consumption (Jin et al., 2017). The successful adoption of advanced manufacturing for sustainability can only be realized by following a systematic approach from concept development, product design and manufacturing to product delivery and service as well as in forward and reverse supply chain management (Jin et al., 2017). The adoption of industrialized building systems (IBS) technology, with its focus on off-site prefabrication and modularization, offers a significant reduction in environmental degradation, while simultaneously achieving significant productivity gains, decreasing labor requirements and improving working conditions (Akmam Syed Zakaria, Gajendran, Rose, et al., 2018). With the increasing need of faster delivery of project, IBS can facilitate quality level maintenance as well as environmental protection to serve as a competitive advantage between other contractors within the construction industry. In other words, for a particular IBS construction project to be successful, the effect towards environment is also a trait to consider successful delivery of IBS project implementation. Reduced environmental degradation can be explained through minimum waste from production, increase ability in separating stream of waste, reused potential, no waste, less debris, and delivery of the exact elements (Yunus & Yang, 2014). IBS can reduce the construction time of a project, minimize the use of timber formwork at construction site, and help to keep construction sites cleaner and neater. Overall it will positively affect the productivity of

work, as well as reducing the solid waste onsite and decrease the transport costs out of the site (Jia Wen, Chin Siong, & Noor, 2015). Jia Wen et al (2015) in their study also pointed that successful IBS project can directly reduce large volume of materials used in components needed to complete construction process.

Management Factor

Management factors are the niche of the whole supply chain system in IBS where it demonstrates a process of controlling and how something is done or used in contrast with management process of IBS, where systematic installation of each beam, column, wall, or plank is carried out after the successful production of the component. Construction of an IBS building has different stages according to type of project and demographic (Akmam Syed Zakaria, Gajendran, Skitmore, & Brewer, 2018). Akmam et. al (2018) also highlighted in their study 5 processes of IBS which are; initial works, components production at factory, transported to construction site, installation and finishing. Management factors demonstrates a process of controlling and how something is done or used making it the niche of the whole supply chain system in IBS (Akmam Syed Zakaria, Gajendran, Skitmore, et al., 2018). Management factors can be described based on good working collaboration, effective communication channel, involvement of team members during design stage, extensive planning and scheduling, risk management, management of supply chain and logistic, top down commitment, strategy and business approach, industry marketing strategy, as well as environmentally friendly method as suggested from the findings of a study conducted by Akmam et. al (2018). A study conducted by Nasir et al (2016) found that top managers should plays an important role in ensuring that project teams are encourage to be cooperative and supportive, lack of attention from senior managers and project manager planning will significantly cause poor procurement management level which will result in project performance disrupt.

Integration of process and training

Process integration and cross-training can facilitate the flow of work within prefabrication networks because multi-skilled resources are not limited to perform single tasks and can operate over a production zone or potentially the whole network (Arashpour, Wakefield, Abbasi, Arashpour, & Hosseini, 2018). The most commonly used architecture is direct integration, in which all resources are capable of covering processes undertaken by over-utilized resources that transfers excess capacity from under-utilized resources in a direct path to over-utilized and alleviates the problem of capacity imbalance in off-site construction networks (Arashpour et al., 2018). Process integration can also be defined as having skill chain integration where exist overlapping work zones as well as multi-skilled resources capable of handling operations. Under skill chain integration, multi-skilled resources can be deployed within upstream and downstream integration process over a limited manufacturing zone at early stages of production which at the same time resulting in multi-skilled resources are provided with production cell over the whole production network (Arashpour et al., 2018). Another type of process integration is when multi-skilled resources can be utilized and able to operate across the whole production network while addressing both problems of capacity imbalance as well as process variability. This type of integration is called a full integration and requires substantial cross-training of resources within production network (Arashpour et al., 2018). Lack of skilled labor and relating training schemes that are limited are becoming obstacle to achieve successful completion of IBS project; generally, program or syllabus for IBS design process in higher learning institution level is still limited and so far there is no code uniformity in IBS project design work among the special consultants even though 'Modular coordination Scheme' (like MS 1064) have been introduced in Roadmap IBS 2003-2010 and 2011-2015, unfortunately this scheme is getting less response from industry (Nawi, Azman, et al., 2015). Nawi et al (2015) further stated that the practice implemented by most manufacturers of IBS currently is their own and they differ with each other in terms of size, type, and method of installation which results in inconsistencies arising from making installation work by the contractors and the construction site more difficult.

Communication

A study conducted by Pozin et al. (2017) indicated that one of many major factors contributing towards successful implementation of IBS is communication. Communication stands firm as one of the most susceptible barrier between a particular IBS project and successful delivery. Poor connection through communication between stakeholders during IBS project would cause time

wasting because of repetition of design plan and working drawing due to delivery and receipt of information that is not very effective (Nasir et al., 2016). A study conducted by (Sadafi et al., 2012) also found that communication among construction players present significant influence towards the successfulness of a particular IBS project. These problems will incur a higher expenses and extra time to cover the damage in order to complete the project A new integrated method of communication need to utilized to better suit the needs and requirement of IBS communication network. Traditional approaches implemented in IBS have been recognized by several studies failing to support effective work teams when team processes are fragmented from each other (Pozin, Nawi, Azman, & Lee, 2017). IBS construction involves large number of teams with different expertise and most of the time from different organizations, all of which are handled by different numbers of management processes, for instance in planning, manufacturing, transportation, positioning, and assembling the structures that involve minimal additional site work (Pozin et al., 2017). Therefore, interconnected of communication between people involve in projects should be given serious consideration (Nasir et al., 2016).

Project involves numerous parties such as the owner of project, architects, engineers, as well as contractors, decisions and data, also a long set of processes starting from initial idea and then followed by feasibility study, design, construction and operation, and maintenance works (Haron et al., 2015). Poor communication between members across the project will cause supply chain breakdown, poor plans and specification, supply chain will also be fatally affected as background of each members within the project will different in terms of goals as well as references. In order to overcome this challenge, construction companies in Malaysia invested in Information and Communication Technologies (ICT) to handle all the information between parties within a construction project as it was believed that ICT can manage as well as utilize data processing in a much more efficient and minimum delay and errors (Haron et al., 2015). Haron et al (2015) in their study also highlighted the relevance of Building Information Modelling (BIM) proposed by the Construction Industry Board of Development (CIDB) Malaysia to be implemented for each and every IBS project to significantly manage and channel related data across the whole project. Implementation of BIM will have significant effect towards increasing productivity and smoothness of coordination process due to the effective flow of information across the project members (Haron et al., 2015). Attention to BIM was focused towards data and information in a way drawn to design and modelling processes control and management (Vernikos, Goodier, Broyd, Robery, & Gibb, 2014). Therefore, in summary BIM is an umbrella term for object-oriented modelling that relates to both vertical and horizontal infrastructure where the objects have extended attributes that can be leveraged to understand the content of a design and allowing for a consistent platform of communication throughout the supply chain (Nasir et al., 2016). Key success factors for offsite construction projects lies in good management for both on-site and off-site processes as well as planning and control of the overall project life-cycle (Rashidi & Ibrahim, 2017). Integration of IBS components and modules into the building construction processes requires various parties and the supply chain create good communication channel in order to implement an integrated approach to the design, manufacturing, and construction of buildings (Rashidi & Ibrahim, 2017).

Financial Status

Poor financial status of a company will also effect on the completion IBS construction project where the management does not have a good financial plan on the IBS construction project which will definitely cause delayed completion of IBS project (Nasir et al., 2016). For example, higher initial cost to implement IBS and will end up with cash flow issues, struggle to pay the significant costs such as those associated with raw materials. Nasir et al (2016) addressed in their study issues commonly faced by contractors in Malaysia is lack of initial capital when starting IBS project and this lack of available capital is the most often cited reason that prevents business growth and failure to complete a particular project. IBS construction project require high initial cost making it critical for contractors to plan their financial needs ahead and well before venturing into a project. It is also important for contractors to obtain appropriate financing to better suits their need to ensure they have sufficient strength to finish their project as well as staying in power within the industry (Nasir et al., 2016). IBS project construction requires specialized machinery and equipment which requires a tremendous amount of capital investment compared to conventional construction method that is labor-intensive method (Zakaria, Majid, & Nazri, 2017). Therefore, making it very hard for local contractors to venture into IBS projects due to the

lack of financial strength especially within the private sectors. Facilities needed to fulfil IBS implementation requires huge amount of continual funding and only companies which are strong and stable monetarily could survive in the utilization of IBS within the highly competitive industry locally as well as globally (Zakaria et al., 2017).

3. RESEARCH METHODOLOGY

To achieve objective of this paper, a systematic review was performed in order to obtain detailed evidence for synreport. *In Step 1: Identifying Keywords for Review*, keywords correlating to IBS that can fulfil the range of search review were identified before starting the systematic review. A total of 6 most appropriate keywords was identified and set to fulfill the requirement of the study. The 6 keywords are "IBS", "Industrialized Building System", "pre-fabrication", "modern method construction", "off-site construction", and "industrialized building system (IBS)". A powerful search engine, 'Scopus' was used in *Step 2: Selecting Data Source* to perform search using all 6 previously identified keywords. Search were done based on the subject area of Engineering as IBS is mainly an engineering method of construction innovation. By using Scopus, search method of 'Title/Abstract/Keywords' were utilized and generated a total number of 11,376 documents from various subject area, document type and also other related keywords.

4. FINDINGS

Development of IBS

Development of IBS came up as the second most popular theme from overall total of 81 articles with 16 articles (19.8%). Development of IBS highlighted histories of IBS throughout the world, achievement within the IBS industry as well as case studies conducted within the field of IBS. The theme 'Development of IBS' discussed in-depth mostly on concepts as well as direction of IBS in a highly competitive construction industry market environment. This theme also consists of case studies of IBS implementation and history in developing countries such as China (Arif & Egbu, 2010), case study in Kano State, Nigeria, (Zakari, Awal, Zakaria, Abdullah, & Hossain, 2017), offsite hub in Scotland (Hairstans & Smith, 2018), evaluation on thermal performance of industrialised housing construction system in Mexico (Becerra-Santacruz & Lawrence, 2016). The theme development of IBS also included studies on history of early documented process of industrialized building through precast manufacturing routine, 'Timber in the buildings of Jean Prouve, an industrial material (Berthier, 2015). Development of IBS also highlighted advancement of IBS integration with other related technology such as Geographical Information System (GIS) used to track IBS trend within the construction industry (Azman et al., 2012). Another related technology is called Weighted Linear Combination (WLC) which was used to determine either an IBS project is more suitable to permanent or mobile infrastructure (Azman, Ahamad, Kusumwardani, & Nawi, 2017).

IBS Connection Model

IBS connection model came up third most popular themes which highlights models of connection between prefabricated components of building. Yip et al (2015) in their study proposed a Special Reinforced Lightweight Aggregate Concrete (SRLWAC) as a beam component in industrialized building system to overcome the difficulties during the component installation due to heavy lifting task. SRLWAC was set-up on two columns corbel and tested under vertical static load and behaved elastically up to 90kN and deformed plastically until ultimate capacity of 250.1 kN in the experiment (Yip, Marsono, Wong, & Amran, 2015). There are five major types of IBS based on structural aspects which were precast reinforced concrete frame, panel and box system, steel framework system, and prefabricated timber frame system (Wong, Marsono, Tap, & Yip, 2015). Wong et al (2015) in their study further stated that existing IBS cannot be mixed or inter-use as they are not compatible to each other especially at its joints and they are manufactured as well as

sold as separate systems due to their own unique designs. IBS connection model theme describes majorly on connection between the mentioned five types of IBS structural aspects as well as statistical evaluation of IBS and also standardized design and process of IBS within a specific project.

Barriers of IBS

Barriers of IBS refers to all elements that impede successfulness of a particular IBS project and falls under fourth place of the synthesized themes with 8 articles from total of 81 consisting of 9.9%. Although IBS has been introduced to the world for more than 40 years, successful implementation of IBS in the construction industry environment, implementation and usage of IBS is still slow and below target while at the same time being major portion of the players within the construction industry were resistance towards change as well as insufficient information regarding the feasibility change of IBS (Nawi, Lee, Kamar, & Hamid, 2011). Higher initial cost, lack of knowledge and expertise, as well as lack of research and development practices, the most noticeable barriers deterring most IBS project from achieving success (Nawi et al., 2011). Another study found factors that can decrease success probability of successful IBS project implementation can be grouped into a specific context such as economic condition, government involvement, stakeholder involvement, sustainability features, technology development, communication process, decision making style, management approach, procurement, condition of project, experience, attitude, awareness, and bounded rationally (Akmam Syed Zakaria, Gajendran, Rose, et al., 2018). These are among what consist in barriers of IBS theme, even though all the mentioned elements can significantly affect successful IBS implementation negatively, all of the elements are also an indicator of what contractors needed to overcome and utilize in order to gain success.

Integration of IBS

Integration of IBS came under fifth place which refers to set of design process and routine of a particular system that relate and connects with each other in an efficient manner. There were 6 articles with the theme integration of IBS that represents7.4% out of all 81 articles in the synreport. As an example, one of many crucial aspects of success elements is integration of all parties involved in the project including designers, engineers, as well as contractors are required to avoid problems such as 'constructability' and 'manufacturability' (Nawi, Azman, et al., 2015). A high level of integration among partners in a construction project is required in the industrialized construction process because high level coordination is necessary in maintaining manpower, materials, and equipment within a particular IBS project (Luo, Mao, Shen, & Li, 2015). An effective collaboration on the key attributes and evaluation of successful factors can help the project to meet the project objectives as well as increase stakeholders' satisfactions which highlight the importance of integration to exist across the internal chain of project in order to ensure success (Yunus et al., 2016). Poor integration as well as communication will significantly delay project from various aspects of routine (Nasir et al., 2016) which will exponentially become major issue affecting performance of not just the particular project but also the whole construction industry itself due to lack of integration across parties from same as well as different project (Haron et al., 2015).

Environmental

The sixth most popular themes synthesized from 81 articles generated through previous step was environmental themes with 4 articles which represents 4.9% of total articles. Environmental theme refers to IBS being a system that not just significantly increase success rate of a particular project in terms of the triple constraint (time, scope, and cost), but also can significantly contributes towards preserving nature by reducing production of waste on project site. IBS concept has the potential to promote sustainability development and green construction that can be achieved through implementation of controlled production environment, minimization of construction waste generation, extensive usage of energy efficient building material, a safer and stable working environment, as well as better investment for long term project economy (Hamid et al., 2012). Industry need to seize this opportunity and apply IBS as their competitive advantages

in promoting sustainable construction industry in the future (Hamid et al., 2012). Hamid et al (2012) further stated in their study several aspects of IBS that have the potential of contributing to different aspects of sustainability and green construction such as sustainability from controlled production environment, controlled emission and energy, industrialized building system and waste, industrialized building system and building materials, industrial building system and logistics, industrial building system and economic sustainability, industrial building system and recycling of building material, industrial building system and economic responsibility, and also industrial building system and safety issue. A case study was done in the European Union (EU) indicates construction and demolition waste is estimated one third of all waste (Kelly & Dowd, 2017). Through implementation of IBS, components can be manufactured in tightly controlled factory environment which enables efficient use of building materials, reduced construction waste and high quality construction (Jiang, Mao, Hou, Wu, & Tan, 2018). IBS is a much more likely option to choose as a method of constructing when viewed environmentally compared to conventional method of construction which was known for its waste generation and excessive expenditure of resources (Sadafi, Zain, & Jamil, 2012). Environmentally, implementation of IBS is a system that can dramatically reduce multiple forms of waste while at the same time will cut down majority inefficiency within the construction industry itself (Haron et al., 2015).

IBS Performance

At number eleventh, IBS performance theme scored three articles with percentage of 3.7% from total 81 articles synthesized. IBS performance refers to the performance of particular IBS project in terms of stakeholder satisfaction, successfulness of IBS implementation, as well as IBS sustainability. There was not much study conducted to accurately measure how well a particular IBS project performed in terms sustainability. To ease decision making process, it is of very crucial importance for a project to have a set of assessments intended towards gathering and providing information to facilitate decision making process which will significantly reduce delay of projects (Kamali & Hewage, 2017). Sustainability for instance is a widely used criteria to define how well a project specifically IBS project performed. Several methodologies as well as systems had been developed and published to assess the level of sustainability in buildings where significant category of sustainability assessment methods includes sustainable rating system also known as green building rating system, sustainability rating systems, or sustainability rating tools (Kamali & Hewage, 2017). Other example of sustainability performance of a particular IBS projects were, LEED (international), BREEAM (international), Green Globes (US and Canada), as well as CASBEE (Japan). These sustainability rating systems deal with sustainability performance of buildings by providing a set of performance criteria and scoring each building project based on those criteria and at the same time provide examination for level of expected performance of a “whole building” and allow comparison of different buildings (Kamali & Hewage, 2017).

IBS Knowledge Management

IBS knowledge management, a theme with three articles generated 3.7% out of total 81 articles came number eighth on the list. Knowledge management refers to the level of IBS knowledge each and every personnel involved with the project possesses, IBS knowledge management is also a theme that discuss mostly on how knowledge management became among the most influential barrier that deter contractors, engineers, as well as designers from changing into IBS. Even though government spent a lot of effort towards encouraging and promoting the implementation of IBS, IBS implementation still falls under unsatisfactory level due to various determinants that had influenced successful implementation of IBS particularly in Malaysia, one of the determinants is lack of knowledge and experience demonstrated by consultants and contractors in utilizing IBS (Hanafi, Abas, Ibrahim, & Abdullah, 2016). Among some most significantly influential factors affecting implementation in Malaysia revealed by several studies were negative perception, readiness issue, poor planning, cost and equipment, regulations, as well as poor knowledge and awareness issue (Tamrin, Nawi, & Nifa, 2016). Tamrin et al (2016) also highlighted in their study that process flow of project can be greatly affected especially in design process if there exists lack of IBS knowledge. Mostly when architect give traditional drawing, the drawing must be redesign and converted into IBS drawing as redesign and

conversion process requires additional cost and time to achieve, which also supports the importance of IBS knowledge management that can prevent unnecessary repetition process during activity in project (Tamrin et al., 2016). The introduction of IBS is not so widespread because IBS level of understanding among the participants of the project are so superficial, resulting in difficulty in adapting these systems in construction projects (Nasir et al., 2016). Therefore, the probability of making mistakes or negligence in the performance of the system is high. Architects and engineers are still unaware of the fundamentals of design process to fabricate, connect and to install (Nawi, Shaharanee, et al., 2015).

Benefits of IBS

The theme benefit of IBS was the ninth theme with three articles forming 3.7% out of total 81 articles in this review. Benefits of IBS is a straightforward theme which articles discussed mainly about the benefits from implementation of IBS towards large spectrum of benefactors. Implementation of IBS can greatly reduce dependencies of foreign labors in this country where involvement of human interface were cut down exponentially, productivity and quality also became one of the most influential trait for why contractors should choose IBS over traditional method of construction where manufacturing of building components were done within a controlled environment (Azman et al., 2012). Azman et al (2012) further highlighted the benefits from implementation of IBS in the construction industry as being environmentally friendly where waste generation will be significantly cut down due to the manufacturing of components will be done off-site and according to specific design will optimize usage of resources. The ranking of IBS from the most beneficial to the least beneficial characteristics (Azman et al., 2012) are as shown:

1. Minimal wastage
2. Cleaner environment
3. Less site materials
4. Reduction of site labor
5. Controlled quality
6. Faster project completion
7. Neater and safer construction sites
8. Lower total construction costs

Safety and Health

Safety and health is the tenth and the last theme with only 2 articles generating 2.4% total out of 81 articles overall. Safety and health is also a straightforward theme which discussed about the safety of workers within the construction industry through implementation of IBS. Industrialization of building activities will lead to a reduction of accident rates in the construction sector, particularly as a result of switching activities from construction sites to factories (Rubio-Romero et al., 2014). The idea is to increase the number of prefabricated elements such as façade panels, floor to ceiling walls, etcetera to reduce accident rate in the construction industry as a result of switching from traditional high risk task performed in building construction to lower risk task in factories (Rubio-Romero et al., 2014). Industrialization represents an increase in rationalization, the intensification of repetitive operations and greater specialization of workers which accompanied by transfer of traditional craftsmanship carried out on construction site to factories (Rubio-Romero et al., 2014). The core of safety and health through implementation of IBS as discussed by Rubio-Romere et al (2014) is that exposure time to on-site work presents significant influence towards explaining accident rates in construction site. IBS significantly reduce workers' exposure to direct on-site tasks by transferring all task into a safer, stable, and controlled environment. Less time workers spend on a particular task, the lesser risk of accident events.

5. CONCLUSION

The objective of this paper is to synthesize factors of IBS that can influence performance of IBS project. This study has conducted systematic review and generated a total of 110 articles from 45 journals after careful consideration and filtering process to ensure quality of study. A total of 29 articles were not shortlisted for discussion as the article were not openly available and cost a lot of money to retrieve. Therefore, only a total of 81 articles were shortlisted for report. From the systematic review, a total of 8 factors were synthesized for being influential towards the performance of a particular IBS project and IBS maturity. 10 main were synthesized from a total of 81 articles which were 'Factors Influencing Successful IBS Implementation' (24 articles, 29.6%), 'Development of IBS' (16 articles,19.8%), IBS Connection Model (12 articles, 14.8%), 'Barriers of IBS' (8 articles, 9.9%), 'Integration of IBS' (6 articles, 7.4%), 'Environmental' (4 articles, 4.9%), 'IBS Performance' (3 articles, 3,7%), 'IBS Knowledge Management' (3 articles, 3.7%), 'Benefits of IBS' (3 articles, 3.7%), and 'Safety and Health' (2 articles, 2.4%). The result from this report were then filtered and synthesized further to detect factors that can significantly influence IBS project success.

Out of 81 articles, only 69 articles mentioned the definition and characteristics of IBS which represents a total of 85.2%. There were eight factors identified from qualitative method of systematic review. The total percentage for each factor was calculated from the total of overall 81 articles as there exists certain articles that mentioned more than one factor in one study. Reduction in environmental degradation come out the highest with total of 24 articles from overall 81 articles with percentage of 29.7%. Integration of process and training came out second with 25.9% representing a total of 21 articles out of 81. Management factor represents 23.5% from overall total of 81 articles with 19 articles. Adequate knowledge and expertise, and communication both come out with 14 articles from total 81 articles and each represents 17.3% from total 100%. Reduced workplace accidents generated 13 articles with 16% out of 81 total articles. Transportation and logistics generated from 11 articles out of 81 articles with 13.6% percentage. Factor with the lowest mentioned articles is financial status with only 8 articles from 81 at 9.9%.

Based on the findings from the systematic review, it can be concluded that in order for a particular IBS project to be mature and successful, it requires substantial effort towards a number of factors as well as barriers. Barriers are another source of factors that can be changed, use, and implement as a critical success factors that can influence the level of success among IBS project implementation.

ACHIEVEMENT

i) Name of articles/ manuscripts/ books published

1. Using Mediation in Project Disputes Based on Theory of Planned Behavior and Technology Acceptance Model, J. Leg. Aff. Dispute Resolut. Eng. Constr., 2020, 12(1): 04519044. (ISI & Scopus)

2. Risk attitudes and the big five personality traits:a study on construction project practitioners in Malaysia. International Journal of Construction Management, DOI: 10.1080/15623599.2020.1793506.

3. Predicting intention to use alternative dispute resolution (ADR): an empirical test of theory of planned behaviour (TPB) model. International Journal of Construction Management, DOI: 10.1080/15623599.2018.1505026.

ii) Title of Paper presentations (international/ local)

iii)

1. Scopus Proceedings – Published 1 in E3S Web of Comference 65, 03001 (2018), title **"Understanding Decisions to Suspend Works: When Employers Do Not Pay".**

2. Scopus Proceedings – Accepted for the FGIC 2nd Conference on Governance and Integrity 2019, title **"Status and Barriers Impeding Utilization of Project Management Tools: Epidemic for Tripartite Construction Parties in Malaysia".**

iv) **Human Capital Development**

Two On going Master Students

v) **Awards/ Others**

CITREX 2018 Silver Award
IFINOG 2018 Gold Award
CITREX 2019 Gold Award
ITEX 2019 Gold Award
CITREX 2020 Gold Award

REFERENCES

Akmam Syed Zakaria, S., Gajendran, T., Rose, T., & Brewer, G. (2018). Contextual, structural and behavioural factors influencing the adoption of industrialised building systems: a review. *Architectural Engineering and Design Management, 14*(1-2), 3-26. doi:10.1080/17452007.2017.1291410

Akmam Syed Zakaria, S., Gajendran, T., Skitmore, M., & Brewer, G. (2018). Key factors influencing the decision to adopt industrialised building systems technology in the Malaysian construction industry: an inter-project perspective. *Architectural Engineering and Design Management, 14*(1-2), 27-45. doi:10.1080/17452007.2017.1298512

Arashpour, M., Wakefield, R., Abbasi, B., Arashpour, M., & Hosseini, R. (2018). Optimal process integration architectures in off-site construction: Theorizing the use of multi-skilled resources. *Architectural Engineering and Design Management, 14*(1-2), 46-59. doi:10.1080/17452007.2017.1302406

Arif, M., & Egbu, C. (2010). Making a case for offsite construction in China. *Engineering, Construction and Architectural Management, 17*(6), 536-548. doi:10.1108/09699981011090170

Asri, M. A. N. M., Nawi, M. N. M., Saad, R., Osman, W. N., & Anuar, H. S. (2016). Exploring lean construction component for malaysian industrialized building system logistics management—A literature review. *Advanced Science Letters, 22*(5-6), 1593-1596. doi:10.1166/asl.2016.6696

Azman, M. N. A., Ahamad, M. S. S., Hamid, Z. A., Gomez, C. P., Kamar, K. A. M., Hilmi, N. D., . . . Ismail, Z. (2012). The selection of IBS precast manufacturing plant in Malaysia using GIS. *Malaysian Construction Research Journal, 10*(1), 77-90.

Azman, M. N. A., Ahamad, M. S. S., Kusumwardani, R., & Nawi, M. N. M. (2017). Incorporating spatial selection criteria with decision preferences in MCE-GIS-based site selection of a precast manufacturing plant. *Malaysian Construction Research Journal, 2*(Special Issue 2), 87-99.

Baharuddin, M. N., Bahardin, N. F., Zaidi, M. A., Lokman, I., & Nawi, M. N. M. (2016). A barriers and challenging criteria of IBS formwork: A current scenario amongs

stakeholder. *Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia, 39*(9), 14-21. doi:10.21311/001.39.9.03

Becerra-Santacruz, H., & Lawrence, R. (2016). Evaluation of the thermal performance of an industrialised housing construction system in a warm-temperate climate: Morelia, Mexico. *Building and Environment, 107*, 135-153. doi:10.1016/j.buildenv.2016.07.029

Berthier, S. (2015). Timber in the buildings of Jean Prouvé: An industrial material. *Construction History, 30*(2), 87-106.

Dawood, N. N. (1999). Integrating design and production system for the precast industry. *Betonwerk und Fertigteil-Technik/Concrete Precasting Plant and Technology, 65*(5), 74-80.

Hairstans, R., & Smith, R. E. (2018). Offsite HUB (Scotland): establishing a collaborative regional framework for knowledge exchange in the UK. *Architectural Engineering and Design Management, 14*(1-2), 60-77. doi:10.1080/17452007.2017.1314858

Hamid, Z. A., Ali, M. C., Kamar, K. A. M., Zain, M. Z. M., Ghani, M. K., Rahim, A. H. A., . . . Ambon, F. (2012). Towards a sustainable and green construction in Malaysia. *Malaysian Construction Research Journal, 11*(2), 55-64.

Hanafi, M. H., Abas, A., Ibrahim, F. A., & Abdullah, S. (2016). Readiness for industrialized building system implementation among Malaysian architectural firms' members. *Jurnal Teknologi, 78*(7), 195-203. doi:10.11113/jt.v78.4960

Haron, A. T., Marshall-Ponting, A. J., Zakaria, Z., Nawi, M. N. M., Hamid, Z. A., & Kamar, K. A. M. (2015). An industrial report on the Malaysian building information modelling (BIM) taskforce: Issues and recommendations. *Malaysian Construction Research Journal, 17*(1), 21-36.

Hong, J., Shen, G. Q., Li, Z., Zhang, B., & Zhang, W. (2018). Barriers to promoting prefabricated construction in China: A cost–benefit analysis. *Journal of Cleaner Production, 172*, 649-660. doi:10.1016/j.jclepro.2017.10.171

Jia Wen, T., Chin Siong, H., & Noor, Z. Z. (2015). Assessment of embodied energy and global warming potential of building construction using life cycle analysis approach: Case studies of residential buildings in Iskandar Malaysia. *Energy and Buildings, 93*, 295-302. doi:10.1016/j.enbuild.2014.12.002

Jiang, R., Mao, C., Hou, L., Wu, C., & Tan, J. (2018). A SWOT analysis for promoting off-site construction under the backdrop of China's new urbanisation. *Journal of Cleaner Production, 173*, 225-234. doi:10.1016/j.jclepro.2017.06.147

Jin, M., Tang, R., Ji, Y., Liu, F., Gao, L., & Huisingh, D. (2017). *Impact of Advanced Manufacturing on Sustainability: An Overview of the Special Volume on Advanced Manufacturing for Sustainability and Low Fossil Carbon Emissions* (Vol. 161).

Kamali, M., & Hewage, K. (2017). Development of performance criteria for sustainability evaluation of modular versus conventional construction methods. *Journal of Cleaner Production, 142*, 3592-3606. doi:10.1016/j.jclepro.2016.10.108

Kamar, K. A. M., Hamid, Z. A., Ghani, M. K., Rahim, A. H. A., Zain, M. Z. M., & Ambon, F. (2012). Business strategy of large contractors in adopting industrialised building system (IBS): The Malaysian case. *Journal of Engineering Science and Technology, 7*(6), 774-784.

Kelly, M., & Dowd, D. (2017). A review of construction waste management practices on selected case studies in Ireland. *Proceedings of Institution of Civil Engineers: Waste and Resource Management, 170*(2), 78-84. doi:10.1680/jwarm.17.00007

Luo, L. Z., Mao, C., Shen, L. Y., & Li, Z. D. (2015). Risk factors affecting practitioners' attitudes toward the implementation of an industrialized building system a case study from China. *Engineering, Construction and Architectural Management, 22*(6), 622-643. doi:10.1108/ECAM-04-2014-0048

Musa, M. F., Yusof, M. R., Mohammad, M. F., & Samsudin, N. S. (2016). Towards the adoption of modular construction and prefabrication in the construction environment: A case study in Malaysia. *ARPN Journal of Engineering and Applied Sciences, 11*(13), 8122-8131.

Nasir, N. M., Nawi, M. N. M., Rahim, M. K. I. A., Bahaudin, A. Y., & Tapa, A. (2016). A review of delay factors in Malaysian industrialized Building System (IBS) construction project. *ARPN Journal of Engineering and Applied Sciences, 11*(16), 9868-9873.

Nawi, M. N. M., Azman, M. N. A., Baluch, N., Kamar, K. A. M., & Abd Hamid, D. Z. (2015). Study on the use of industrialised building system in Malaysian private construction projects. *ARPN Journal of Engineering and Applied Sciences, 10*(17), 7368-7374.

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2011). A critical literature review on the concept of team integration in industrialised building System (IBS) project. *Malaysian Construction Research Journal, 9*(2), 1-17.

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2012). Critical success factors for improving team integration in Industrialised Building System (IBS) construction projects: The Malaysian case. *Malaysian Construction Research Journal, 10*(1), 44-62.

Nawi, M. N. M., Shaharanee, I. N. M., Hashim, K. F., Azman, M. N. A., & Ibrahim, S. H. (2015). Qualitative analysis on the barriers of industrialised building system (IBS) uptake in Malaysian construction projects. *Advanced Science Letters, 21*(6), 2134-2138. doi:10.1166/asl.2015.6233

Pozin, M. A. A., Nawi, M. N. M., Azman, M. N. A., & Lee, A. (2017). Improving communication in managing industrialised building system (IBS) projects: Virtual environment. *Malaysian Construction Research Journal, 2*(Special Issue 2), 1-13.

Rashidi, A., & Ibrahim, R. (2017). Industrialized construction chronology: The disputes and success factors for a resilient construction industry in Malaysia. *Open Construction and Building Technology Journal, 11*, 286-300. doi:10.2174/1874836801711010286

Rubio-Romero, J. C., Suárez-Cebador, M., & Abad, J. (2014). Modeling injury rates as a function of industrialized versus on-site construction techniques. *Accident Analysis and Prevention, 66*, 8-14. doi:10.1016/j.aap.2014.01.005

Sadafi, N., Zain, M. F. M., & Jamil, M. (2012). Adaptable industrial building system: Construction industry perspective. *Journal of Architectural Engineering, 18*(2), 140-147. doi:10.1061/(ASCE)AE.1943-5568.0000075

Tamrin, N., Nawi, M. N. M., & Nifa, F. A. A. (2016). Readiness in knowledge and ability for implementation of industrialised building system (IBS) in Malaysian construction industry. *Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia, 39*(9), 47-53. doi:10.21311/001.39.9.07

Vernikos, V. K., Goodier, C. I., Broyd, T. W., Robery, P. C., & Gibb, A. G. F. (2014). Building information modelling and its effect on off-site construction in UK civil engineering. *Proceedings of Institution of Civil Engineers: Management, Procurement and Law, 167*(3), 152-159. doi:10.1680/mpal.13.00031

Wong, J. Y., Marsono, A. K., Tap, M. M., & Yip, C. C. (2015). Performance-based pushover cyclic test for innovative prefabricated hybrid industrialised building system sub-frame. *Jurnal Teknologi, 74*(1), 91-103. doi:10.11113/jt.v74.3372

Yip, C. C., Marsono, A. K., Wong, J. Y., & Amran, M. Y. H. (2015). Flexural strength of special reinforced lightweight concrete beam for Industrialised Building System (IBS). *Jurnal Teknologi, 77*(1), 187-196. doi:10.11113/jt.v77.3505

Yunus, R., Abdullah, A. H., Yasin, M. N., Masrom, M. A. N., & Hanipah, M. H. (2016). Examining performance of Industrialized Building System (IBS) implementation

based on contractor satisfaction assessment. *ARPN Journal of Engineering and Applied Sciences, 11*(6), 3776-3782.

Yunus, R., & Yang, J. (2014). Improving ecological performance of industrialized building systems in Malaysia. *Construction Management and Economics, 32*(1-2), 183-195. doi:10.1080/01446193.2013.825373

Zakari, I., Awal, A. S. M. A., Zakaria, R., Abdullah, A. H., & Hossain, M. Z. (2017). Application of industrialized building system: A case study in Kano State, Nigeria. *International Journal of GEOMATE, 13*(39), 80-86. doi:10.21660/2017.39.19788

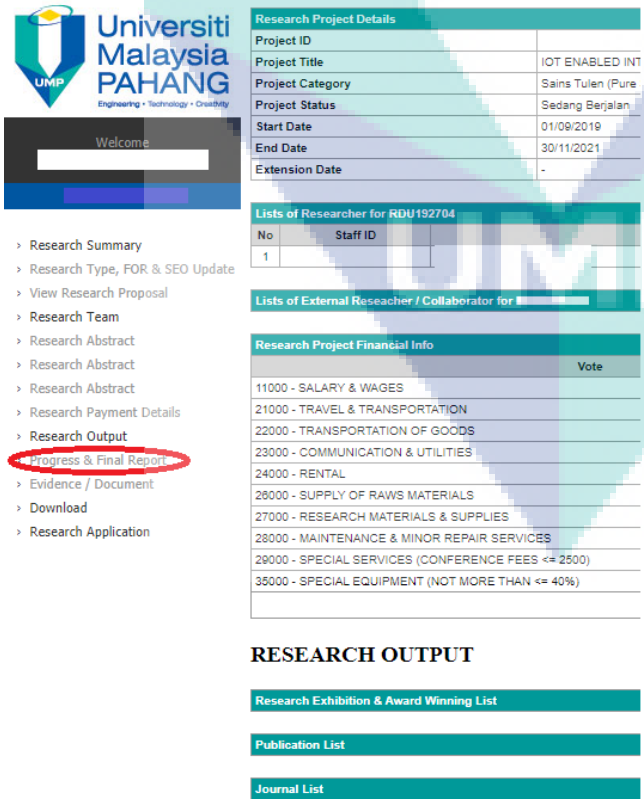
Zakaria, S. A. S., Majid, T. A., & Nazri, F. M. (2017). Adoption of industrialised building system (IBS): Exploring competitive advantages from a technology valuation perspective in northern Malaysia. *Malaysian Construction Research Journal, 22*(2), 1-17.

APPENDIXES

UPLOAD PROGRESS REPORT & FINAL REPORT ONLINE

1. ECOMM STAFF > RESEARCH MANAGEMENT > PERSONAL

2. PERSONAL > CHOOSE YOUR GRANT RDU NO. > PROGRESS REPORT / FINAL REPORT



- ***Select file to upload Progress Report or Final Report***
- ***Upload Progress Report or Final Report***
- ***Upload supporting documents (proof of KPI achievement)***

CHECKLIST FOR PROGRESS AND FINAL REPORT SUBMISSION
(Kindly upload IRIMS and submit hardcopy to PNI)

1. **P3 FORM (Pindaan 2020)**
   Portal research > grant & funding > download > internal grant > no.4 (final & progress report)
   ☐

2. **PROFILE BOOK TEMPLATE (FINAL REPORT ONLY)**
   Portal research > grant & funding > download > internal grant > no.4 (final & progress report)
   ☐

3. **TECHNICAL REPORT / THESIS (FINAL REPORT ONLY)**
   Upload IRIMS only
   ☐

OUTPUT:

4. **PUBLICATIONS**
   Attach fully published version with acknowledgement – full papers (Partial papers are not accepted)
   ☐

5. **TALENT**
   Attach appointment letter (SPPS / SPB), Letter of Graduated (if status graduated)
   ☐

6. **INTELLECTUAL PROPERTY**
   Attach evidences (Registration No & certificate of filing)
   ☐

7. **ASSET**
   Mention / state (Registration No / Serial No. / Location)
   ☐

8. **PROTOTYPE**
   Attach evidences (Registration No)
   ☐

JABATAN PENYELIDIKAN & INOVASI

SENARAI SEMAK PENGHANTARAN DOKUMEN LAPORAN PRESTASI & LAPORAN AKHIR GERAN KPT / AGENSI / GERAN DALAM / PGRS / SEED MONEY

NO	PERKARA / ITEMS	√
1	BORANG LAPORAN PRESTASI DAN LAPORAN AKHIR / *RESEARCH PROJECT REPORT FORM* (PINDAAN TAHUN 2020) TDR FAKULTI @ DEKAN FAKULTI / PENGARAH CoE PERLU MENGESAHKAN LAPORAN (SEKSYEN J) (KECUALI BAGI GERAN LUAR KPT) Portal research > grant & funding > download > internal grant (DALAMAN UMP) / external grant (KPT)	
2	TEMPLAT BUKU PROFILE (UNTUK LAPORAN AKHIR SAHAJA) (KECUALI PGRS DAN SEED MONEY) Portal research > grant & funding > download > internal grant / external grant	
3	*TECHNICAL REPORT / THESIS* (KECUALI PGRS DAN SEED MONEY) (UNTUK LAPORAN AKHIR SAHAJA)	
4	DOKUMEN HASIL PENERBITAN *(PUBLICATIONS)* SERTAKAN PENERBITAN PENUH (*FULLY PUBLISHED VERSION*) BESERTA PENGHARGAAN YANG JELAS KEPADA PIHAK PEMBIAYA (*ACKNOWLEDGEMENT*)	

SENARAI SEMAK PENGHANTARAN DOKUMEN LAPORAN PRESTASI & LAPORAN AKHIR GERAN KPT / AGENSI / GERAN DALAM / PGRS / SEED MONEY

NO	PERKARA / ITEMS	√
5	**DOKUMEN BAKAT / PELAJAR *(TALENT)*** SERTAKAN BUKTI SURAT LANTIKAN SPPS / SPB ; SURAT TAMAT PENGAJIAN (JIKA BERKAITAN)	
6	**HARTA INTELEK *(INTELLECTUAL PROPERTY)*** SERTAKAN BUKTI PEMFAILAN (NO. PENDAFTARAN / *CERTIFICATE OF FILING*)	
7	**PEMBELIAN ASET / HARTA MODAL *(ASSET)*** NYATAKAN MAKLUMAT HARTA DI BORANG LAPORAN (SEKSYEN E) (NO. PENDAFTARAN / NO. SIRI / LOKASI)	
8	**PROTOTAIP *(PROTOTYPE)*** NYATAKAN NAMA DAN HASIL PROTOTAIP - GAMBAR / VIDEO	

LAPORAN PRESTASI DAN LAPORAN AKHIR YANG LENGKAP PERLU DIKEMUKAKAN DALAM 2 CARA :

1. MUAT NAIK DALAM SISTEM IRIMS – E COMMUNITY
   (KETUA PROJEK PERLU MAKLUMKAN KEPADA PNI SETELAH LAPORAN BERJAYA DI UPLOAD) – UNTUK TINDAKAN SETERUSNYA PIHAK KAMI
2. LAPORAN SECARA *HARDCOPY* JUGA PERLU DIKEMUKAKAN KEPADA PNI UNTUK TINDAKAN / SEMAKAN DEKAN PENYELIDIKAN
3. STATUS PROJEK AKAN DIKEMASKINI SETELAH SELESAI SEMAKAN DI PERINGKAT DEKAN PENYELIDIKAN

Scholarly Paper

Using Mediation in Project Disputes Based on Theory of Planned Behavior and Technology Acceptance Model

Chia Kuang Lee[1]; Mei Sin Lee[2]; and Ramayah Thurasamy[3]

Abstract: The construction industry has been afflicted by various contractual issues. Alternative dispute resolution (ADR) methods such as arbitration, mediation, expert review, and adjudication techniques have been used to resolve construction disputes effectively. However, among these types of ADR methods, mediation is less applied in the Malaysian construction industry. To better understand and intervene in the use of mediation, this study tested a model conceptualized based on the theory of planned behavior (TPB) and technology acceptance model (TAM) in explaining the decision to use mediation. Both models posit that behavioral intention is the culmination of decision-making. The conceptualized model was empirically tested with partial least-squares (PLS) modeling, drawing from 65 mediation decision makers specializing in building and civil engineering works. Both measurement and structural models were assessed by SmartPLS version 3.0. The results suggest that intention (INT) toward the use of mediation technique is directly predicted by both attitude (ATT) and perceived behavioral control (PBC). The decision-making process is less desired by the influences of subjective norm (SN) and perceived usefulness (PU). The study concluded several strategies to intervene in the use of mediation through the effects of each critical factor at the end of the paper.
DOI: 10.1061/(ASCE)LA.1943-4170.0000361.

Author keywords: Construction disputes; Mediation; Theory of planned behavior; Technology acceptance model.

Introduction

Disputes are inevitable in the construction sector and need to be resolved quickly before they affect the project reputation (Hussin and Ismail 2015). Among all the resolution techniques, mediation is considered to be effective in improving the relationship between conflicting parties and the quality of settlement. Mediation is a voluntary process facilitated by a neutral third party to discuss with disputants and help reach consensus (Cheng 2015). Mediation is popular in developed countries as an alternative dispute resolution (ADR) method. Although most companies appreciate the benefits of mediation, its implementation is still discouraging (Hussin and Ismail 2015).

Due to the merits of mediation, numerous studies have been conducted on this technique. Previous studies on mediation emphasized the overall implications of mediation in resolving disputes (Radulescu 2012), factors influencing the use of mediation (Hussin and Ismail 2015), users' attitude toward mediation (Diekmann and Girard 1995), the level of mediation use in different dispute scenarios (Gună 2014), the neutrality of mediators in the dispute resolution process (Jacobs 2002), and mediation skills needed for academic delivery (Cheng 2015). Although previous studies focused on the use of mediation in resolving disputes, they failed to highlight any interventions to increase the use of mediation.

To address this need, this study aims to test a conceptualized model to predict and explain the use of mediation behavior. Drawing on the frameworks of the theory of planned behavior (TPB) and the technology acceptance model (TAM), the decision to use mediation is conceptualized as intention. The relationship between the determinants of intention (INT), such as attitude (ATT), subjective norm (SN), perceived behavioral control (PBC), perceived usefulness (PU), and perceived ease of use (PE), are further discussed in this paper.

Literature Review

Mediation is a dispute resolution technique (Radulescu 2012) and is often recognized as an alternative resolution option instead of juridical session (Jacobs 2002). In reality, it is a resolution technique that is superior to the other options and will ensure a positive attitude in its implementation (Lee et al. 2017). Nevertheless, mediation is considered easier and more economical in resolving disputes compared to other resolution techniques. To increase the use of mediation, this study postulates the factors influencing an individual's intention through both TAM and TPB.

TAM is an extended framework based on the theory of reasoned action (TRA) (Ajzen and Fishbein 1977) and TPB (Ajzen 1989). The TAM framework hypothesizes that actual behavior of an individual is predicted by INT. TAM recommends two predictors of attitude, such as perceived usefulness and perceived ease of use. Behavioral intention is determined by the combination of PU and ATT. ATT is determined by the function of both PE and PU. Finally, PU is influenced by PE. According to Lee et al. (2017), TAM has been commonly applied in the construction industry to understand an individual's acceptance of the latest innovation. It has been used to evaluate the behavioral intention of using e-learning among university students (Park 2009), the factors

[1]Senior Lecturer, Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, Gambang, Pahang 26300, Malaysia (corresponding author). ORCID: https://orcid.org/0000-0001-6063-8071. Email: chiakuang85@gmail.com

[2]Student, Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, Gambang, Pahang 26300, Malaysia. ORCID: https://orcid.org/0000-0002-3176-0497

[3]Professor, Management Dept., Universiti Sains Malaysia, Minden, Penang 11800, Malaysia. ORCID: https://orcid.org/0000-0002-7580-7058

Note. This manuscript was submitted on April 13, 2019; approved on July 3, 2019; published online on December 8, 2019. Discussion period open until May 8, 2020; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Legal Affairs and Dispute Resolution in Engineering and Construction***, © ASCE, ISSN 1943-4162.

influencing the acceptance of web-based training among construction professionals (Park et al. 2012), the adoption of software measures in quality management (Wallace and Sheetz 2014), learning management systems (Alharbi and Drew 2014), the utilization of technology in construction projects (Sepasgozaar et al. 2017), a user's intention toward the use of alternative dispute resolution in the construction dispute (Lee et al. 2017), and the implementation of big data analytics (Verma et al. 2018).

Behavioral INT is defined as the probability for a person in performing a behavior (Surendran 2012). TAM postulates that INT leads to action that corresponds to the decision of a person (Lee et al. 2017). According to Zhang et al. (2017), intention is the major predictor of human behavior and can be influenced by the function of both PU and ATT in TAM (Davis 1989) or PBC and SN in TPB (Ajzen 1991). Intention may be determined by external predictors according to the type of situation (Wu and Wang 2005).

ATT is influenced by PU and PE in TAM. TAM postulates that a person's intention toward using a system is determined by a person's attitude toward the application of the system (Verma et al. 2018). In TPB, attitude plays the same role as in TAM in predicting intention. Attitude overall refers to favorable or unfavorable feelings toward a particular behavior (Ajzen and Fishbein 2000). In using mediation, the decision maker generates attitude toward a behavior through the structure of beliefs that can be mathematically represented as $\sum_{i=1}^{n} B_i a_i$, where B_i refers to sum of beliefs of consequences of using mediation to resolve disputes, and such beliefs can exist in the form of "using mediation to resolve disputes would preserve relationships", while a_i refers to evaluation of consequences in using mediation, for example, using mediation to preserve relationships is beneficial or bad (Taylor and Todd 1995).

Based on these, the following hypotheses are postulated:

Hypothesis 1 (H_1): ATT toward the use of mediation positively influences behavioral intention (BI) to use mediation.

PU is defined as the dimension of a person's beliefs toward the latest technology that will improve their work performance (Davis 1989). When users accept the system and believe that the system is beneficial to their future job performance, their willingness to apply the system will be higher, and this will increase the chances of them using it again (Verma et al. 2018; Wallace and Sheetz 2014). Thus, the following hypotheses are given:

Hypothesis 2 (H_2): PU of mediation positively influences ATT toward the use of mediation.

Hypothesis 5 (H_5): PU of mediation positively influences BI to use mediation.

PE is defined as the degree of users' understanding in the use of a system or technology without putting in much effort (Davis et al. 1989; Verma et al. 2018). Basically, users will opt for the most convenient method and the fewest resources required on the application (Verma et al. 2018). Previous studies of Ha and Stoel (2009) and Verma et al. (2018) showed that PE has a positive influence toward PU and user's BI.

Hypothesis 3 (H_3): PE of mediation positively influences ATT toward the use of mediation.

Hypothesis 4 (H_4): PE of mediation positively influences PU of mediation.

TPB was first introduced by Ajzen (1991) as the most adaptive theoretical framework in analyzing actual behaviors. According to TPB, intention is the joint function of three determinants, attitude, perceived behavioral control, and subjective norm. TPB firmly hypothesized that integration between the determinants will define an individual's decision to perform the actual behavior. TPB has been successfully implemented to explain citizens' environmental complaint behavior (Zhang et al. 2017), contractor's waste management behavior in construction (Wu et al. 2017), waste minimization in construction (Li et al. 2015), selection and use of ADR in construction projects (Lee et al. 2016), behavioral intentions to use trial products (O'Connor and White 2010), and construction industry attitudes toward disputes and resolution techniques (Diekmann and Girard 1995).

SN is the second predictor in TPB after attitude. It is a social factor that refers to the positive or negative perceived social pressure to perform or not to perform the behavior (Ajzen 1991). According to Jimenez and Iyer (2016) and Kim et al. (2013), a friend's experience, a colleague's opinion, or justification from the user's family member can be influencers affecting the user's decision. The subjective norm can be mathematically written as $\sum_{i=1}^{n} N_i M_i$, where N_i represents the perceived importance of people (referents) who are important to the decision maker, for example, peers, project team members, and internal or external stakeholders who would support or influence the decision maker in using mediation; while M_i refers to the motivation to adhere to the expectations of these important referents in using mediation. The product of $\sum_{i=1}^{n} N_i M_i$ implies the opinions perceived by the decision maker and such normative beliefs influence decision-making (Chen and Tung 2014). Therefore,

Hypothesis 6 (H_6): SN toward the use of mediation positively influences BI to use mediation.

PBC refers to the perceived ease or difficulty in performing the behavior (Ajzen 1991). External control may be more critical in measuring an individual's intention compared to internal control (Ru et al. 2018). PBC draws on past behavior, previous experience, secondary information, and the availability of resources and opportunities. The availability or absence of resources will influence the perceptions of control over a particular behavior. PBC can be illustrated with the equation $\sum_{i=1}^{n} C_i P_i$, where C_i are the control beliefs, for example, a particular decision maker thinks that they have adequate experience and knowledge in the mediation process, and this experience and knowledge in the mediation process is very important in resolving disputes with mediation. Eventually, favorable control beliefs lead to higher intentions to perform a particular behaviour. Hansen et al. (2018) used both the theory of planned behavior and the technology acceptance model in predicting the user's intention toward the use of social media in performing transaction. Thus,

Hypothesis 7 (H_7): PBC toward the use of mediation positively influences BI to use mediation.

Based on the discussion, this study theorized that PA and PE would influence the use of mediation positively in the TAM framework. SN, PBC, PU, and ATT would influence BI. The hybrid of both TPB and TAM frameworks is further shown in Fig. 1.

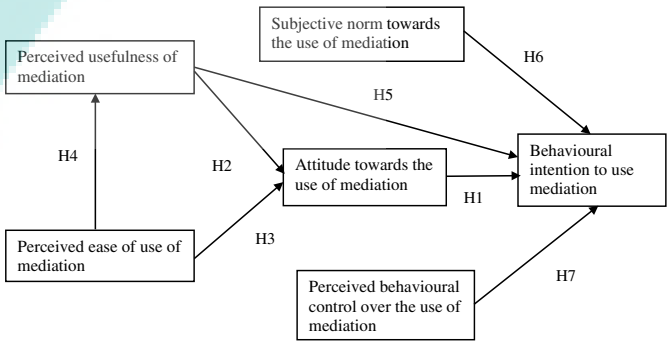


Fig. 1. Proposed model for understanding the use of mediation in project disputes.

Table 1. Questionnaire section C: Indicator

Indicator construct	Item code	Measurement item
Behavioral intention	INT_1	I intend to resolve disputes using mediation frequently
	INT_2	I plan to use mediation in resolving disputes
	INT_3	I am willing to use mediation in resolving disputes
Perceived usefulness	PU_1	Mediation would resolve disputes more quickly
	PU_2	Mediation would resolve disputes easily
	PU_3	Mediation would enhance the effectiveness of resolving the dispute
Perceived ease of use	PE_1	Instruction provided for mediation would be easy to use
	PE_2	It would be easy to learn how to use mediation
	PE_3	It would be easy to comply with the process of mediation
Attitude	ATT_1	Resolving disputes using mediation is a good idea
	ATT_2	Resolving disputes using mediation is a wise idea
	ATT_3	I have positive feelings in using mediation in resolving disputes
Subjective norm	SN_1	Most people like me to use mediation technique in resolving disputes
	SN_2	My project manager expects me to use mediation in resolving disputes
	SN_3	My colleagues expect me to use mediation in resolving disputes
Perceived behavioral control	PBC_1	I am confident that I can use mediation in resolving disputes
	PBC_2	I think I am able to use mediation in resolving disputes
	PBC_3	I have adequate support to use mediation in resolving disputes

Research Objectives

This study aims to test the conceptual models explaining the intention to use mediation in project disputes. The seven hypotheses stated in preceding were tested.

Methodology

Data Collection

A structured survey questionnaire that consisted of four major sections was designed and used for data collection. The first section requests personal details such as (1) gender, (2) grade, (3) position in the organization, (4) authority to make decisions on the use of mediation in project disputes, (5) working experience in the construction industry, and (6) experience in using mediation (Lee et al. 2017). For the second section, respondents proceed to the project details with five questions: (1) type of project, (2) project location (project in Malaysia), (3) type of project dispute, (4) contract sum (in Malaysia ringgits), and (5) which dispute resolution technique is preferable by the respondents. In the following section, the respondents choose the desired answer based on Likert scale with seven measurements (1 = strongly agree, 2 = moderately agree, 3 = somewhat disagree, 4 = neutral, 5 = somewhat agree, 6 = moderately agree, and 7 = strongly agree). The indicators used to measure the validity of those hypotheses were based on previous studies and are given in Table 1. The last section presents the strategies proposed to increase the use of mediation. Respondents are allowed to comment on other strategies that increase the use of each construct for the further verification process. The strategies proposed are provided in Table 2.

Survey Procedure

The designed structured questionnaire was first piloted by three experts. Further refinements were done where a trial run of the questionnaire was conducted by 15 Grade G7 contractors. The purpose of the pilot test was to ensure respondents understand the questionnaire provided. The measurement scales and content validity of the questionnaire were then refined and standardized (Park 2009). At last, the finalized standard questionnaire was sent to 650 Grade G7 construction companies registered under Construction Industry Development Board (CIDB) in Kuala Lumpur, Malaysia.

Results

The results are discussed and presented as follows. First, the personal details of the respondents (Table 3) are discussed, followed by project details (Table 4), then assessment of the conceptual model, and finally the summation of the proposed strategies in increasing the application of mediation.

The assessment of the proposed model was accomplished by using partial least-squares structural equation modeling (PLS-SEM). The minimum sample size for PLS path model assessment should be equal to or larger than 10 times the largest number of structural path pointing at a particular construct in the model (Hair et al. 2014). PLS-SEM generally has more flexible assumptions on data contribution and requirements of the sample size. The minimum sample size of this research follow the guidelines suggested by Marcoulides and Saunders (2006), which depend on the maximum number of arrows pointing at latent variables as specified in the structural equation model.

Table 3 gives the backgrounds of the 65 respondents. Most of the respondents hold prominent positions. The top three positions are project manager (13.85%, $n = 9$), then director and administrative manager (10.77%, $n = 7$), followed by quantity surveyor (9.23%, $n = 6$). A majority of the respondents have high decision-making authority in their respective projects because most of them agree that they are authorized to make decisions with respect to mediation use in their respective projects. Because the population required is Grade 7 contractors, those contractors who are downgraded will be excluded and 75.38% ($n = 49$) of the respondents reported having experience in the use of mediation. Because 65 respondents were acquired in this study, both the PLS algorithm (path weighting scheme) with a maximum of 300 iterations and a bootstrapping procedure of 65 cases and 5,000 samples were taken to evaluate the level of R^2 (predictive accuracy of the model), assessments of structural model path coefficients and hypothesis

Table 2. Questionnaire Section D: Possible strategies

Indicator construct	Strategy code	Strategy proposed	Source for strategy proposed
Behavioral intention	SINT_1	Improve the attitude toward mediation	Adapted and modified based on Ozturk et al. (2016)
	SINT_2	Ease the process of mediation	
	SINT_3	Allow flexibility of mediation	
	SINT_4	Ease the procedures of initiating mediation.	
	SINT_5	Restructure industrial hierarchy	
Perceived usefulness	SPU_1	Improve visualized outcomes of using mediation	Adapted from Cheng and Mitomo (2017), Piatkowski et al. (2017), Verma et al. (2018), Vicente et al. (2017), Sharifzadeh et al. (2017), Kim et al. (2013), and Alsabawy et al. (2016)
	SPU_2	Improve emotional security of disputants	
	SPU_3	Increase users' confidence in mediation	
	SPU_4	Reasonable cost in mediation	
	SPU_5	Competencies of mediator	
	SPU_6	Increase awareness of employees of mediation	
	SPU_7	Provide standard operating procedure (SOP) of mediation	
	SPU_8	Enhance the quality of delivery of the mediator	
Perceived ease of use	SPE_1	Increase level of trust toward mediator	Adapted from Hansen et al. (2018), Hamid et al. (2016), Alsabawy et al. (2016), Abdullah et al. (2016), and Vicente et al. (2017)
	SPE_2	Increase validity of information about mediation	
	SPE_3	Shorter duration of mediation process	
	SPE_4	Clear instruction by the mediator	
	SPE_5	Previous experience in using mediation	
	SPE_6	Increase interest in the use of mediation	
Attitude	SATT_1	Addressing knowledge gaps in mediation	Adapted from Ho et al. (2017), Jenerette et al. (2016), Seewooruttun and Scior (2014), Vicente et al. (2017), Singh et al. (2016), and Ülger et al. (2018)
	SATT_2	Full support from top management	
	SATT_3	Education in mediation	
	SATT_4	Education and training program related to mediation	
	SATT_5	Positive group interaction within employee group toward mediation	
Subjective norm	SSN_1	Provide sufficient information related to mediation	Adapted from Kim et al. (2013), Robinson (2015), and Dohnke et al. (2011)
	SSN_2	Increase public awareness of mediation	
	SSN_3	Implement social-norm-based program in mediation	
	SSN_4	Increase expectation from others of mediation	
	SSN_5	Provide consistent information pertaining to mediation	
Perceived behavioral control	SPBC_1	Organize web-based education program in mediation	Adapted from Qamar et al. (2017) and Ülger et al. (2018)
	SPBC_2	Conduct training to increase the use of mediation	
	SPBC_3	Frequently communicate with experienced personnel	

testing, effect sizes (f^2), and predictive relevance Q^2 and the q^2 effect sizes.

Table 4 provides the overall project details faced by the respondents. The types of project include residential (41.54%, $n = 27$), commercial (9.23%, $n = 6$), cultural (1.54%, $n = 1$), healthcare (3.08%, $n = 2$), civil and infrastructure (30.77%, $n = 20$), and industrial (13.85%, $n = 9$). Most of the projects were located in Selangor (56.92%, $n = 37$), followed by Kuala Lumpur (20%, $n = 13$), Perak (4.62%, $n = 3$), Melaka, Negeri Sembilan, Penang, Johor, and Pahang (3.08%, $n = 2$), and Kedah and Perlis (1.54%, $n = 1$).

From the type of dispute issues, most of the respondents had nonpayment or delayed payment progress issues (30.77%, $n = 20$), followed by variation requirement (27.69%, $n = 18$), errors in drawings, specifications, and quantities (10.77%, $n = 7$), awards and recognition (9.23%, $n = 6$), ambiguous contracts or contract documents (7.69%, $n = 5$), performance issues (6.15%, $n = 4$), and information suspension, personal injuries, property damage, justification on extension of time, and none (1.54%, $n = 1$). A majority of the projects (23.08%, $n = 15$) had a contract sum of between RM 10 million and RM 50 million. Twelve projects (18.46%) were reported to have a value between RM 50 million and RM 100 million. Eleven projects (16.92%) had a value between RM 100 million and RM 150 million, and another five projects (7.69%) had values more than RM 250 million. A majority of the respondents (49.23%, $n = 32$) chose negotiation as the intended dispute resolution technique, followed by mediation (40%, $n = 26$), arbitration (6.15%, $n = 4$), litigation (3.08%, $n = 2$), and The Construction Industry Payment and Adjudication Act (CIPAA) (1.54%, $n = 1$).

Table 5 shows the strategies to increase the use of mediation in resolving disputes. Most of the respondents preferred a strategy of process easiness toward mediation in increasing the user's behavioral intention toward mediation (40.00%, $n = 26$), followed by increasing level of convenience of mediation (32.00%, $n = 21$) and ease of use of mediation (26.20%, $n = 17$). To increase the perceived usefulness, increasing a user's confidence in mediation (27.7%, $n = 18$), visualize the outcomes of mediation (21.5%, $n = 14$), and improve the emotional security of the disputant (16.9%, $n = 11$) are the top three strategies. Three major strategies to increase the user's perceived ease of use of mediation includes increasing the validity of the information about mediation (29.2%, $n = 19$), increase the level of trust in the mediator (23.1%, $n = 15$), shorter duration of mediation and clear instructions provided in mediation (16.9%, $n = 11$).

Strategies to increase users' attitude toward mediation include full support and responses from top management (30.8%, $n = 20$), addressing knowledge gaps in mediation (24.6%, $n = 16$), and education and training program related to mediation (21.5%, $n = 14$). The subjective norm of mediation can be intervened through strategies such as provide sufficient information for mediation (41.5%, $n = 27$), increase the public communication of mediation (18.5%, $n = 12$), and provide competent and consistent information about mediation (23.1%, $n = 15$). Perceived behavioral control of mediation can be increased through conducting training (58.5%, $n = 38$), frequently communicating with experienced personnel

J. Leg. Aff. Dispute Resolut. Eng. Constr., 2020, 12(1): 04519044

Table 3. Demographic results

Demographic attribute	Frequency	Percentage
Position in organization		
President	—	—
Executive director	2	3.1
Chief executive director	—	—
Director	7	10.8
Project manager	9	13.8
Contract manager	5	7.7
General manager	2	3.1
Site engineer	3	4.6
Site manager	2	3.1
Project engineer	1	1.5
Executive manager	2	3.1
Administrative manager	7	10.8
Senior executive	5	7.7
Manager	2	3.1
Junior staff	1	1.5
Executive administrator	1	1.5
Engineer	4	6.2
Quantity surveyor	6	9.2
Contract executive	1	1.5
Junior executive	1	1.5
Design engineer	1	1.5
Safety supervisor	1	1.5
Chief executive officer	2	3.1
Authorized to make decisions for mediation use in projects		
1: Strongly disagree	4	6.2
2: Moderately disagree	1	1.5
3: Somewhat disagree	4	6.2
4: Neutral	11	16.9
5: Somewhat agree	15	23.1
6: Moderately agree	16	24.6
7: Strongly agree	14	21.5
Working experience in the construction industry		
1–5 years	23	35.4
6–10 years	13	20.0
11–15 years	7	10.8
16–20 years	6	9.2
21–25 years	5	7.7
26–30 years	6	9.2
31–35 years	4	6.2
More than 35 years	1	1.5
Experience in using mediation (in years)		
Half year	1	1.5
1	14	21.5
2	8	12.3
3	11	16.9
4	5	7.7
5	7	10.8
18	1	1.5
20	1	1.5
30	1	1.5
No	16	24.6

Table 4. Project details

Project detail	Frequency	Percentage
Type of project		
Residential	27	41.5
Commercial	6	9.2
Cultural	1	1.5
Sporting	0	0.0
Healthcare	2	3.1
Civil and infrastructure	20	30.8
Industrial	9	13.8
Project location (Malaysia)		
Johor	2	3.1
Kedah	1	1.5
Kelantan	—	—
Kuala Lumpur	13	20.0
Melaka	2	3.1
Negeri Sembilan	2	3.1
Pahang	2	3.1
Penang	2	3.1
Perak	3	4.6
Perlis	1	1.5
Sabah	—	—
Sarawak	—	—
Selangor	37	56.9
Terengganu	—	—
Type of project dispute		
Ambiguous contracts or contract documents	5	7.7
Variation requirement	18	27.7
Errors in drawings, specifications, and quantities	7	10.8
Nonpayment or delayed payment progress	20	30.8
Performance issues	4	6.2
Information suspension	1	1.5
Awards and recognition	6	9.2
Personal injuries	1	1.5
Property damages	1	1.5
Justification on extension of time	1	1.5
None	1	1.5
Contract sum		
Contract sum < 10 million	3	4.6
10 million ≤ contract sum < 50 million	15	23.1
50 million ≤ contract sum < 100 million	12	18.5
100 million ≤ contract sum < 150 million	11	16.9
150 million ≤ contract sum < 200 million	10	15.4
200 million ≤ contract sum < 250 million	9	13.8
250 million ≤ contract sum	5	7.7
Choice of dispute resolution		
Arbitration	4	6.2
Litigation	2	3.1
Mediation	26	40.0
Negotiation	32	49.2
Adjudication Act (CIPAA)	1	1.5

(23.1%, $n = 15$), and organizing a web-based education program (18.5%, $n = 12$).

Normality Test

The data collected were first tested for normality; the Kolmogorov-Smirnov test and Shapiro-Wilk test were used to ensure the result obtained was normally distributed by examining p-values greater than 0.05 (Hair et al. 2014). The p-values of all the items in the study were less than 0.05, which is not normal. The value of all results for skewness and kurtosis were in an acceptable range, between −1 and +1.

Harman's Single-Factor Test

If the total variance for a single factor is more than 50%, it suggests that the common method bias is pertinent in the study. The result shows that one factor extracted accounts for 48.283% of the variance in the data sample. Therefore, common method bias was not a problem in the data set

Measurement Model

The measurement model was first examined to assess the reliability and validity of the construct (Hair et al. 2014). All the constructs were assessed reflectively in the conceptual model. For reflective measurement models, both composite reliability (CR) and indicator loadings should be higher than 0.7, whereas indicator loadings

Table 5. Questionnaire Section D: Strategies proposed

Strategy proposed	Frequency	Percentage
Increase the user's behavioral intention		
Improve the attitude toward mediation	21	32.0
Ease the process of mediation	26	40.0
Allow flexibility of mediation	17	26.2
Ease the procedures of initiating mediation	—	0.0
Restructure industrial hierarchy	1	1.5
Increase the usefulness perceived by the user		
Improve visualized outcomes of using mediation	14	21.5
Improve emotional security of disputants	11	16.9
Increase user's confidence in mediation	18	27.7
Reasonable cost in mediation	6	9.2
Competencies of mediator	5	7.7
Increase awareness of employees toward mediation	—	0.0
Provide standard operating procedure (SOP) of mediation	6	9.2
Enhance the quality of delivery of the mediator	5	7.7
Increase the user's perceived ease of use		
Increase level of trust in mediator	15	23.1
Increase validity of information in mediation	19	29.2
Shorter duration of mediation process	11	16.9
Clear instruction by the mediator	11	16.9
Previous experience in using mediation	8	12.3
Increase interest in the use of mediation	1	1.5
Increase users' attitude		
Addressing knowledge gaps in mediation	16	24.6
Full support from top management	20	30.8
Education in mediation	6	9.2
Education and training program related to mediation	14	21.5
Positive group interaction within employee group toward mediation	9	13.8
Increase subjective norm		
Provide sufficient information related to mediation	27	41.5
Increase public awareness of mediation	12	18.5
Implement social-norm-based program in mediation	5	7.7
Increase expectation from others of mediation	6	9.2
Provide consistent information pertaining to mediation	15	23.1
Increase perceived behavioral control		
Organize web-based education program in mediation	12	18.5
Conduct training that will increase the use of mediation	38	58.5
Frequently communicate with experienced personnel	15	23.1

should exceed cross loadings. To achieve convergent validity, the average variance extracted (AVE) of the latent construct should be higher than 0.5. For discriminant validity, the square root of AVE of each construct should be higher than the constructs' correlation with other constructs according to the Fornell-Larcker criterion (Hair et al. 2014). Table 6 gives the results of outer loadings, composite reliability, and AVE.

Based on the guidelines in Hair et al. (2014), all CR values for all constructs exceed 0.7 and confirm a satisfying result of reliability. All of the AVE values were above 0.5 as provided in the Table 6, which reflects a reasonable degree convergent validity.

To examine the discriminant validity of the constructs, the cross loadings were listed. The overall result shows that there were no higher indicator loadings than the opposing constructs. The results ensured satisfactory discriminant validity. Besides Fornell-Larcker, heterotrait-monotrait ratio of correlations (HTMT) (Table 7) is one of the measurements for discriminant validity with an acceptable range of less than 1 (Henseler et al. 2015).

Collinearity Test

According to Hair et al. (2014), a collinearity test should be first addressed in the structural model. Collinearity assessments were conducted by examining the tolerance value to be more than 0.20 and variance inflation factor (VIF) values with the range of less than 0–5.0 (Table 8). The results show that the values were within the acceptable range and there was no collinearity problem in the data sets.

Structural Model Assessment

To test for hypotheses, path coefficients and *t*-statistics were examined by using the bootstrapping method. Bootstrapping and blindfolding routines analyzed the effect sizes (f^2), predictive accuracy (R^2), and predictive relevance (Q^2 and q^2 values).

Table 9 provides that the overall model is structurally good with firm values (R^2 intention = 0.505, Q^2 intention = 0.3141). The model explains 50.5% of variance in the intention to use mediation. The R^2 of values of ATT were moderate (R^2 attitude = 0.429, Q^2 intention = 0.3007), while R^2 of perceived usefulness was substantial (R^2 perceived usefulness = 0.462, Q^2 intention = 0.2665). The values imply a predictive model because they exceed 0 (Hair et al. 2014). The structural model results confirm that ATT has the strongest effect on INT (0.402), followed by PBC (0.247), PU (0.160), and SN (0.014). The four exogenous constructs together explained 50.5% of the variance of the endogenous construct INT ($R^2 = 0.505$), as indicated by the value in the construct circle. PU and PE also jointly

J. Leg. Aff. Dispute Resolut. Eng. Constr., 2020, 12(1): 04519044

Table 6. Composite reliability and average variance extracted

Construct	Item	Loading	AVE	Composite reliability
ATT	ATT_1	0.895	0.553	0.787
	ATT_2	0.948		
	ATT_3	0.880		
INT	INT_1	0.902	0.663	0.855
	INT_2	0.877		
	INT_3	0.878		
PBC	PBC_1	0.822	0.596	0.816
	PBC_2	0.899		
	PBC_3	0.782		
PE	PE_1	0.932	0.721	0.886
	PE_2	0.942		
	PE_3	0.923		
PU	PU_1	0.923	0.724	0.886
	PU_2	0.970		
	PU_3	0.956		
SN	SN_1	0.866	0.682	0.865
	SN_2	0.949		
	SN_3	0.959		

Table 7. Heterotrait-monotrait ratio

Construct	ATT	INT	PBC	PE	PU	SN
ATT	—	—	—	—	—	—
INT	0.946	—	—	—	—	—
PBC	0.966	0.822	—	—	—	—
PE	0.784	0.484	0.680	—	—	—
PU	0.907	0.710	0.727	0.841	—	—
SN	0.860	0.659	0.808	0.630	0.796	—

explained 42.9% of the variance of ATT, whereas PE explained 68% of the variance of PU.

The t-statistics in Table 8 indicate that three of the seven structural paths are statistically significant at $p < 0.01$, one structural path is statistically significant at $p < 0.05$, and one structural path is statistically significant at $p < 0.10$. The nonsignificant paths are PU-INT (t-value = 0.849) and SN-INT (t-value = 0.098). The hypothesis test shows that when disputes arise, ATT and PBC relate significantly to INT ($\beta_{\text{attitude}\rightarrow\text{intention}} = 0.402$, $t_{\text{attitude}\rightarrow\text{intention}} = 2.582$, and $p_{\text{attitude}\rightarrow\text{intention}} < 0.01$) and ($\beta_{\text{PBC}\rightarrow\text{intention}} = 0.247$, $t_{\text{PBC}\rightarrow\text{intention}} = 1.813$, and $p_{\text{PBC}\rightarrow\text{intention}} < 0.05$). Attitude has a larger effect on INT ($f^2 = 0.168$, $q^2 = 0.092$) in comparison to PBC on INT ($f^2 = 0.063$, $q^2 = 0.010$), whereas PU has a larger predictive relevance on INT ($f^2 = 0.026$, $q^2 = 0.099$) and SN shows no effect toward INT ($f^2 = 0.000$, $q^2 = -0.0007$). Meanwhile, PU and PE have significant influence on ATT ($\beta_{\text{PU}\rightarrow\text{ATT}} = 0.490$, $t_{\text{PU}\rightarrow\text{ATT}} = 3.843$, $f^2 = 0.219$, $q^2 = 0.239$, and $p_{\text{PU}\rightarrow\text{ATT}} < 0.01$) and ($\beta_{\text{PE}\rightarrow\text{ATT}} = 0.215$, $t_{\text{PE}\rightarrow\text{ATT}} = 1.284$, $f^2 = 0.007$, $q^2 = 0.136$, and $p_{\text{PE}\rightarrow\text{ATT}} < 0.10$). Moreover, PE has a significant effect on PU ($\beta_{\text{PE}\rightarrow\text{PU}} = 0.680$, $t_{\text{PE}\rightarrow\text{PU}} = 10.958$, and $p_{\text{PE}\rightarrow\text{PU}} < 0.01$) and ATT. Perceived usefulness and subjective norm, however, have no significant effect on intention. Hypotheses H_1, H_2, H_3, H_4, and H_7 were supported, but H_5 and H_6 were not. The overall paths are illustrated in Fig. 2.

Table 9. Effect sizes

Path	f^2 effect size	q^2 effect size	R^2	Q^2
ATT	—	—	0.429	0.3007
INT	—	—	0.505	0.3141
PU	—	—	0.462	0.2665
H_1: ATT → INT	0.168	0.092	—	—
H_2: PU → ATT	0.219	0.239	—	—
H_3: PE → ATT	0.007	0.136	—	—
H_4: PE → PU	—	—	—	—
H_5: PU → INT	0.026	0.099	—	—
H_6: SN → INT	0.000	−0.0007	—	—
H_7: PBC → INT	0.063	0.010	—	—

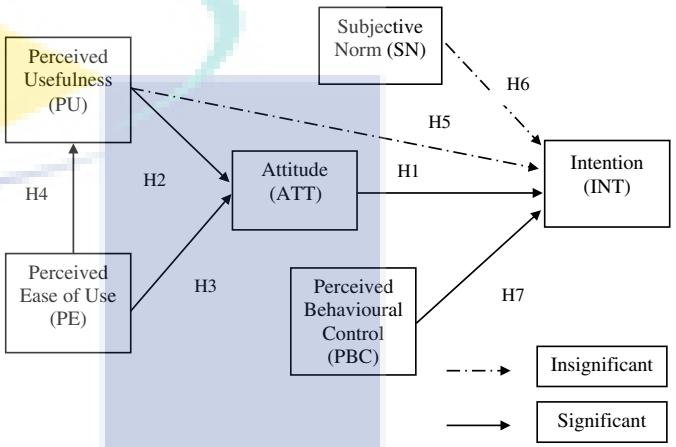


Fig. 2. Decision-making model when dispute occurs.

Table 8. Result of path significance

Model	Construct or path	Tolerance	VIF	Path coefficient	t-statistic	f^2 effect size	Significance
1	PU	0.659	1.860	—	—	—	—
	PE	0.659	1.860	—	—	—	—
2	PU	0.408	2.007	—	—	—	—
	ATT	0.351	2.116	—	—	—	—
	PBC	0.442	1.798	—	—	—	—
	SN	0.348	1.972	—	—	—	—
	H_1: ATT → INT	—	—	0.402	2.582	0.168	***
	H_2: PU → ATT	—	—	0.490	3.843	0.219	***
	H_3: PE → ATT	—	—	0.215	1.284	0.007	*
	H_4: PE → PU	—	—	0.680	10.958	—	***
	H_5: PU → INT	—	—	0.160	0.849	0.026	NS
	H_6: SN → INT	—	—	0.014	0.098	0.000	NS
	H_7: PBC → INT	—	—	0.247	1.813	0.063	**

Note: NS = not significant; *$p < 0.1$; **$p < 0.05$; and ***$p < 0.01$.

Discussion

The overall findings of this research indicate that decisions on the use of mediation are intentional. Making choices in mediation behavior is intended based on potential losses in time and cost (Deffains et al. 2017). Both attitude ($t_{\text{attitude}\rightarrow\text{intention}} = 2.582$, $p_{\text{attitude}\rightarrow\text{intention}} < 0.01$) and perceived behavioral control ($t_{\text{PBC}\rightarrow\text{intention}} = 1.813$, $p_{\text{PBC}\rightarrow\text{intention}} < 0.05$) in mediation significantly influence intention. The effect of both attitude and perceived behavioral control in the occurrence of a dispute indicate that disputants would use mediation based on a personal evaluation to utilize settlement. Mediation benefits resolution outcomes such as increased cost efficiency, greater time saving, and strengthening the business relationship throughout the settlement process. Furthermore, perceived usefulness ($t_{\text{PU}\rightarrow\text{attitude}} = 3.843$, $p_{\text{PBC}\rightarrow\text{attitude}} < 0.01$) and perceived ease of use ($t_{\text{PE}\rightarrow\text{attitude}} = 1.284$, $p_{\text{PE}\rightarrow\text{attitude}} < 0.1$) would influence attitude on the basis of self-belief in better performance through applying such technique. When a dispute arises, PU and PE in mediation significantly influence attitude, as hypothesized. Regardless, perceived ease of use contributes to the use of mediation if it is easy to understand and implement. Nevertheless, PE significantly influences PU through its influential effects. However, the results show no relationship between PU and INT; and SN and INT. This implies that intention to use mediation in resolving disputes is purely guided by the significant effect of attitude (self-perception) and perceived behavioral control (personal feelings).

Conclusion, Implications, Limitations, and Future Suggestions

Previous research focused on the benefits and factors in implementing the use of mediation in resolving disputes, yet the relationships among the factors and strategy being proposed to increase the use of mediation have not been explored. This study aimed to fill the research gap with the conceptualization of a decision-making model based on the hybrid of TPB and TAM. Seven hypotheses were formulated and analyzed to study the relationship within each factor.

Based on the empirical study, five hypotheses were supported and it shows a reasoned and planned decision-making process about mediation to use in resolving disputes. The significant effect from both attitude ($t_{\text{attitude}\rightarrow\text{intention}} = 2.582$, $p_{\text{attitude}\rightarrow\text{intention}} < 0.01$) and perceived behavioral control ($t_{\text{PBC}\rightarrow\text{intention}} = 1.813$, $p_{\text{PBC}\rightarrow\text{intention}} < 0.05$) indicates that the decision to use mediation is jointly affected by intuitive feelings and emotional evaluations on the benefits of mediation. Perceived ease of use in mediation influences ATT ($t_{\text{PE}\rightarrow\text{attitude}} = 1.284$, $p_{\text{PE}\rightarrow\text{attitude}} < 0.1$) through the implication of self-perception as well as the influential effect on PU ($t_{\text{PE}\rightarrow\text{PU}} = 10.958$, $p_{\text{PE}\rightarrow\text{PU}} < 0.01$). Most of the decision makers' intention is based on their own evaluation of the utility of mediation and the ease in implementing it in the current operation. Enhancing perceived ease of use of mediation through strategies increases the validity of information and level of trust toward mediator.

ATT, which is one's belief about the positive outcomes of the behavior is aligned with the PBC ($t_{\text{PU}\rightarrow\text{attitude}} = 3.843$, $p_{\text{PBC}\rightarrow\text{attitude}} < 0.01$) explains the self-perception in performing the mediation behavior. Strategies imposed on the constructs ensure the continuous effect on the intention of mediation. The results show that full support and responses to mediation will enhance attitude's contribution, whereas conducting trainings will increase the use of mediation in the sense of perceived behavioral control. The results showed that the conceptual model is well formulated because of the substantial R^2 and f^2 values for the intention of mediation.

Causal analysis greatly aids the understanding of the use of mediation through structural equation modeling. Although this statistical technique allows researchers to arrive at good model interpretations and hypotheses tests from the extension and hybridization of theories, the model can be further validated by expert mediators and refined through additional network analysis such as the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. Nevertheless, since the theory of planned behavior model welcomes the inclusion of additional variables and extensions, future studies can be done in a more reasonable time to ensure that the data bias can be reduced. More external variables and hypotheses could be added to further improve the model.

Acknowledgments

We would like to thank the Faculty of Industrial Management of Universiti Malaysia Pahang and Grant No. RDU1703296 for their continuous support and contribution in allowing us to complete this research.

References

Works Cited

Abdullah, F., R. Ward, and E. Ahmed. 2016. "Investigating the influence of the most commonly used external variables of TAM on students' perceived ease of use (PEOU) and perceived usefulness (PU) of e-portfolios." *Comput. Hum. Behav.* 63 (Oct): 75–90. https://doi.org/10.1016/j.chb.2016.05.014.

Ajzen, I. 1989. *Attitude structure and behavior.* Mahwah, NJ: Lawrence Erlbaum Associates.

Ajzen, I. 1991. "The theory of planned behavior." *Organizational Behav. Hum. Decis. Processes* 50 (2): 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Ajzen, I., and M. Fishbein. 1977. "Attitude-behavior relations: A theoretical analysis and review of empirical research." *Psychol. Bull.* 84 (5): 888–918. https://doi.org/10.1037/0033-2909.84.5.888.

Ajzen, I., and M. Fishbein. 2000. "Attitudes and the attitude-behavior relation: Reasoned and automatic processes." *Eur. Rev. Social Psychol.* 11 (1): 1–33. https://doi.org/10.1080/14792779943000116.

Alharbi, S., and S. Drew. 2014. "Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems." *Int. J. Adv. Comput. Sci. Appl.* 5 (1): 143–155.

Alsabawy, A. Y., A. Cater-Steel, and J. Soar. 2016. "Determinants of perceived usefulness of e-learning systems." *Comput. Hum. Behav.* 64 (Nov): 843–858. https://doi.org/10.1016/j.chb.2016.07.065.

Chen, M. F., and P. J. Tung. 2014. "Developing an extended theory of planned behavior model to predict consumers' intention to visit green hotels." *Int. J. Hosp. Manage.* 36 (Jan): 221–230. https://doi.org/10.1016/j.ijhm.2013.09.006.

Cheng, F. K. 2015. "Mediation skills for conflict resolution in nursing education." *Nurse Educ. Pract.* 15 (4): 310–313. https://doi.org/10.1016/j.nepr.2015.02.005.

Cheng, J. W., and H. Mitomo. 2017. "The underlying factors of the perceived usefulness of using smart wearable devices for disaster applications." *Telematics Inf.* 34 (2): 528–539. https://doi.org/10.1016/j.tele.2016.09.010.

Davis, F. D. 1989. "Perceived usefulness, perceived ease of use, and user acceptance of information technology." *MIS Q.* 13 (3): 319–339. https://doi.org/10.2307/249008.

Davis, F. D., R. P. Bagozzi, and P. R. Warshaw. 1989. "User acceptance of computer technology: A comparison of two theoretical models." *Manage. Sci.* 35 (8): 982–1003. https://doi.org/10.1287/mnsc.35.8.982.

Deffains, B., D. Demougin, and C. Desrieux. 2017. "Choosing ADR or litigation." *Int. Rev. Law Econ.* 49 (Mar): 33–40. https://doi.org/10.1016/j.irle.2016.11.002.

Diekmann, J. E., and M. Girard. 1995. "Construction industry attitudes toward disputes and prevention/resolution techniques." *Project Manage. J.* 26 (1): 3–11.

Dohnke, B., E. Weiss-Gerlach, and C. D. Spies. 2011. "Social influences on the motivation to quit smoking: Main and moderating effects of social norms." *Addict. Behav.* 36 (4): 286–293. https://doi.org/10.1016/j.addbeh.2010.11.001.

Gună, D. A. 2014. "Observations regarding the international regulation of mediation, as a diplomatic way to resolve the conflicts between states." *Procedia Social Behav. Sci.* 149 (Sep): 376–381. https://doi.org/10.1016/j.sbspro.2014.08.194.

Ha, S., and L. Stoel. 2009. "Consumer e-shopping acceptance: Antecedents in a technology acceptance model." *J. Bus. Res.* 62 (5): 565–571. https://doi.org/10.1016/j.jbusres.2008.06.016.

Hair, J. F., C. M. Ringle, and M. Sarstedt. 2014. "PLS-SEM: Indeed a silver bullet." *J. Marketing Theory Pract.* 19 (2): 139–152. https://doi.org/10.2753/MTP1069-6679190202.

Hamid, A. A., F. Z. A. Razak, A. A. Bakar, and W. S. W. Abdullah. 2016. "The effects of perceived usefulness and perceived ease of use on continuance intention to use e-government." *Procedia Econ. Finance* 35: 644–649. https://doi.org/10.1016/S2212-5671(16)00079-4.

Hansen, J. M., G. Saridakis, and V. Benson. 2018. "Risk, trust, and the interaction of perceived ease of use and behavioral control in predicting consumers' use of social media for transactions." *Comput. Hum. Behavior* 80 (Mar): 197–206. https://doi.org/10.1016/j.chb.2017.11.010.

Henseler, J., C. M. Ringle, and M. Sarstedt. 2015. "A new criterion for assessing discriminant validity in variance-based structural equation modeling." *J. Acad. Marketing Sci.* 43 (1): 115–135. https://doi.org/10.1007/s11747-014-0403-8.

Ho, H. J., Y. Y. Chan, M. A. B. Ibrahim, A. A. Wagle, C. M. Wong, and A. Chow. 2017. "A formative research-guided educational intervention to improve the knowledge and attitudes of seniors towards influenza and pneumococcal vaccinations." *Vaccine* 35 (47): 6367–6374. https://doi.org/10.1016/j.vaccine.2017.10.005.

Hussin, S. N., and Z. Ismail. 2015. "Factors to further enhance the use of mediation in Malaysian construction industry." *J. Technol. Manage. Bus.* 2 (1): 1–19.

Jacobs, S. 2002. "Maintaining neutrality in dispute mediation: Managing disagreement while managing not to disagree." *J. Pragmatics* 34 (10–11): 1403–1426. https://doi.org/10.1016/S0378-2166(02)00071-1.

Jenerette, C. M., C. A. Brewer, S. Silva, and P. Tanabe. 2016. "Does attendance at a sickle cell educational conference improve clinician knowledge and attitude toward patients with sickle cell disease?" *Pain Manage. Nursing* 17 (3): 226–234. https://doi.org/10.1016/j.pmn.2016.05.001.

Jimenez, P., and G. S. Iyer. 2016. "Tax compliance in a social setting: The influence of social norms, trust in government, and perceived fairness on taxpayer compliance." *Adv. Acc.* 34 (Sep): 17–26. https://doi.org/10.1016/j.adiac.2016.07.001.

Kim, E., S. Ham, I. S. Yang, and J. G. Choi. 2013. "The roles of attitude, subjective norm, and perceived behavioral control in the formation of consumers' behavioral intentions to read menu labels in the restaurant industry." *Int. J. Hosp. Manage.* 35 (Dec): 203–213. https://doi.org/10.1016/j.ijhm.2013.06.008.

Lee, C. K., T. W. Yiu, and S. O. Cheung. 2016. "Selection and use of alternative dispute resolution (ADR) in construction projects—Past and future research." *Int. J. Project Manage.* 34 (3): 494–507. https://doi.org/10.1016/j.ijproman.2015.12.008.

Lee, C. K., T. W. Yiu, and S. O. Cheung. 2017. "Understanding intention to use alternative dispute resolution in construction projects: Framework based on technology acceptance model." *J. Leg. Aff. Dispute Resolut. Eng. Constr.* 10 (1): 04517021. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000245.

Li, J., V. W. Y. Tam, J. Zuo, and J. Zhu. 2015. "Designers' attitude and behaviour towards construction waste minimization by design: A study in Shenzhen, China." *Resour. Conserv. Recycl.* 105 (Dec): 29–35. https://doi.org/10.1016/j.resconrec.2015.10.009.

Marcoulides, G. A., and C. Saunders. 2006. "Editor's comments: PLS: A silver bullet?" *MIS Q.* 30 (2): 3–9. https://doi.org/10.2307/25148727.

O'Connor, E. L., and K. M. White. 2010. "Willingness to trial functional foods and vitamin supplements: The role of attitudes, subjective norms, and dread of risks." *Food Qual. Preference* 21 (1): 75–81. https://doi.org/10.1016/j.foodqual.2009.08.004.

Ozturk, A. B., A. Bilgihan, K. Nusair, and F. Okumus. 2016. "What keeps the mobile hotel booking users loyal? Investigating the roles of self-efficacy, compatibility, perceived ease of use, and perceived convenience." *Int. J. Inf. Manage.* 36 (6): 1350–1359. https://doi.org/10.1016/j.ijinfomgt.2016.04.005.

Park, S. Y. 2009. "An analysis of the technology acceptance model in understanding university students' behavioral intention to use e-learning." *Educ. Technol. Soc.* 12 (3): 150–162.

Park, Y., H. Son, and C. Kim. 2012. "Investigating the determinants of construction professionals' acceptance of web-based training: An extension of the technology acceptance model." *Autom. Constr.* 22 (Mar): 377–386. https://doi.org/10.1016/j.autcon.2011.09.016.

Piatkowski, D. P., W. Marshall, and A. Johnson. 2017. "Identifying behavioral norms among bicyclists in mixed-traffic conditions." *Transp. Res. Part F: Traffic Psychol. Behav.* 46 (Apr): 137–148. https://doi.org/10.1016/j.trf.2017.01.009.

Qamar, Z., A. McIntosh, and K. Hicks. 2017. "Improved perceived behavioral control in choosing fruits and vegetables as a result of the online nutrition program for South Asians." *J. Acad. Nutr. Diet.* 117 (9): A58. https://doi.org/10.1016/j.jand.2017.06.173.

Radulescu, D. M. 2012. "Mediation—An alternative way to solve conflicts in the international business environment." *Procedia Social Behav. Sci.* 62 (Oct): 290–293. https://doi.org/10.1016/j.sbspro.2012.09.047.

Robinson, E. 2015. "Perceived social norms and eating behaviour: An evaluation of studies and future directions." *Physiol. Behav.* 152 (Dec): 397–401. https://doi.org/10.1016/j.physbeh.2015.06.010.

Ru, X., S. Wang, and S. Yan. 2018. "Exploring the effects of normative factors and perceived behavioral control on individual's energy-saving intention: An empirical study in eastern China." *Resour. Conserv. Recycl.* 134 (Jul): 91–99. https://doi.org/10.1016/j.resconrec.2018.03.001.

Seewooruttun, L., and K. Scior. 2014. "Interventions aimed at increasing knowledge and improving attitudes towards people with intellectual disabilities among lay people." *Res. Dev. Disabilities* 35 (12): 3482–3495. https://doi.org/10.1016/j.ridd.2014.07.028.

Sepasgozaar, S. M. E., S. Shirowzhan, and C. Wang. 2017. "A scanner technology acceptance model for construction projects." *Procedia Eng.* 180: 1237–1246. https://doi.org/10.1016/j.proeng.2017.04.285.

Sharifzadeh, M. S., C. A. Damalas, and G. Abdollahzadeh. 2017. "Perceived usefulness of personal protective equipment in pesticide use predicts farmers' willingness to use it." *Sci. Total Environ.* 609 (Dec): 517–523. https://doi.org/10.1016/j.scitotenv.2017.07.125.

Singh, A. P., C. Haywood Jr., M. C. Beach, M. Guidera, S. Lanzkron, D. V. Araujo, R. E. Rothman, and A. F. Dugas. 2016. "Improving emergency providers' attitudes toward sickle cell patients in pain." *J. Pain Symptom Manage.* 51 (3): 628–632. https://doi.org/10.1016/j.jpainsymman.2015.11.004.

Surendran, P. 2012. "Technology acceptance model: A survey of literature." *Int. J. Bus. Social Res.* 2 (4): 175–178.

Taylor, S., and P. A. Todd. 1995. "Understanding information technology usage: A test of competing models." *Inf. Syst. Res.* 6 (2): 144–176. https://doi.org/10.1287/isre.6.2.144.

Ülger, Z., D. E. Dette-Hagenmeyer, B. Reichle, and S. L. Gaertner. 2018. "Improving outgroup attitudes in schools: A meta-analytic review." *J. Sch. Psychol.* 67 (Apr): 88–103. https://doi.org/10.1016/j.jsp.2017.10.002.

Verma, S., S. S. Bhattacharyya, and S. Kumar. 2018. "An extension of the technology acceptance model in the big data analytics system implementation environment." *Inf. Process. Manage.* 54 (5): 791–806. https://doi.org/10.1016/j.ipm.2018.01.004.

Vicente, S., M. Veríssimo, and E. Diniz. 2017. "Infant massage improves attitudes toward childbearing, maternal satisfaction and pleasure in

parenting." *Infant Behav. Dev.* 49 (Nov): 114–119. https://doi.org/10.1016/j.infbeh.2017.08.006.
Wallace, L. G., and S. D. Sheetz. 2014. "The adoption of software measures: A technology acceptance model (TAM) perspective." *Inf. Manage.* 51 (2): 249–259. https://doi.org/10.1016/j.im.2013.12.003.
Wu, J.-H., and S.-C. Wang. 2005. "What drives mobile commerce?: An empirical evaluation of the revised technology acceptance model." *Inf. Manage.* 42 (5): 719–729. https://doi.org/10.1016/j.im.2004.07.001.
Wu, Z., A. T. W. Yu, and L. Shen. 2017. "Investigating the determinants of contractor's construction and demolition waste management behavior in mainland China." *Waste Manage. (Oxford)* 60 (Feb): 290–300. https://doi.org/10.1016/j.wasman.2016.09.001.
Zhang, X., G. Geng, and P. Sun. 2017. "Determinants and implications of citizens' environmental complaint in China: Integrating theory of planned behavior and norm activation model." *J. Cleaner Prod.* 166 (Nov): 148–156. https://doi.org/10.1016/j.jclepro.2017.08.020.

International Journal of Construction Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tjcm20

Risk attitudes and the big five personality traits: a study on construction project practitioners in Malaysia

Chia Kuang Lee & Mei Yit Foo

To cite this article: Chia Kuang Lee & Mei Yit Foo (2020): Risk attitudes and the big five personality traits: a study on construction project practitioners in Malaysia, International Journal of Construction Management, DOI: 10.1080/15623599.2020.1793506

To link to this article: https://doi.org/10.1080/15623599.2020.1793506

Published online: 20 Jul 2020.

INTERNATIONAL JOURNAL OF CONSTRUCTION MANAGEMENT
https://doi.org/10.1080/15623599.2020.1793506

Risk attitudes and the big five personality traits: a study on construction project practitioners in Malaysia

Chia Kuang Lee and Mei Yit Foo

Faculty of Industrial Management, Universiti Malaysia Pahang, Gambang, Malaysia

ABSTRACT

Risk management often applies in any decision making process to ensure success of an objective. However, many organizations fail to realize the importance of such knowledge, especially in high risk and complex industries in construction. The decision made while taking uncertainty into account varies among individuals based on their attitudes. Hence, their perspectives towards uncertainty may be the determinant to ensure success in a project. As risk attitudes and perception varies among individuals, so does personality. Henceforth, this study aims to investigate the relationship of the factors in the Big Five theory in influencing risk attitude, by using the Big Five Inventory (BFI) model and the Domain Risk-attitude scale, in order to determine individuals' personality based on the five dimensions for both categories. The proposed model was tested on 70 decision makers, particularly project practitioners specialize in the construction industry in Malaysia. Partial Least Squared Structural Equation Modelling (PLS-SEM) was used to investigate both variables based on the objectives. The results showed that all variables but one has a significant effect towards risk attitude, where extraversion has the most effect towards risk attitude. All factors of the Big Five except neuroticism reacts positively towards risk attitude. The study of relationship between personality traits and risk taking will signify the vast variations of how every decision maker will choose to respond to uncertainty depending on their respective human behaviour. Such understanding helps in the development of a comprehensive risk management plan.

KEYWORDS

Risk attitude; risk perception; personality traits

Introduction

The construction industry in Malaysia has significantly contribute to the growth of the Malaysian's economy (Mohamed et al. 2015). However, due to the scale and complexity, magnitude and time consuming characteristics, the industry is prone to high levels of risks (Kang et al. 2015). This causes impediments to the development and success of construction projects. With the natural existence of risks in decision making process, risk management practice among employees are considered an essential factor to the industry. Risks are often complex and dynamic in nature and should be viewed as an interrelated system rather than individual factors (Etemadinia and Tavakolan 2018). Dealing with risks in large projects is difficult and challenging. The severity of risk impact varies and requires the cooperation of managers to actively access risk on a daily basis and devise the correct action to be taken. Effective strategies are needed to manage the people and also achieve project objectives (Ogwueleka and Udoudoh 2018). However, the use of a good risk management in Malaysia is often ignored in most construction companies due to lack of practice and awareness on the subject (Kang et al. 2015). Only simple tools are used which are brainstorming and checklists, which are not considered as a formal risk management technique (Goh and Abdul-Rahman 2013). With the lack of proper tools, the likelihood for a project to fail increases when managers fail to identify and assess the potential outcome. This causes delays, cost overrun, inaccurate scope, or even abandonment of the construction project entirely. Reported by the Ministry of Housing and Local Government, there are a total of 134 abandoned private housing projects recorded (KPKT. 2019). Such outcome may have been caused by the complex practice by nature with the fragmented working process, which involve multiple stakeholders (Chong and Low 2014).

Hence, the managers and decision makers are responsible in understanding risk management. It is important to identify and assess risk at the right manner. However, individuals are often unique and different compared to others. Personality, in particular, is one of the characteristics that distinguishes a person's behaviour or perception. This does not exclude that risk is affected by perception of individuals. In other words, risk attitudes and personality traits predict in decision making, but very little study is made to study their influence among experts participating in the decision making process (Beyer et al. 2015). It is difficult to highlight which characteristics in an individual would denote either a positive or negative perception towards risk. With many types of personality test to investigate individual characteristics, it is not widely known how accurate it defines or predicts a person. The big five personality traits had been implemented for its practicality and researchers such as John and Srivastava (1999) have known to implement the concept in researching different individual traits, but yet to prove whether is it effective to categorize individuals based on their risk attitudes.

Risk attitude is a chosen state of mind of an individual that could bring potential positive or negative outcomes towards a decision (Hillson and Murray-Webster 2005). The term is closely related or affected by the individual's perception of risk, regarding whether they view risk as a form of opportunity or a threat. The level of perception towards uncertainty from individuals

CONTACT Chia Kuang Lee chiakuang85@gmail.com

affects decision-making actions based on different types of risks. These types are categorized into domains, such as ethical, financial, health or safety, recreational and social items (Weber et al. 2002). Therefore, this study aims to investigate whether risk attitudes contain any form of influences towards a personality of an individual. Items from the Big Five Inventory (BFI) and Domain Risk-attitude scale (DOSPERT) are used to study the correlation between the two variables as well as identify decision makers of their adopted risk attitudes in the construction industry.

Literature review

Risk management in construction project

Management of risks has been essential in construction projects, and the relevance of project risk management has been growing over the years (Nabawy and Khodeir 2020). Construction projects are vulnerable to myriads of threats such as political, regulatory and execution risks (Khodeir and Nabawy 2019). Risk management is prominent in ensuring the survival of companies and overcome such uncertainties (Ferreira de Araújo Lima et al. 2020). Proactive risk management plays a vital role in project management, often through various means such as risk exposure and Monte Carlo methods (Tsiga et al. 2017), and utilization of risk registers in response to various risky situations (Leva et al. 2017). Risk responses towards these situations however largely depends on personalities and attitudes of the decision makers. According to Wang et al. (2016), construction managers however would decide their risk management strategies and perceived differently towards risks based on their personalities. Despite the importance of risk management, decisions made without the decision maker's risk attitude would not be substantial and reliable (Taofeeq et al. 2020). Understanding the relationship between personalities and risk attitudes, and the particular attributes and personalities of people who undertake crucial risky decisions have both practical and theoretical implications to the construction industry. This would help both researchers and practitioners to better understand risk management behaviour of the project stakeholders, and thus leading to a better risk culture through substantial interventions and policies. (Tsiga et al. 2016).

Risk attitude

Risk attitude can be defined as a chosen response to uncertainty that matters, influenced by perception. Risk attitude is known to be a significant contributor on the risk management process in the project management industry at both individual and group levels. It is a chosen act to view at significant uncertainties. Since perception is a subjective matter, it suggests that the risk attitude of an individual might be unique compared to other attitudes adopted by others (Hillson and Murray-Webster 2005). In other words, risk attitude is influenced by individual's perception towards risk, depending on their own judgment and evaluations of hazards or potential rewards.

Depending on the field of research, risk attitudes may vary significantly. Several intertwined facets have been deliberated for risk attitude. While risk behaviour has been researched in both psychological and economic studies, very little studies have been done on risk attitudes. This is because the very topic of risk attitude has been a constant debate regarding to its adequate elicitation (Elisabet Rutström and Harrison 2008). Several behavioural measures are proposed among researchers, including incentivized measures such as lottery choice tasks or non-incentivized questionnaires from Likert scales (Holt and Laury 2005). Although lottery choices are easier to translate into formal indices and are preferable, but over time, evidence gathered that a large degree of noise exists in such measurement which varies the stimulation and cognitive ability. Hence, this leads to the growing popularity of questionnaire measures over the recent years. Despite difficulty to translate into numerical parameters, they remain important as predictors in behaviour (Lönnqvist et al. 2015).

Risk attitudes are to evaluate situations based on intentions, either favourable or unfavourable way and to be executed in the proper manner. Rohrmann (2005) believed that underlying traits of risk attitudes include risk propensity and risk aversion while Hillson and Murray-Webster (2005) had different factors in consideration. Risk attitudes are neither stable nor homogeneous in identifying hazards. Rather, humans tend to hold domain-specific attitudes depending on physical, financial and social risks. Weber et al. (2002) had categorized risk situations in five different domains, namely ethical, financial, health or safety, recreational and social items, thus formed the domain specific risk-attitude scale (DOSPERT). Their measurement towards risk attitude is affected by three factors, namely risk taking, risk perception through gut level assessment, and expected benefits. Weber et al. (2002) further included gambling as a criteria to measure risk attitude. However, many researchers have debated on the reliability of its measurement (Lönnqvist et al. 2015). Attitudes towards risk differ based on the types of risk in various situations. Each individual has a unique way to evaluate risk and are not necessarily consistent across domains, and the motivations for risk acceptance vary significantly, depending on the type of situation (Pearson et al. 2002). For example, Weber et al. (2002) discovered that respondents were not consistently risk averse or risk seeking across all domains. They included that gender is also a factor, where risk averse is more commonly found in women than men, except for social risk. The difference in gender and content domain in apparent risk taking are associated with the way people view activities through benefits and risk, rather than differences with attitudes towards perceived risk. Perceptions of risk are driven by many factors, in which Hillson and Murray-Webster (2008) had grouped them into three categories, namely conscious assessments, subconscious factors and gut level affective factors. Although existing factors that affect perception of risk can be detailed separately, they are unable to operate independently. Hence, this forms the triple strand of influence, describing how an individual or group responds in any given situation based on three factors.

Big five personality traits

Meanwhile, the five core personality traits are believed to be the cornerstone of human personality. This theory has been growing consistently, from the findings of Fiske (1949) and later supported by Norman (1967), and McCrae and Costa (1987). The factors represent endless variety of personality traits, namely openness, conscientiousness, extraversion, agreeableness and neuroticism (OCEAN). Each of the dimensions are measured by a continuum, whereby an individual may be either highly or low in certain personality traits or in between these two ends of a spectrum. Despite the label is given for each personality traits, it is not necessarily specific and can be tangible based on the personality characteristics measured.

Like personality traits, attitude cannot be evaluated through the naked eye. It should be interpreted from measurable

responses. An attitude towards risk could be inferred in different types of responses, including cognitive (perception), affective (feelings) and conative (intention) responses (Ajzen 2005). These responses are similar to the findings by Hillson and Murray-Webster (2008) from their triple strand of influences, where they explained that perceptions of risk are divided into conscious, subconscious and affective factors. Some of these elements are contained in personality traits in the Big Five theory. For example, neuroticism is discussed as feelings and emotions of an individual, guided by self-conscious and impulses (Costa, Jr. et al. 2012).

Openness (O)

Openness has been long renowned in the psychology fields. The concept of openness cannot be interpreted as a culture that can be obtained through reproduction or learning, nor as intellect or any other cognitive ability. Rather, openness should be viewed in structural and motivational terms. It is seen through breath, depth, and permeability of consciousness, examined through experience (McCrae and Costa 1997). It is the most controversial trait among the five personality traits of the Big Five Theory (McCrae and John 1992). Preconceptions regarding openness psychological definition however tends to be inconsistent (Funder and Sneed 1993).

The term openness to experience has its limitations and may suggest a rather different trait of interpersonal openness or self-disclosure. Openness may suggest a passive or non-critical receptivity that is considered inappropriate. Open minded people tend to seek out new experience and are mindful and reflective to the ideas they have encountered (McCrae and Costa 1997).

McCrae and Costa (1997) explained how individuals differ in openness. They divided two categories based on their influences, such as culture and cognitive ability. Openness is different from skills and knowledge and involves the person to seek and appreciate new experiences for one's own benefit. Curiosity, creative thinking, and willingness to entertain unconventional ideas and values are some of the characteristic of open individuals. These individuals experience the whole spectrum of intense emotions. In contrast, those who score low in openness, or closed individuals, tend to have standard beliefs and attitudes, and exhibit dogmatic and rigidity in their own beliefs. They are usually set in their own ways of living and emotionally unresponsive (Costa, Jr. et al. 2012).

Conscientiousness (C)

Conscientiousness is an aspect of ego and strength over time, and is often associated with terms such as willpower, initiative and responsibility. Costa et al. (1991) stated that conscientiousness contains both inhibitive and proactive aspects. The proactive side of this dimension is seen most clearly as the desire for achievement, and an individual's commitment to their work, while the inhibitive side is seen in a moral scrupulousness and cautiousness. The proposed facets for this dimension are competence, order, dutifulness, achievement striving, self-discipline, and deliberation (Costa et al. 1991). This dimension interprets the degree of organization, persistence, control, and motivation of goal-directed behaviour. People who scored high in conscientiousness tend to be well organized, independent, hardworking, self-directed, scrupulous, ambitious, and having high perseverance. In contrast, people who scored low are frequently aimless, lazy, careless, lax, negligent and hedonistic (Costa, Jr. et al. 2012).

Conscientiousness is one of the highly evaluated dimension among the personality traits, along with agreeableness. Agreeableness and conscientiousness are the traditional dimensions, describing between "good" versus "evil" and "strong-willed" versus "weak-willed" individuals. A number of different concepts of conscientiousness have been offered. Past researches view conscientiousness as a dimension that maintain impulsive behaviour in check. The term combines both aspects of organization and behaviour, governed through conscience or diligence (Costa, Jr. et al. 2012).

Extraversion (E)

Extraversion refers to the amount and the strength of preferred way of communicating, activity level, the need for stimulation, and amount of happiness. People who are high in extraversion are more socially active, talkative, person-oriented, optimistic, fun loving, and affectionate; while people who scored low are more reserved in nature, but does not mean that they are socially hostile, but instead are sober, aloof, independent, and quiet. Despite many confusions, introverts are not unhappy or pessimistic individuals, rather they do not prefer to experience the exuberant high spirits compared to their countered extroverts (Costa, Jr. et al. 2012).

Extraversion is expressed in individual differences based on characteristic patterns or feelings, actions, thoughts, and goals in a way that is similar to other personality traits. There are at least 3 basic elements of extraversion to be studied. First of all, extraversion emerged as one of the fundamental dimensions in personality. As such, it has the importance to describe the covariation of wide variety of behaviours, which is one of the main concerns in the field of personality. It also predicts effective functioning and well-being across multiple domains, from cognitive performance and social endeavours, to socioeconomic status. Besides that, extraversion is a good determinant of risk and also resilience for different forms of psychopathology (Leary and Hoyle 2009). This is due to the fact that extraverted individuals desire to seek active social contact, and willing to strive risky actions that include intimacy and interdependence (King 1995).

Agreeableness (A)

Agreeableness, is primarily a dimension of interpersonal behaviour, whereas extraversion is more related to the preferred quantity of social excitability. Agreeableness represents more on the quality characteristics of interaction. This dimension is mostly familiar in its role as one of the defining axes of interpersonal behaviour. Agreeableness also influences self-image of an individual and helps shaping social attitudes and the principles of life itself. According to Costa et al. (1991), the elements that describe agreeableness include trust, straightforwardness, altruism, compliance, modesty, and tender-mindedness.

Agreeableness also refers to the preferred way to interact along a continuum from goodness to antagonism. People who are high in agreeableness are soft hearted, kind, good-natured, trustworthy, helpful, forgiving and altruistic. They are eager to help others and tend to be responsive and emphatic, believing that other individuals want to and will, behave in the same manner as them. Despite that, those who scored low in agreeableness, are also called antagonistic, tend to by cynical, rude, or even abrasive, suspicious, unwilling to cooperate with others, and can be irritable that leads to manipulative, vengeful and ruthless behaviour (Costa, Jr. et al. 2012). Agreeableness can be visualized as a moderator of various kinds of interpersonal behaviours. If

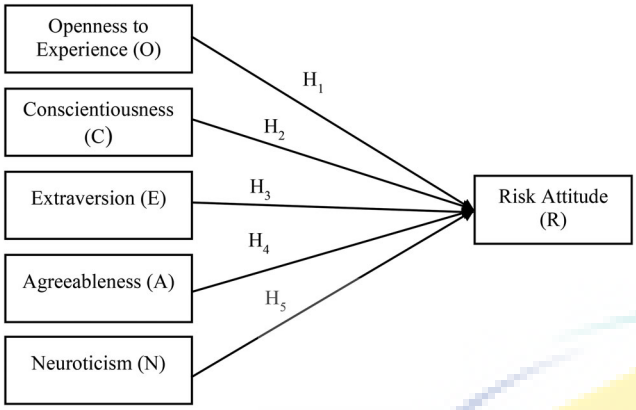


Figure 1. Proposed model.

an individual differs in their motivations to maintain good relationship in others, then it can be expected that they will show higher levels of motivation to execute optimistic, constructive behaviour in various domains than their peers. Such findings had assisted to uncover several important findings in conflict, cooperation, helping, and prejudice (Leary and Hoyle 2009).

In other words, a person high in agreeableness expect others to be pleasant and likeable and appear to implicate such behaviour from their partners. Rather than treating agreeableness as a variable that merely raises or lowers the level of situational effects, agreeableness enters the stage as an equal partner. In some cases, the presence of individuals who have different level of agreeableness can fundamentally alter situations themselves (Leary and Hoyle 2009).

Neuroticism (N)

Neuroticism refers to the chronic level of how an individual adjust its emotions and instability. Individuals who score high in neuroticism tend to identified as those who are vulnerable to psychological distress. This includes high pessimistic way of thinking, such as anger, hostility, depressiveness, anxiety, and volatility. However, neuroticism also involves the vulnerability of an individual towards stress, self-consciousness, and extreme desire, urges, and the difficulty to handle frustration caused by not acting based on their will (Costa, Jr. et al. 2012).

The fundamental trait of general personality, has mainly focused on enduring tendency or disposition to experience negative emotional stress. High neuroticism refers to an individual who responds poorly on environmental stress. These neurotic people, are likely to have perceptions that ordinary situations as risky, and can experience minor frustrations in exaggeration, which feels overwhelming. They are also self-conscious and shy and may have trouble controlling their desires or impulses when feeling upset. However, neuroticism is now recognized as one of the more reliably identified and basic dimensions of personality functioning and structure (Costa, Jr. et al. 2012). Bolger and Schilling (1991) emphasizes on studies where reactions towards stressful situations are more important compared to situations in explaining how neuroticism leads to distress in daily life. They tested claims in regard that some of the estimated relationship between neuroticism and distress might cause people who are high in neuroticism may take longer time compared to their counterparts to recover from daily stressors. Factors such as receiving support socially and the amount of their chronic stress affect recovery speed, as those who receives less support will show subsequent-day effects of daily stressors. Despite claims, their findings show no frequency for high neuroticism individuals to remain relatively more distressed on days following for an event but does not necessarily rule out the possibility that neuroticism affects recovery speed (Bolger and Schilling 1991).

The big five personality traits and risk attitude

Multiple personality traits have been identified over the years and vary among researchers as new trait dimensions continue to grow from theories. Besides that, the concept of attitude has been popular in describing human behaviour offered by social psychologists (Ajzen 2005). Ajzen (2005) have explained the relationship between attitudes, behaviour and personality traits, given that these principles have correlations among them.

Like personality trait, attitude is a hypothetical construct that could not be evaluated through direct observation. Rather, it must be interpreted from measurable responses. Given to nature of decisions, responses or outcomes will reflect positive or negative impacts of the attitude object. An attitude may have different type of responses in which it can be inferred, including cognitive responses (perception), affective responses (feelings) and conative responses (intention) (Ajzen 2005). These type of responses are similar to the findings by Hillson and Murray-Webster (2008) by constructing the triple strand of influences for risk attitude. The Theory of Planned Behaviour (TPB) explains the correlation between these two traits in an indirect manner. One of the factors that influence intention, is the attitude towards the behaviour could be could be correlated to personality traits. This is due to the fact that personality traits consist of multiple behaviours that are categorized through five dimensions.

Hillson and Murray-Webster (2008) investigated the factors affecting risk perception and risk attitude, describing that the factors are divided into three individual, yet dependent strands, namely conscious (rationalism), subconscious, and affective or emotional factors. These findings proved to contain similar elements to the personality traits in the Big Five Theory. For example, neuroticism and extraversion are personality traits that involves the use of feelings of an individual. The characteristics is similarly found in the affective factors of the triple strand of influence, which is a factor of feelings and emotions that contribute to an effect on risk perception and attitude.

Personality traits like conscientiousness may have a significant relationship towards risk attitude behaviour. It is known that the term conscientiousness consists of goal-directed, organised and responsibility behaviour of an individual, hence these traits have a similarity towards the conscious factors in the triple strand of influence. The conscious factors emphasize on how individual makes rational assessments to determine the severity of risk, which leads to change in risk perception and risk attitude.

Based on these grounds, this study postulates that the dimensions in the Big Five theory relates both positively and negatively towards risk attitude. The following hypotheses are formulated, and shown in Figure 1

Relationship between openness (O) to experience to risk attitude

The term openness to experience generally implies the willingness of individuals to actively seek new experiences. This implies that individuals who score high in openness are willing to face uncertainty in order to gain new experiences for their own benefit. McGhee et al. (2012) studied how the predictive relation between Big Five personality traits had an effect on degrees of risk-

taking behaviours in preadolescents. He learned that those who score high in Openness to experience were correlated with risk taking behaviour, signifying that there is a relationship between these two variables. Hence, this study postulates that there is a positive relationship between openness to experience and risk attitude.

Hypothesis 1 (H_1): Openness to experience relates positively to risk attitude.

Relationship between conscientiousness (C) and risk attitude

Conscientiousness is described as responsibility and goal-achieving behaviour of an individual, indicating that those who score high in this particular dimension tend to be well organised. Because such individuals keep their impulses in check and make careful decisions in situations, it is predicted that high conscientiousness individuals will be more cautious of risks based on their rational thinking (Costa, Jr. et al. 2012). McGhee et al. (2012) have concluded that the preadolescents who scored low in conscientiousness have a significant relationship with risk taking behaviour. Therefore, this study postulates that there is a negative relationship between conscientiousness and risk attitude

Hypothesis 2 (H_2): Conscientiousness relates negatively to risk attitude.

Relationship between extraversion (E) and risk attitude

Extraversion refers to the use of cognitive ability and feelings, in which these factors can be founded in the subconscious and affective factors of the triple strand, as extraverted people willing to take risks in order to achieve social contact, including intimacy and interdependence (King 1995). Previous studies have shown that preadolescents who score high in extraversion highly correlates with risk taking behaviour (McGhee et al. 2012). It is hypothesized that there is a positive relationship between extraversion and risk attitude.

Hypothesis 3 (H_3). Extraversion relates positively to risk attitude.

Relationship between agreeableness (A) and risk attitude

Agreeableness is a continuum between compassion and antagonism (Costa, Jr. et al. 2012). With the contrast of empathy and hostility, it is difficult to analyse the relationship of risk towards this dimension. However, the risk perception is influenced based on the type of risk faced by the individuals. In the face of dangerous situations that may affect health and well-being, individuals who score high in agreeableness would rather not take chances to deteriorate their own health, thus avoiding the given risk. In contrast, antagonistic individuals are unwilling to corporate with others and tend to act ruthless, in which, showing negative relationship among this dimension and risk (Costa & Widiger 2012). By taking these factors into consideration, this study postulates that there is a negative relationship between agreeableness with risk attitude.

Hypothesis 4 (H_4). Agreeableness relates negatively to Risk Attitude.

Relationship between neuroticism (N) and risk attitude

Neuroticism (N) is a personality trait that emphasizes on emotional stress towards the environment, where it has similar elements in the affective factors (emotions and feelings) of the triple strand (Hillson and Murray-Webster 2008). When neurotic people experience emotional stress, they tend to avoid situations that cause stress for them, including risky situations. This is due to the characteristic of neurotic individuals, where they are generally self-conscious and may have trouble in controlling their desires or impulses when upset (Costa, Jr. et al. 2012). Therefore, this study postulates that neuroticism relates negatively to risk attitude.

Hypothesis 5 (H_5). Neuroticism relates negatively to Risk Attitude.

Research objective

The study aims to examine the relationship of the factors in the Big Five theory in influencing risk attitude among project practitioners in the Malaysian construction industry.

Research methodology

Data collection

The use of structured questionnaire was designed under three major sections for data collection. The first section focuses on collecting demographic information on respondents, including their position, age, gender and education.

The second section consists of 20 items adapted from the big five inventory, which measures each dimension of personality traits, including openness, conscientiousness, extraversion, agreeableness and neuroticism (John and Srivastava 1999) using the 5-point Likert scale (1 = strongly disagree, 2 = disagree slightly, 3 = neutral, 4 = slightly agree, 5 = strongly agree)

In the final section of the questionnaire measures domain risk attitudes of respondents, depending on their gut-level assessment perception on how risky certain activities are based on 5 different domains, such as ethical, financial, health/safety, recreational and social items. These responses are measured on a 5-point Likert scale (1 = not risky at all, 2 = slightly risky, 3 = moderately risky, 4 = highly risky, 5 = extremely risky). These measurements were based on previous studies using the DOSPERT scale (Weber et al. 2002). The use of DOSPERT scale allows risk taking to be measured in five different domains, rather than one single factor, which would better measure specific traits of an individual in the decision making process. The measurement items are shown in Table 1.

Survey procedure

The questionnaire was piloted by three experts. After several adjustments, a pilot test was conducted on 25 managers specializing in the construction industry. The properties of the items and the scales were further improved to ensure clarity and effectiveness. Six hundred questionnaires were administered to Grade 7 construction companies in Johor Bahru, Malaysia using simple random sampling method and were distributed through invitation emails for an online questionnaire. Seventy project professionals working under these Grade 7 construction companies responded to the survey. The data collected was then analysed through the use of PLS-SEM software. They were tested for normality, common method bias, reliability and validity, collinearity issues, and the overall structural model.

Results

Results are discussed and presented as follows. First of all, demographic results of respondents are discussed and the hypotheses were posited. The hypotheses will be assessed by using partial least-squares structural equation modelling (PLS-SEM), which allows the

Table 1. Measurement items.

Model construct	Item code	Sample of measurement items	Source for item development
The Big Five Personality Traits		I see myself as some as someone who	
Openness to Experience (four items)	O_1	Is original, comes up with new ideas	Adapted from John and Srivastava (1999)
	O_2	Is curious, about many different things	
	O_3	Is inventive	
	O_4	Has an active imagination	
Conscientiousness (four items)	C_1	Does a thorough job	
	C_2	Is a reliable worker	
	C_3	Perseveres until the task is finished	
	C_4	Does things efficiently	
Extraversion (four items)	E_1	Is talkative	
	E_2	Is full of energy	
	E_3	Generates a lot of enthusiasm	
	E_4	Is outgoing, sociable	
Agreeableness (four items)	A_1	Is helpful and unselfish to others	
	A_2	Has a forgiving nature	
	A_3	Is generally trusting	
	A_4	Is considerate and kind to almost everyone	
Neuroticism (four items)	N_1	Is depressed, blue	
	N_2	Can be tense	
	N_3	Worries a lot	
	N_4	Can be moody	
Risk attitude (twenty items)		I am more likely to perceive such activities … to be [1 (Not risky at all) – 5 (Extremely Risky)]	
	R_1	Forging somebody's signature	Adapted from Weber et al. (2002)
	R_2	Cheating on an exam	
	R_3	Cheating a fair amount of my income tax	
	R_4	Illegally copying a piece of software	
	R_5	Investing in a business that has a good chance of failing	
	R_6	Taking a job that pays exclusively on a commission basis	
	R_7	Spending on money impulsively without thinking about the consequences	
	R_8	Investing 10% of my annual income on a very speculative stock	
	R_9	Eating 'expired' food products that still 'look okay'	
	R_10	Ignoring some persistent physical pain by not going to the doctor	
	R_11	Taking a medicinal drug that has a high likelihood of negative side effects	
	R_12	Not wearing a seatbelt	
	R_13	Exploring an unknown city or section of town	
	R_14	Going on a two-week vacation in a foreign country without booking accommodations ahead	
	R_15	Travelling on a commercial airplane	
	R_16	Periodically engaging in a dangerous sport (mountain climbing or sky diving)	
	R_17	Asking my boss for a raise	
	R_18	Dating someone that I am working with	
	R_19	Moving to a new city	
	R_20	Openly disagreeing with my boss in front of co-workers	

use for both explanatory and predictive research (Henseler et al. 2016). The PLS-SEM overall offers more flexible distributional assumption and requirement of sample size, where the minimum sample size for PLS path model assessment should be at least equal or larger than 10 times of the largest number of structural path pointing to a construct in the model (Hair et al. 2011).

Demographic results

70 respondents answered all three sections of the questionnaire. As shown in Table 2, these respondents mainly took the position of decision makers or managers in the construction industry. The top three positions held were CEO (1.43%, $n = 1$), Director (4.29%, $n = 3$) and Project director (1.43%, $n = 1$). All of these respondents have high-decision making authority in their respective positions because every decision involves a certain amount of risk in their outcomes. All respondents come from Grade 7 contractors with different age groups, ranging from age 19 to 24 (1.43%, $n = 1$), 25 to 39 (71.43%, $n = 50$), 40 to 59 (24.29%, $n = 17$) and those aged 60 and above (2.86%, $n = 2$). Genders were equally split among respondents, with both males and females amounting 35 people respectively. Furthermore, respondents possess either one of the four types of education categories, namely lower secondary (1.43%, $n = 1$), Diploma (24.29%, $n = 17$), Degree (52.86%, $n = 37$) or Masters or PhD (21.43%, $n = 15$). The respondents are also assessed from their years working in the company, ranging from 2 years and below (7.14%, $n = 5$,), 3-6 years (24.29%, $n = 17$), 7-10 years (24.29%, $n = 17$), and 11 years and above (44.29%, $n = 31$).

Normality test

Kolmogorov-Smirnov and Shapiro-Wilks test are used to the examine the normality of the distribution. Skewness and kurtosis is also tested to measure symmetrical distribution. The data

Table 2. Respondents background.

Job position	Frequency	%
CEO	1	1.43
Director	3	4.29
Project director	1	1.43
Project manager	7	10.00
Project assistant	5	7.14
Project coordinator	3	4.29
HR executive	1	1.43
admin executive	1	1.43
QA/QC	3	4.29
contract manager	1	1.43
construction manager	1	1.43
site supervisor	4	5.71
finance manager	3	4.29
HR manager	5	7.14
site manager	8	11.43
Safety manager	7	10.00
admin manager	3	4.29
General manager	10	14.29
quantity surveyor	3	4.29
Age		
19 to 24	1	1.43
25 to 39	50	71.43
40 to 59	17	24.29
60 and above	2	2.86
Gender		
Male	35	50.00
Female	35	50.00
Highest degree of education received		
Lower secondary (PMR)	1	1.43
Diploma	17	24.29
Degree	37	52.86
Masters or PhD	15	21.43
Years working in the company		
2 years and below	5	7.14
3-6 years	17	24.29
7-10 years	17	24.29
11 years and above	31	44.29

Table 3. Kolmogorov-Smirnov and Shapiro-Wilks test.

Constructs	Items	Kolmogorov-Smirnov	Shapiro-Wilk
O	O_1	0.000	0.000
	O_2	0.000	0.000
	O_3	0.000	0.000
	O_4	0.000	0.000
C	C_1	0.000	0.000
	C_2	0.000	0.000
	C_3	0.000	0.000
	C_4	0.000	0.000
E	E_1	0.000	0.000
	E_2	0.000	0.000
	E_3	0.000	0.000
	E_4	0.000	0.000
A	A_1	0.000	0.000
	A_2	0.000	0.000
	A_3	0.000	0.000
	A_4	0.000	0.000
N	N_1	0.000	0.000
	N_2	0.000	0.000
	N_3	0.000	0.000
	N_4	0.000	0.000
R	R_1	0.000	0.000
	R_2	0.000	0.000
	R_3	0.000	0.000
	R_4	0.000	0.000
	R_5	0.000	0.000
	R_6	0.000	0.000
	R_7	0.000	0.000
	R_8	0.000	0.000
	R_9	0.000	0.000
	R_10	0.000	0.000
	R_11	0.000	0.000
	R_12	0.000	0.000
	R_13	0.000	0.000
	R_14	0.000	0.000
	R_15	0.000	0.000
	R_16	0.000	0.000
	R_17	0.000	0.000
	R_18	0.000	0.000
	R_19	0.000	0.000
	R_20	0.000	0.000

collected from Kolmogorov-Smirnov and Shapiro Wilks should be valued at $p > 0.05$ for it to be normally distributed. For skewness and kurtosis, tests should not be substantially skewed. As shown in Tables 3 and 4, skewness and kurtosis are in acceptable range, but not for Kolmogorov-Smirnov and Shapiro-Wilks test. Regardless, the non-normally distributed data warrants the use of PLS-SEM method (Hair et al. 2011).

Common method bias test

Harman's single factor test was used to ensure that all data collected is free from common method bias. The measurement is considered acceptable if the common latent factor holds less than 50% of the variance. As shown in Table 5, the result shows that one factor extracted accounts for 39.20% of the variance in the data sample. Therefore, common method bias is not a problem in the data set.

Measurement model

Reliability and validity of the measurements must first be assessed (Hair et al. 2011). All constructs are assessed reflectively. In the reflective measurement models, the composite reliability (CR) should exceed 0.70, and the indicator outer loadings should be higher than 0.708 to achieve convergent validity, the average variance extracted (AVE) of the latent construct should be in values above 0.50. In order to achieve discriminant validity, square root of AVE for each construct needs to be valued higher than the construct's correlation with other constructs (Hair et al. 2011). Besides that, the values of Heterotrait-Monotrait Ratio Correlations (HTMT) should below the value of 0.85. Table 6 shows the result of composite reliability and AVE, while Tables 7–9 show the results of cross loadings, Fornell-Larcker criterion and Heterotrait-Monotrait Ratio of Correlations (HTMT).

According to guidelines by Hair et al. (2011), CR values exceeding the threshold value of 0.7 would confirm a satisfactory degree of reliability. All AVE values are above 0.5, which describe a reasonable degree of convergent validity. To access descriminant validity of constructs, the cross loadings and Fornell-Larker criterion were examined. The overall result shows that the indicator loadings are no higher than their opposing constructs, as the square root of each construct's AVE arelarger than its correlation with other constructs. Results shown confirm the intstruments to have a satisfactory discriminant validity.

Structural model assessment

Before assessing the actual structural model, collinearity issues should be first addressed (Hair et al. 2011; Wong 2013). Collinearity can be determined by examining the tolerance and variance inflation factor (VIF) values. As shown in Table 10, the overall tolerance values exceed 0.2 threshold value while inner VIF values were below 5.0. These values show acceptable range

Table 4. Skewness and Kurtosis test.

		(*n* = 70)	
Constructs	Items	Skewness	Kurtosis
O	O_1	−0.246	−0.845
	O_2	−0.137	−0.974
	O_3	−0.228	−0.905
	O_4	−0.231	−0.993
C	C_1	−0.686	−0.021
	C_2	−0.784	0.248
	C_3	−0.824	0.279
	C_4	−0.686	−0.021
E	E_1	−0.348	−0.292
	E_2	−0.451	−0.214
	E_3	−0.294	−0.406
	E_4	−0.400	−0.380
A	A_1	−0.691	−0.284
	A_2	−0.610	−0.391
	A_3	−0.611	−0.363
	A_4	−0.610	−0.460
N	N_1	0.131	−0.573
	N_2	0.186	−0.509
	N_3	0.153	−0.763
	N_4	0.150	−0.637
R	R_1	0.183	−0.075
	R_2	0.310	−0.182
	R_3	0.229	−0.157
	R_4	0.308	−0.113
	R_5	0.293	−0.148
	R_6	0.287	−0.128
	R_7	0.292	−0.252
	R_8	0.346	−0.086
	R_9	0.405	−0.029
	R_10	0.229	−0.157
	R_11	0.329	−0.167
	R_12	0.213	−0.077
	R_13	0.200	−0.195
	R_14	0.229	−0.157
	R_15	0.318	−0.117
	R_16	0.239	−0.351
	R_17	0.346	−0.086
	R_18	0.229	−0.157
	R_19	0.269	−0.007
	R_20	0.382	0.018

Table 5. Common method bias.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	15.683	39.206	39.206	15.683	39.206	39.206

and that there are no collinearity problems occurred in these data sets.

In order to test the hypotheses, path coefficients and t-statistics were investigated through bootstrapping. The amount of samples used were 5,000 in total. Effect sizes (f^2), predictive accuracy (R^2 values), and predictive relevance (Q^2 and q^2 values) were assessed. As shown in Table 11, the overall models are structurally good with substantial values ($R^2_{\text{risk attitude}} = 0.392$). The model explains 39.2% of variance in risk attitude. The cross validated redundancy Q^2 values of risk attitude were 0.184. The values indicate a predictive relevance in the variables because the value is larger than zero (Hair et al. 2011).

The hypotheses test shows that all variables but one (agreeableness) correlates significantly towards risk attitude. Four of these variables in the Big Five Personality traits relate significantly towards risk attitude: Openness ($\beta_{\text{Openness} \rightarrow \text{risk attitude}} = 0.150$, $t_{\text{Openness} \rightarrow \text{risk attitude}} = 1.374$, $p_{\text{Openness} \rightarrow \text{risk attitude}} < 0.1$); Conscientiousness ($\beta_{\text{Conscientiousness} \rightarrow \text{risk attitude}} = 0.259$, $t_{\text{Conscientiousness} \rightarrow \text{risk attitude}} = 2.527$, $p_{\text{Conscientiousness} \rightarrow \text{risk attitude}} < 0.01$); Extraversion ($\beta_{\text{Extraversion} \rightarrow \text{risk attitude}} = 0.285$, $t_{\text{Extraversion} \rightarrow \text{risk attitude}} = 3.558$, $p_{\text{Extraversion} \rightarrow \text{risk attitude}} < 0.01$); and Neuroticism ($\beta_{\text{Neuroticism} \rightarrow \text{risk attitude}} = -0.288$, $t_{\text{Neuroticism} \rightarrow \text{risk attitude}} = 2.722$, $p_{\text{Neuroticism} \rightarrow \text{risk attitude}} < 0.01$). Both Extraversion and Neuroticism has a larger effect size and predictive relevance towards risk attitude ($f^2_{\text{Extraversion}} = 0.12$, $q^2_{\text{Extraversion}} = 0.048$); ($f^2_{\text{Neuroticism}} = 0.12$, $q^2_{\text{Neuroticism}} = 0.054$) in comparison to other variables. There is no significant effect of Agreeableness towards risk attitude. Figure 2 shows that Hypotheses H_1, H_2, H_3 and H_5 are supported, but H_4 is rejected.

Table 6. Composite reliability and average variance extracted.

Constructs	Items	Loadings	CR	AVE
O	O_1	0.856	0.925	0.755
	O_2	0.912		
	O_3	0.901		
	O_4	0.802		
C	C_1	0.804	0.848	0.584
	C_2	0.735		
	C_3	0.710		
	C_4	0.804		
E	E_1	0.951	0.944	0.808
	E_2	0.908		
	E_3	0.929		
	E_4	0.800		
A	A_1	0.926	0.950	0.827
	A_2	0.989		
	A_3	0.733		
	A_4	0.966		
N	N_1	0.957	0.945	0.811
	N_2	0.848		
	N_3	0.900		
	N_4	0.894		
R	R_1	0.703	0.977	0.681
	R_2	0.802		
	R_3	0.891		
	R_4	0.907		
	R_5	0.702		
	R_6	0.740		
	R_7	0.856		
	R_8	0.764		
	R_9	0.852		
	R_10	0.939		
	R_11	0.720		
	R_12	0.809		
	R_13	0.784		
	R_14	0.900		
	R_15	0.797		
	R_16	0.826		
	R_17	0.933		
	R_18	0.788		
	R_19	0.811		
	R_20	0.914		

Discussion

This study shows that risk attitude is strongly influenced by extraversion. An extroverted project professional tends to be willing to take more risks despite the outcomes. As these factors are based on cognitive ability and feelings, extraversion tends to challenge people to take risks in order to achieve social contact (King 1995). Driven by desire, extraverted people are likely to be risk seekers and views risk as a positive matter as opposed by introversion.

On the other hand, Neuroticism seems to influence negatively towards risk attitude. Neuroticism basically measures the

Table 7. Cross loadings.

Items	O	C	E	A	N	R
O_1	**0.856**	0.072	0.052	0.010	−0.337	0.287
O_2	**0.912**	0.097	0.215	−0.102	−0.249	0.242
O_3	**0.901**	0.121	0.238	−0.136	−0.258	0.333
O_4	**0.802**	0.136	0.294	−0.085	−0.281	0.281
C_1	0.143	**0.804**	0.220	−0.054	−0.100	0.371
C_2	0.139	**0.735**	0.142	0.012	−0.127	0.235
C_3	0.052	**0.710**	0.168	0.072	−0.139	0.284
C_4	0.016	**0.804**	0.168	0.126	0.085	0.210
E_1	0.226	0.205	**0.951**	−0.022	−0.084	0.410
E_2	0.227	0.194	**0.908**	−0.053	−0.105	0.297
E_3	0.234	0.171	**0.929**	−0.058	−0.099	0.285
E_4	0.154	0.250	**0.800**	0.114	−0.123	0.435
A_1	−0.106	−0.013	0.032	**0.926**	−0.018	0.052
A_2	−0.059	0.054	0.019	**0.989**	−0.090	0.131
A_3	−0.126	−0.025	0.068	**0.733**	−0.115	−0.016
A_4	−0.141	0.021	−0.02	**0.966**	−0.095	0.074
N_1	−0.339	−0.048	−0.049	−0.100	**0.957**	−0.373
N_2	−0.233	−0.102	−0.057	−0.074	**0.848**	−0.308
N_3	−0.373	−0.196	−0.141	−0.099	**0.900**	−0.388
N_4	−0.214	−0.032	−0.16	0.001	**0.894**	−0.378
R_1	0.275	0.324	0.351	0.095	−0.418	**0.703**
R_2	0.32	0.307	0.369	0.154	−0.378	**0.802**
R_3	0.276	0.339	0.349	0.057	−0.278	**0.891**
R_4	0.283	0.308	0.303	0.083	−0.293	**0.907**
R_5	0.358	0.363	0.337	0.094	−0.437	**0.702**
R_6	0.127	0.304	0.292	0.129	−0.331	**0.740**
R_7	0.244	0.38	0.386	0.174	−0.353	**0.856**
R_8	0.339	0.300	0.358	0.150	−0.370	**0.764**
R_9	0.181	0.298	0.297	0.078	−0.210	**0.852**
R_10	0.310	0.357	0.377	0.075	−0.349	**0.939**
R_11	0.249	0.142	0.306	0.167	−0.357	**0.720**
R_12	0.313	0.291	0.336	−0.038	−0.322	**0.809**
R_13	0.326	0.285	0.396	0.172	−0.366	**0.784**
R_14	0.262	0.336	0.350	−0.011	−0.342	**0.900**
R_15	0.301	0.322	0.292	0.020	−0.307	**0.797**
R_16	0.289	0.315	0.346	0.022	−0.266	**0.826**
R_17	0.283	0.340	0.377	0.010	−0.313	**0.933**
R_18	0.193	0.266	0.316	0.124	−0.312	**0.788**
R_19	0.184	0.261	0.282	0.189	−0.213	**0.811**
R_20	0.269	0.306	0.325	0.025	−0.317	**0.914**

Note: The bold values are used to distinguish the cross loadings of items to their construct.

Table 8. Fornell-Larker criterion.

	O	A	C	E	N	R
O	**0.869**	–	–	–	–	–
A	−0.091	**0.909**	–	–	–	–
C	0.124	0.035	**0.764**	–	–	–
E	0.231	0.007	0.235	**0.899**	–	–
N	−0.325	−0.076	−0.105	−0.116	**0.901**	–
R	0.333	0.108	0.378	0.414	−0.404	**0.825**

Note: The bold values are used to distinguish the respective criterion value to their own construct.

Table 9. Heterotrait-Monotrait Ratio of Correlations (HTMT).

	O	A	C	E	N
O	–	–	–	–	–
A	0.129	–	–	–	–
C	0.143	0.090	–	–	–
E	0.257	0.072	0.263	–	–
N	0.354	0.107	0.176	0.121	–
R	0.346	0.110	0.410	0.415	0.417

emotional stability of an individual, showing that neurotic people may react negatively towards risk, which leads to risk averse behaviour. These individuals may perceive risk as something to be stressed or fearful and be avoided at any costs. Besides that, conscientiousness has a significant correlation towards risk

Table 10. Collinearity assessments.

Types Construct	Collinearity statistics ($n = 70$)	
	Tolerance	VIF
O	0.841	1.189
C	0.935	1.023
E	0.902	1.070
A	0.978	1.108
N	0.879	1.138

Table 11. Results of path significance.

Path	Path Coefficient (β)	t-statistics	f^2 effect size	q^2 effect size	R^2	Q^2
R	–	–	–	–	0.392	0.184
H_1: Openness → risk attitude	0.150	1.374[a]	0.031	0.003	–	–
H_2: Conscientiousness → risk attitude	0.259	2.527[b]	0.103	0.033	–	–
H_3: Extraversion → risk attitude	0.285	3.558[b]	0.120	0.048	–	–
H_4: Agreeableness → risk attitude	0.089	0.608	0.013	−0.018	–	–
H_5: Neuroticism → risk attitude	0.288	2.722[b]	0.120	0.054	–	–

[a]Significant at $p < 0.1$.
[b]Significant at $p < 0.01$.

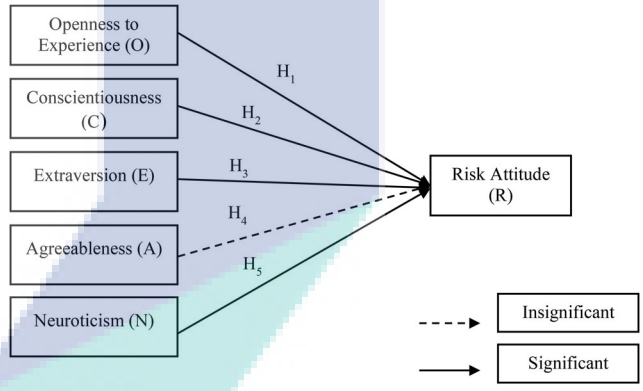


Figure 2. Path coefficient after hypothesis test.

attitude, where an individual's desire for achievement and commitment brings them willingness to take risk to achieve their goals. Other elements include Competence, Order, Dutifulness, Achievement Striving, Self-Discipline, and Deliberation (Costa et al. 1991).

Openness to experience and agreeableness has a slight influence towards risk attitude of a person. The term openness to experience explains that of an individual who is motivated to seek out new opportunities and to be mindful or reflective to the ideas they have encountered (McCrae and Costa 1997). These involves a person to seek out new experiences for their benefit, along with curiosity, creative thinking and willing to practice unconventional ideas. This shows that open minded people are willing to accept and tolerate risks that is present in new opportunities and perceive it as a positive matter. Agreeableness on the other hand, is focused on the interpersonal behaviour that emphasize on quality of interaction. It can be expected that they will show higher levels of motivation to execute optimistic, constructive behaviour in various domains. Such behaviour seems to allow individuals to perceive risk as something that may be positive and may bring benefit or helpfulness to the environment.

Conclusion and implications

The study of behaviour is known to be unique and complex among individuals in society. Prior studies had emphasized perceptions towards risk and the factors underpinning it. Despite that risk perception is an underlying factor in risk attitude, the relationship among factors of personality traits and risk attitude is yet to be explored and understood. Personality traits was conceptualized with Big Five theory, while risk attitude was conceptualized with the DOSPERT scale.

Based on the verified results, four hypotheses are supported, but one is rejected. The hypotheses supported suggested that risk attitude is influenced significantly in a positive manner through an individual's openness to experience and extraversion, while reacts negatively towards neuroticism. The direct effects indicate that perceptions towards risk is affected by their motivation to seek out opportunities, cognitive ability and emotional stability. On the other hand, all but one variables from personality traits seem to influence positively on risk attitude. The results also showed that the tested model is structurally good (substantial R^2 values in risk attitude). Investigation of risk attitudes would offer wide range of acceptable risk threshold and tells how much risk a construction organization can withstand. The study of relationship between personality traits and risk taking will signify the vast variations of how every decision maker, especially in construction industry, will choose to respond to uncertainty depending on their respective human behaviour. This allows practitioners consider how personalities may affect every decision maker to choose the right response in face of uncertainty. Such understanding would help the development of a comprehensive risk management plan in construction projects. Further research can be done to provide a better theoretical justification and solid evidence on which specific characteristics of personality traits may be interlinked with an individual's risk attitude. Additionally, investing the proposed model in different environment through cross-sectional study would be an interesting research for future studies.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Universiti Malaysia Pahang under Grant RDU 1703296.

References

Ajzen I. 2005. Attitudes, personality and behavior. London (UK): Open University Press-McGraw-Hill.

Beyer AR, Fasolo B, De Graeff PA, Hillege HL. 2015. Risk attitudes and personality traits predict perceptions of benefits and risks for medicinal products: A field study of European medical assessors. Value Health. 18(1): 91–99.

Bolger N, Schilling EA. 1991 Sep. Personality and the problems of everyday life: the role of neuroticism in exposure and reactivity to daily stressors. J Personality. 59(3):355–386.

Chong HY, Low TS. 2014. Accidents in Malaysian construction industry: Statistical data and court cases. Int J Occup Saf Ergon. 20(3):503–513.

Costa PT, McCrae RR, Dye DA. 1991. Facet scales for agreeableness and conscientiousness: A revision of the NEO personality inventory. Personality Individual Differences. 12(9):887–898.

Costa Jr., PT, Widiger TA. 2012. Personality disorders and the five-factor model of personality. Washington, DC: APA.

Elisabet Rutström E, Harrison GW. 2008. Risk aversion in the laboratory. Bingley (UK): Emerald Group Publishing Limited; p. 41–196.

Etemadinia H, Tavakolan M. 2018. Using a hybrid system dynamics and interpretive structural modeling for risk analysis of design phase of the construction projects. Int J Constr Manage. DOI: 10.1080/15623599.2018.1511235.

Ferreira de Araújo Lima P, Crema M, Verbano C. 2020. Risk management in SMEs: A systematic literature review and future directions. Eur Manage J. 38(1):78–94.

Fiske DW. 1949. Consistency of the factorial structures of personality ratings from different sour sources. J Abnorm Psychol. 44(3):329–344.

Funder D, Sneed C. 1993. Behavioral manifestations of personality: an ecological approach to judgmental accuracy. J Personality Soc Psychol. 64(3): 479–490.

Goh S, Abdul-Rahman H. 2013. The identification and management of major risks in the Malaysian construction industry. J Constr Dev Countries. 18(1):19–32.

Hair JF, Ringle CM, Sarstedt M. 2011. PLS-SEM: indeed a silver bullet. J Marketing Theory Pract. 19(2):139–152.

Henseler J, Hubona G, Ray PA. 2016. Using PLS path modeling in new technology research: Updated guidelines. Ind Manage Data Syst. 116(1):2–20.

Hillson D, Murray-Webster R. 2008. Managing group risk attitude. London: Routledge.

Hillson D, Murray-Webster R. 2005. Understanding and managing risk attitude. [accessed 2019 Nov 28]. https://www.kent.ac.uk/scarr/events/finalpapers/Hillson%20+%20Murray-Webster.pdf.

Holt CA, Laury SK. 2005. Risk aversion and incentive effects: new data without order effects. Am Econ Rev. 95(3):902–912.

John OP, Srivastava S. 1999. The Big-Five trait taxonomy: history, measurement, and theoretical perspectives. In: Pervin LA, John OP, editors. Handbook of personality: theory and research. Vol. 2. New York: Guilford Press; p. 102–138.

Kang BG, Fazlie MA, Goh BH, Song MK, Zhang C. 2015. Current practice of risk management in the malaysia construction industry–the process and tools/techniques. IJSCER. 4(4):371–377.

Khodeir LM, Nabawy M. 2019. Identifying key risks in infrastructure projects – case study of Cairo Festival City project in Egypt. Ain Shams Eng J. 10(3):613–621.

King L. 1995. Wishes, motives, goals, and personal memories: relations of measures of human motivation. J Personality. 63(4):985–1007.

KPKT. 2019. Initiatives for people. [accessed 2019 Nov 28]. http://www.kpkt.gov.my/.

Leary MR, Hoyle RH. 2009. Handbook of individual differences in social behavior. Ann Phys (USA). 42(2):624–624.

Leva MC, Balfe N, McAleer B, Rocke M. 2017. Risk registers: structuring data collection to develop risk intelligence. Saf Sci. 100:143–156.

Lönnqvist J-E, Verkasalo M, Walkowitz G, Wichardt PC. 2015. Measuring individual risk attitudes in the lab: task or ask? An empirical comparison. J Econ Behav Organ. 119:254–266.

McCrae RR, Costa PT. 1987. Validation of the five-factor model of personality across instruments and observers. J Pers Soc Psychol. 52(1):81–90.

McCrae RR. Costa PT. 1997. Chapter 31 - Conceptions and correlates of openness to experience. In: Hogan R, Johnson J, Briggs S, editors. Handbook of personality psychology. San Diego, CA: Academic Press; p. 825–847.

McCrae R, John O. 1992. An introduction to the five-factor model and its applications. J Personality. 60(2):175–215.

McGhee RL, Ehrler DJ, Buckhalt JA, Phillips C. 2012. The relation between five-factor personality traits and risk-taking behavior in preadolescents. Psychology. 3(8):558–561.

Mohamed O, Abd-Karim SB, Roslan NH, Mohd Danuri MS, Zakaria N. 2015. Risk management: Looming the modus operandi among construction contractors in Malaysia. Int J Constr Manage. 15(1):82–93.

Nabawy M, Khodeir LM. 2020. A systematic review of quantitative risk analysis in construction of mega projects. Ain Shams Eng J. DOI: 10.1016/j.asej.2020.02.006.

Norman W. 1967. 800 personality trait descriptors: normative operating characteristics for a university population. Ann Arbor: Michigan University, College of Literature, Science, and the Arts.

Ogwueleka AC, Udoudoh FP. 2018. The impact of risk and reward dynamics in incentive compensation plans in the Nigerian construction industry. Int J Constr Manage. 18(3):247–259.

Pearson MN, Russell RLQ, Rohrmann GF. 2002. Functional analysis of a conserved region of the baculovirus envelope fusion protein, LD130. Virology. 304(1):81–88.

Rohrmann B. 2005 Jan. Risk attitude scales: concepts, questionnaires, utilizations. Melbourne: University of Melbourne; p. 21–21.
Taofeeq DM, Adeleke AQ, Lee C-K. 2020. The synergy between human factors and risk attitudes of Malaysian contractors': moderating effect of government policy. Saf Sci. 121:331–347.
Tsiga Z, Emes M, Smith A. 2016. Attitudes to risk in petroleum projects. Proc Comput Sci. 100:305–312.
Tsiga Z, Emes M, Smith A. 2017. Implementation of a risk management simulation tool. Proc Comput Sci. 121:218–223.
Wang CM, Xu BB, Zhang SJ, Chen YQ. 2016. Influence of personality and risk propensity on risk perception of Chinese construction project managers. Int J Project Manage. 34(7):1294–1304.
Weber EU, Blais A-R, Betz NE. 2002. A domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors. J Behav Decis Making. 15(4):263–290.
Wong KK. 2013 May 28. Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. Market Bull. 24:1–32.

JOURNAL OF GOVERNANCE AND INTEGRITY (JGI)
ISSN: 2600-7479 e-ISSN: 2600-786X
VOL. XX, ISSUE XX, XXX – XXX
DOI: https://doi.org/10.15282/jgi.v#i#.###

ORIGINAL ARTICLE

Factors Influencing Industrialized Building System (IBS) Project Performance: A Systematic Review

Yusmin Jaffar[1*], Chia Kuang Lee[2]

[1,2] Project Management Program, Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang Darul Makmur.

ABSTRACT – Industrialized Building System (IBS) is a form of construction with focused processes comprise of methods, products and a set of connected components which work together to achieve objectives. Malaysian construction industry is one of contributors towards the development of the country. To ensure vitality of construction performance, utilization and application of IBS is the right system to shift to from the current conventional construction method. Adaptability of IBS in Malaysia's construction industry is very low due to various limitations and barriers. To better understand IBS, this paper performs a systematic review of studies underpinning the factors influencing IBS success. From a total of 111 articles reviewed in this paper, 16 factors were highly mentioned, such as *knowledge and expertise*, *cost of construction*, *training*, *Communication, Lean Construction, Government Policies*, *Contractors' Satisfaction, Integration of Resources, Utilization of Software*, *Market Factor, On-site Management, Technical factor, Integrated Processes Assessment, Management Factor, Payment Issues, and Employee Empowerment*. These factors significantly influence IBS project performance.

ARTICLE HISTORY
Received: 11-06-2020
Accepted: 20-07-2020

KEYWORDS
Industrialized building system (IBS);
Construction Performance;
Construction integrity;
Pre-fabrication;
IBS Project Performance;
IBS integrity

INTRODUCTION

Introduction of modern technologies as well as building system innovation development has contributed significant influence towards many aspects of construction industry. Construction industry in Malaysia benefited well through fundamental transformation by implementing IBS throughout the whole industry. The application of the Industrialized Building System (IBS) in Malaysia started in 1963 but still, participation and adoption of IBS in the local construction industry is relatively low compared to other developed countries (Nawi et al., 2015, Jabar et al., 2019). In 1999, "The IBS Strategic Plan" was launched. Following that, the IBS Roadmap 2003-2010 was introduced in 2003 to promote IBS in the effort to reduce dependency on foreign site operatives, improve governance and integrity of management on site, whilst advancing towards a more systematic approach to construction (Jabar et al., 2019). In 2008, government has made it mandatory for every contractor in Malaysia to achieve a minimum of 70% IBS content for every project, thereafter replacing the IBS Roadmap 2003-2010 to IBS Roadmap 2011-2015 (Jabar et al., 2019).

These plans were to support development towards a more extensive IBS implementation among construction projects in Malaysia. Malaysia houses a competitive construction environment, yet very labour intensive, which makes the Malaysian Government continuously encourage application of modern methods of construction to achieve a healthy and sustainable construction industry environment (Nawi et al., 2019). Being among the main contributor towards the development of the country, the construction industry in Malaysia need to ensure performance of the industry meets minimum standards as well as client requirements, and adhering to standards, integrity and governance on site. To ensure the vitality of performance within the construction industry, construction players are encouraged to shift towards modern method of construction through the utilization and application of IBS (Yunus et al., 2016). IBS is an alternative method to replace conventional construction to achieve sustainable deliverables (Yunus et al., 2019).

In conventional methods of construction, building components are prefabricated on site and require intense labour as well as high cost for raw material transportation (Jabar et al., 2019; Rubio-Romero et al., 2014; Yip et al., 2019). As generally known, intense activities are the most natural aspects of conventional on-site work which can cause a bad environment such as traffic chaos, noise and air pollution (Akmam et al., 2018; Yunus et al., 2019). By removing some or most of the work off-site, it will greatly contribute towards harmonization of development with surrounding environment. The application of off-site prefabrication and modularization can also significantly contribute towards productivity gains, decreasing labour requirements, as well as improving working condition not just among workers who are directly involved in the project, but also its surrounding environment (Akmam et al., 2018; Yip et al., 2019; Yunus et al., 2019). IBS is a form of system or a technique to manufacture components for construction of structures in a controlled environment. However, how one defines and perceives IBS can differ according to various reasons.

The objective of this paper is to highlight factors that can significantly influence IBS project performance through systematic review of articles. Articles will be divided into themes of IBS and factors will be derived from these themes. The highlighted factors will then be discussed in terms of which factor is the most influential based on the most mentioned factor through careful review of each articles.

*CORRESPONDING AUTHOR | Yusmin Jaffar | ✉ yusminjaffar@gmail.com

LITERATURE REVIEW

To understand the concept used in this paper, this section will explain and discuss key concepts, definitions and previous studies related to the research investigation.

Industrialized Building System (IBS)

Industrialized Building System (IBS) is an engineering innovation to deter most influential disadvantages of conventional methods of construction in order to boost project performance. There are several widely used performance indicators for IBS. One of it is construction cost for construction activities.

Construction activities requires high initial investment capital designated for machineries, steel mould, foreign technology, transportation and the wages of skilled workers for the installation process (Azman et al., 2012; Baharuddin et al., 2016; Kamar et al., 2014; Zakari et al., 2017). Dependency on unskilled workers may save some costs, but inefficient conventional process will eventually cause delay in projects, waste materials, lead to low quality and efficiency in projects and totally increase financial losses (Taherkhani et al., 2019). The early stage of IBS implementation requires a huge amount of cost due to the paid-up capitals and maintenance of machineries (Baharuddin et al., 2016; Nasir etal., 2016; Tamrin et al., 2016). Cost of construction is one of the major influential factors that can directly alter performance of IBS project (Kamar et al., 2014; Xue et al., 2018). High cost factor involves cost for the purchase of new machinery, mould-manufacturing, tax for machinery and equipment imported from overseas and employee retraining cost (Kamar et al., 2012; Nawi et al., 2015a). When venturing into the world of construction, cost became a part of project where minimising it is crucially of importance to achieve successful end. Besides high initial capital requirement, cost can be wasted during construction processes caused by incompetence as well as lack of proper management (Yip et al., 2019).

Knowledge and expertise in IBS play a major role towards the performance of IBS projects (Kamar et al., 2014). Successful IBS implementation requires extensive knowledge of processes, design, and manufacturing (Baharuddin et al., 2016; Rashidi & Ibrahim, 2017). Implementation of IBS requires expertise to delegate and foster cooperation between the key players of the project to ensure the success of IBS projects (Abas et al., 2014; Nasir et al., 2016). Lack of adequate knowledge and expertise among clients, designers, as well as constructors can adversely impact the project (Baharuddin et al., 2016; Kamar et al., 2012; Nawi et al., 2015b). Study conducted by Zakari et al (2017) also support the notion of major barrier in IBS performance is lack of research and inadequate knowledge of IBS.

Communication greatly affects the performance of construction project. Failure to adhere to effective communication can cause problems such as double handling, time delay, as well as storage problems which will later present negative impact towards cost of operation, quality, and project completion duration. Effective communication is crucial in order to efficiently exercise control over all processes to ensure they perform accurately, appropriately, and at the right instance (Pozin et al., 2017; Pozin et al., 2019). In a typical construction project, information can be in many forms including drawings, contracts, reports, charts and worksheets (Nasir et al., 2016). Construction projects consists of various parties (owner, architects, engineers, contractors), decisions and data, and a long set of processes starting with the initial idea and followed by a feasibility study, design, construction and operation and maintenance works.

Information flow is important. Poor communication between stakeholders would cause unnecessary repetition and delay, caused by ineffective exchange of information. These problems will lead to the incur of high expenses and extra time to remedy the damages in project (Nasir et al., 2016). Therefore, interconnected of communication between people involved in the projects should be given serious consideration. According to Kamar et al (2010), a good project communication should be able to assure seamless information and instructions flow to carry out construction activities across the project phases.

Training to inculcate sufficient knowledge and awareness in IBS construction does not solely rest on the contractors. The authorities need to harness such knowledge as well. Many local authorities are depicted to be lack of knowledge and are unfamiliar with modular coordination and standardization concept related with IBS design and assembling process (Zakaria et al., 2017). This has significantly slowed down building approval and result in unnecessary delay in the development process. Local construction authorities tend to misunderstand IBS guidelines adding to further delays in approval (Zakaria et al., 2017). Zakari et al (2017) also found that building regulation as well code and standard are factors that can highly influence performance of IBS and can be seen to fit to authorities instead of the contractors. Therefore, instead of having contractors to acquire sufficient training to better understand and utilize IBS, the local construction authorities also require appropriate training to optimize the performance of IBS.

Government policies have been prominent in promoting new construction techniques or products in the construction industry, simply because the government is one of the biggest clients in the construction industry (Nawi et al., 2012). The role of government plays significant role in IBS project performance and can vary in forms. Among government's policies that positively contribute towards IBS application increment in Malaysia is through the IBS Roadmap 2011-2015 where every project is mandatory to achieve a minimum of 70% IBS content (Jabar et al., 2019). A study conducted by Yunus et al (2019) highlighted the economic reality of 'rising energy cost' where contractors will have to bear and participate whether they agree or not in the effort to provide deliverables as well as to fulfil their own interest. Yunus et al (2019) further explains that the role of government is crucial as far as establishing mandatory regulations, or building codes in order to ensure every parties involve in a particular project will actively take part towards sustainable delivery of project. Lack of government's policies enforcement can be viewed where there is no specific IBS building regulation or standard guidelines for contract documents or procurement systems in terms of tendering, design, construction and operation of a

project pertaining to IBS (Baharuddin et al., 2016). Nasir et al (2016) also indicated that financial problems stemming from building materials as well as land costs from have seriously impacted and delayed the completion of IBS projects.

Resources is critical in construction management. Evidence of below par performance in construction projects has been recognized by government and industry bodies around the world. This problem has been partially caused by variability in resource availability and shortage of specialized contractors (Arashpour et al., 2018). Process integration and cross-training can facilitate the flow of work within prefabrication networks because multi-skilled resources are not limited to perform single tasks and can operate over a production zone or potentially the whole network (Arashpour et al., 2018). In the construction industry, the term of 'integration' has been used to describe a collaborative work environment culture created by all participants involved in a project either by individuals or organizations. This culture is required in order to bring the various organizations that make up the project delivery team to work together more effectively as a single unit.

Process integration: IBS is an integrated process involving all subsystems, components, manufacturing and construction processes, and which all requires efficient management (Jabar et al., 2019). Design, production, and onsite erection are strongly interrelated which can be viewed as part of an integrated process that requires planning and coordination (Aljawadi et al., 2019). Integration processes across the whole project must undergo certain level of assessment in order for contractor to achieve high level of efficiency and synergy between processes as well as to avoid future unnecessary costs. Problems such as changing orders, delays in production or construction and budget overrun during implementation are among factors that influence IBS project delivery (Yunus et al., 2012).

Other related performance indicators for IBS are management and lean construction: IBS consist of integrated processes scattered throughout the whole period and project itself. Processes involved subsystems in manufacturing, components, as well as the construction process itself (Jabar et al., 2019). Jabar et al (2019) further pressed that in order for all the systems to be executed in an efficient and appropriate manner, management factor is an inevitable variable. Effective management can significantly increase efficiency of each system as well as subsystems integrated within a particular project. Lean means getting the right things to the right place, at the right time, and in the right quantity while minimizing waste and being flexible and open to change (Nahmens and Ikuma, 2012). The prevailing goal of lean production is to deliver value to all stakeholders, including internal and external customers, and to eliminate waste (Nahmens and Ikuma, 2012). In construction, the application of lean production stems from the creation of value through the conversion of inputs into finished products with a systematic flow and process of production. Lean construction also refers to the adaptation of lean production principles and practices to the construction industry. One of the key focus of lean construction is waste elimination from construction processes, while simultaneously creating a culture within the company of continuous improvement (Nahmens and Ikuma, 2012).

METHODOLOGY

To achieve the objective of this paper, a systematic review was performed in order to collect and obtain detailed evidence for the impact of the important factors. The systematic review approach was adopted based on a study by Lee et al., (2016) which consists of 5 basic steps of doing systematic review.

Step 1: Identifying Keywords For Review

Keywords relevant for the systematic review were identified. A total of 6 most appropriate keywords were identified and used to fulfil the requirement of the study. The 6 keywords are "IBS", "Industrialized Building System", "pre-fabrication", "modern method construction", "off-site construction", and "industrialized building system (IBS)".

Step 2: Selecting Data Source

Specific data source was selected to perform the search using all 6 previously identified keywords. Search was made based on the subject area of engineering as IBS is mainly an engineering method of construction innovation. Scopus search engine was used to generate results from keywords identified in previous step. In Scopus, the search was made considering 'Title/Abstract/Keywords' and it generated a total number of 11,376 documents from various subject areas, document types and also other related keywords.

Step 3: Preliminary Search

Search was done using all the keywords obtained from the first step within the subject area indicated in the second step. 'Scopus' search engine was used to perform a comprehensive search as well as systematic review on IBS.

Step 4: Assessing The Quality Of The Studies

Results generated through Scopus search engine were further filtered to obtain the most suitable articles in order to achieve the objective. Total of 11,376 documents were trimmed down to 111 documents to be synthesized to obtain factors that influence performance of IBS project.

Step 5: Summarizing The Evidence

All 111 total filtered documents were then synthesized and grouped into themes consisting of what factors were the articles mostly mentioned or highly discussed. From total of 111 articles, 73 corresponds towards factors influencing IBS project performance. The remaining 38 articles were studies that were not directly related towards IBS project performance. These rejected articles were studies

of 'Mechanics of Materials' which deals with behaviour of solid objects, in this context, the materials used in construction. The papers mostly discussed on various methods and results of calculating stresses and strains in structural members rather than relating to the main objective of this paper. Therefore, from total 111 articles, only 73 were deemed useful which mainly discussed on factors relating to IBS project performance.

Step 6: Interpreting Findings, Includes Synthesizing

Articles obtained were then interpreted and synthesized. As a result, 16 factors were classified under the theme of 'Factors influencing IBS project performance'. The 16 factors were then described in detail of what and how much does the factor itself influence performance of particular IBS project.

RESULTS

Identifying Keywords For Review

Industrialised Building System (IBS) is the term coined by the government and industry in Malaysia to represent the construction industry and the application of the prefabrication method in building construction (Kamar et al., 2012). IBS can be defined as a construction technique where the manufacturing of components is made in a controlled environment, on or off site, and which involved transportation, positioning and assembling of the components into a structure without using extensive extra site works (Nawi et al., 2015a). IBS can be referred to prefabrication, mass production, standardized components and design using modular coordination (Musa et al., 2016). In Malaysia, IBS is defined as a construction technique where components in projects are manufactured off-site, and then transported to site and assembled with minimum amount of work. In Singapore, IBS refers to manufacturing and construction systems of all structures including infrastructure. IBS is also a technique suited to overcome disadvantages of current conventional methods of construction which can also be referred to as a modern method construction. Keywords that appropriately define the range in IBS used in this review are: "IBS", "Industrialized Building System", "pre-fabrication", "modern method construction", "off-site construction", "industrialized building system (IBS)".

Selecting Data Source

For this particular review, documents will be selected under engineering themes only. Search engine 'Scopus' was chosen as it houses the largest abstract and citation databases for peer-reviewed journals, books, and conference proceedings (Lee et al., 2016). Using the keywords addressed from the first step, searches were made in the 'Title/Abstract/Keywords' method of search in the Scopus search engine.

Preliminary Search

Preliminary search was made using all the keywords obtained from the first step within the subject area indicated in the second step. 'Scopus' search engine was used to perform a comprehensive search as well as systematic review on IBS. Scopus is also widely known to perform much better than other world-known search engines such as Google Scholar, Web of Science and also PubMed in terms of coverage and accuracy. Comprehensive searches were done under 'Title/Abstract/keyword' using keywords such as "IBS", "Industrialized Building System", "pre-fabrication", "modern method construction", "off-site construction", "industrialized building system (IBS)". Preliminary search generated a total of 11,376 documents. The code is as follows:

(TITLE-ABS-KEY ("IBS") OR TITLE-ABS-KEY ("industrialised building system") OR TITLE-ABS-KEY ("pre-fabrication") OR TITLE-ABS-KEY ("modern method construction") OR TITLE-ABS-KEY ("off-site construction") OR TITLE-ABS-KEY ("industrialized building system (IBS)")

Assessing The Quality Of The Studies

From the total number of 11,376 generated documents, the search was restricted to subject area of engineering only as the rest of the subject area refers to medical and psychology area of subject matter. A total of 656 documents related to the keywords were generated. In order to achieve a more focused and specific search result, the 656 documents generated were filtered further by limiting the search results into journals only as well as into only document type such as: article, review, and conference paper. Limitations were also imposed towards specific keywords only such as "Off-site Construction", "Industrialized building system (IBS)", "Industrialized Building System", "Industrialised Building System", "Industrialised Building Systems", Prefabrication", "Industrialized Building Systems (IBS)", "Malaysian Construction Industry", "Prefabricated Construction", and "Industrialized Buildings". The full code is shown as follows:

(TITLE-ABS-KEY ("IBS") OR TITLE-ABS-KEY ("industrialised building system") OR TITLE-ABS-KEY ("pre-fabrication") OR TITLE-ABS-KEY ("modern method construction") OR TITLE-ABS-KEY ("off-site construction") OR TITLE-ABS-KEY ("industrialized building system (IBS)")) AND (LIMIT-TO (SUBJAREA , "ENGI")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "cp")) AND (LIMIT-TO (EXACTKEYWORD , "Off-site Construction") OR LIMIT-TO (EXACTKEYWORD , "Industrialised Building System (IBS)") OR LIMIT-TO (EXACTKEYWORD , "Industrialized Building System") OR LIMIT-TO (EXACTKEYWORD , "Industrialised Building System") OR LIMIT-TO (EXACTKEYWORD , "Industrialised Building Systems") OR LIMIT-TO (EXACTKEYWORD , "Prefabrication") OR LIMIT-TO (EXACTKEYWORD , "Industrialized Building Systems (IBS)") OR LIMIT-TO (EXACTKEYWORD , "Malaysian Construction Industry") OR LIMIT-TO (EXACTKEYWORD , "Prefabricated Construction") OR LIMIT-TO (EXACTKEYWORD , "Industrialized Buildings"). Table 1 and Figure 1 shows the list of 111 articles from a total of 46 retrieved journals.

Table 1: Retrieved Journals

Journals	Articles
Accident Analysis and Prevention	1
Advanced Science Letters	2
Architectural Engineering and Design Management	4
ARPN Journal of Engineering and Applied Science	4
Automation in Construction	6
Building and Environment	3
Building Engineer	2
Computers and Concrete	1
Concrete Precasting Plant and Technology	3
Construction History	1
Construction Innovation	1
Construction Managements and Economics	3
Dams and Reservoirs	1
Earthquake Engineering and Engineering Vibration	1
Electrical Journal of Information Technology in Construction	1
Energy and Buildings	2
Engineering, Construction and Architectural Management	4
Frontiers of Architectural Research	1
IES Journal Part A: Civil and Structural Engineering	1
International Journal of Housing Science and Its Applications	1
International Journal of Applied Engineering Research	1
International Journal of GEOMATE	1
Journal if Architectural Engineering	11
Journal of Civil Engineering and Management	2
Journal of Cleaner Production	5
Journal of Computing and Engineering	2
Journal of Construction Engineering and Management	1
Journal of Engineering Science and Technology	3
Journal of Infrastructure Systems	1
Journal of Management in Engineering	2
Journal of Robotics and Mechatronics	1
Journal of The Institution of Engineers (India): Architectural Engineering Division	1
Jurnal Teknologi	7
KSCE Journal of Civil Engineering	1
Malaysian Construction Research Journal	17
Open Construction and Building Technology Journal	1
Proceedings of Institution of Civil Engineers: Management, Procurement and Law	1
Proceedings of Institution of Civil Engineers: Waste and resource Management	1
Proceedings of Institution of Civil Engineers: Engineering Sustainability	1
Revista Tecnica de la Faculdad de Ingenieria Universidad del Zulia	2
Stahlbau	1
Steel and Composite Structure	1
Structural Design of Tall and Special Buildings	2
Structural Engineering International: Journal of the International Association for Bridge and Structural Engineering (IABSE)	1
Structural Survey	1
International Journal of Interactive Mobile Technologies	1
TOTAL	112

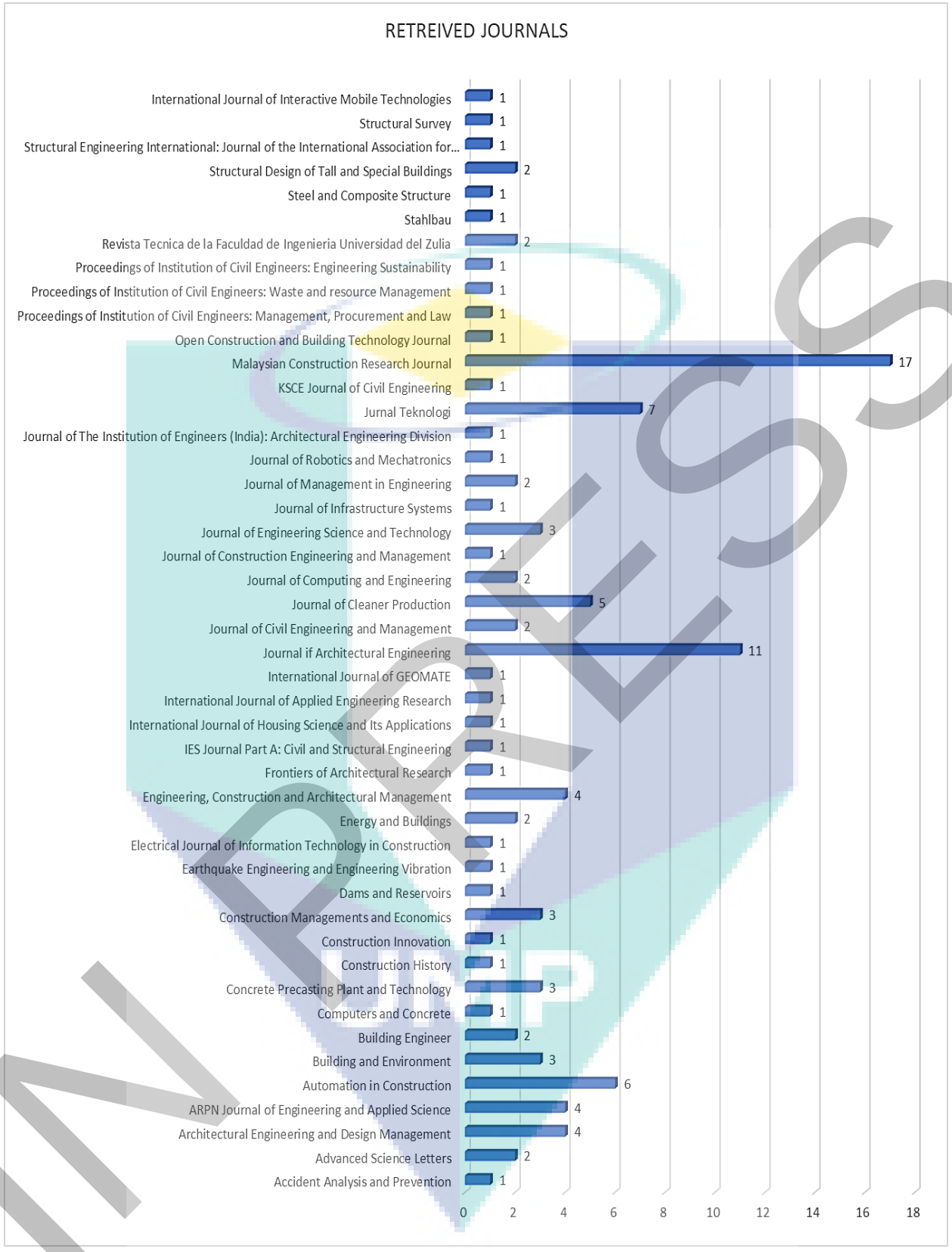


FIGURE 1: Retrieved Journals

Table 2: Filtered Articles

Journals	Articles
Accident Analysis and Prevention	1
Advanced Science Letters	1
Architectural Engineering and Design Management	3
ARPN Journal of Engineering and Applied Science	4
Automation in Construction	3
Betonwerk und Fertigteil-Technik/Concrete Precasting Plant and Technology	1
Building and Environment	3
Construction History	1
Construction Innovation	1
Construction Managements and Economics	2
Earthquake Engineering and Engineering Vibration	1
Energy and Buildings	1
Engineering, Construction and Architectural Management	3
Frontiers of Architectural Research	1
International Journal of Housing Science and Its Applications	1
International Journal of Applied Engineering Research	1
International Journal of Technology	1
International Journal of GEOMATE	2
Journal if Architectural Engineering	6
Journal of Civil Engineering and Management	1
Journal of Cleaner Production	4
Journal of Engineering Science and Technology	3
Journal of Infrastructure Systems	1
Jurnal Teknologi	7
KSCE Journal of Civil Engineering	1
Malaysian Construction Research Journal	12
Open Construction and Building Technology Journal	1
Procedia - Social and Behavioral Sciences	1
Proceedings of Institution of Civil Engineers: Management, Procurement and Law	1
Revista Tecnica de la Faculdad de Ingenieria Universidad del Zulia	2
Structural Survey	1
International Journal of Interactive Mobile Technologies	1
TOTAL	73

Summarizing The Evidence

Step 5 aims to analyse and synthesize the content of the shortlisted 73 articles. All articles related to IBS were analysed qualitatively based on careful interpretation for each individual article. The synthesized themes represent 'Factors Influencing Successful IBS Implementation' and numbers of citations used to back up each factors as shown in **Table 2.**

Table 3: Synthesized IBS Success Factors

Factors	Number of Citations	Number of Journals
Cost of Construction	14	9
Knowledge and expertise	10	7
Communication	7	5
Training	6	5
Government Policies	5	5
Integration of Resources	4	4
Integrated Processes Assessment	3	3
Management Factor	2	2
Lean Construction	1	1
Contractors' Satisfaction	1	1
Utilization of Software	1	1
Market Factor	1	1
On-site Management	1	1
Technical factor	1	1
Payment Issues	1	1
Employee Empowerment	1	1

Interpreting Findings

This step synthesizes the factors that significantly influence the performance of IBS projects from the filtered 44 articles generated from previous steps. **Table 3** shows the factors that were mentioned in all 67 journals. The factors were rated based on frequency percentage of the particular factor.

DISCUSSIONS

This section presents and synthesizes all 16 factors influencing the IBS project performance as stated in **Table 3**.

Table 4: List of Factors, Authors, and Journals

No.	FACTOR	AUTHOR	JOURNAL
1.	**Cost of Construction**	Azman, et al., (2012)	*Malaysian Construction Research Journal*
		Baharuddin et al., (2016)	*Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia*
		Hong et al., (2018)	*Journal of Cleaner Production*
		Kamar et al., (2014)	*Journal of Engineering Science and Technology*
		Kamar et al., (2012)	*Journal of Engineering Science and Technology*
		Nasir et al., (2016)	*ARPN Journal of Engineering and Applied Sciences*
		Nawi et al., (2015a)	*ARPN Journal of Engineering and Applied Sciences*
		Nawi et al., (2017)	*AENSI Journals*
		Shamsuddin et al., (2015)	*Jurnal Teknologi*
		Tamrin et al., (2016)	*Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia*
		Xue et al., (2018)	*Journal of Cleaner Production*
			International Journal of GEOMATE
			Jurnal Teknologi
			Jurnal Teknologi

No.	FACTOR	AUTHOR	JOURNAL
		Zakari et al., (2017)	
		Yip et al., (2019)	
		Taherkhani et al., (2019)	
2.	**Knowledge & Expertise in IBS Project**	Abas et al., (2014)	*International Journal of Applied Engineering Research*
			Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia
		Baharuddin et al., (2016)	*Jurnal Teknologi*
		Hanafi et al., (2016)	*Journal of Engineering Science and Technology*
		Kamar et al., (2014)	*Journal of Engineering Science and Technology*
		Kamar et al., (2012)	*Journal of Engineering and Applied Sciences*
			Advanced Science Letters
		Nasir et al., (2016)	*Open Construction and Building Technology Journal*
			Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia
		Nawi et al., (2015)	*International Journal of GEOMATE*
		Rashidi et al., (2017)	
		Tamrin et al., (2016)	
		Zakari et al., (2017)	
3.	**Training**	Alazzaz, et al., (2015)	*Engineering, Construction and Architectural Management*
			Journal of Architectural Engineering
		Arif et al., (2012)	*Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia*
		Baharuddin et al., (2016)	*Open Construction and Building Technology Journal*
		Rashidi et al., (2017)	*Malaysian Construction Research Journal*
			Jurnal Teknologi
		Zakaria et al., (2017)	
		Aljawadi et al., (2019)	
4.	**Communication**	Arif et al., (2010)	*Engineering, Construction and Architectural Management*
			Malaysian Construction Research Journal
		Baharuddin et al., (2017)	*Malaysian Construction Research Journal*
		Haron et al., (2015)	*Journal of Engineering and Applied Sciences*
		Nasir et al., (2016)	*Malaysian Construction Research Journal*
		Pozin et al., (2017)	*International Journal of GEOMATE*
		Yunus et al., (2019)	*International journal of Interactive Mobile Technologies*
		Pozin et al., (2019)	
5.	**Lean Construction**	Nahmens et al., (2012)	*Journal of Architectural Engineering*
		Baharuddin et al., (2016)	*Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia*

No.	FACTOR	AUTHOR	JOURNAL
6.	**Government Policies**	Nawi et al., (2012)	*Malaysian Construction Research Journal*
		Yunus et al., (2019)	*International Journal of GEOMATE*
		Nasir et al., (2016)	*ARPN Journal of Engineering and Applied Sciences*
		Jabar et al., (2019)	*International Journal of Technology*
7.	**Contractor's Satisfaction**	Yunus et al., (2016)	*ARPN Journal of Engineering and Applied Sciences*
8.	**Integration of Resources**	Arashpour et al., (2018)	*Architectural Engineering and Design Management*
		Nawi et al., (2015b)	*Malaysian Construction Research Journal*
		Nawi et al., (2014)	*Journal of Engineering Science and Technology*
		Nawi et al., (2011)	*Malaysian Construction Research Journal*
9.	**Utilization of Software**	Vernikos et al., (2014)	*Proceedings of Institution of Civil Engineers: Management, Procurement and Law*
10.	**Market Factor**	Luo et al., (2015)	*Engineering, Construction and Architectural Management*
11.	**On-Site Management**	Luo et al., (2015)	*Engineering, Construction and Architectural Management*
12.	**Technical Factor**	Luo et al., (2015)	*Engineering, Construction and Architectural Management*
13.	**Integrated Assessment Processes**	Yunus et al., (2012)	*Construction Innovation*
		Jabar et al., (2019)	*International Journal of Technology*
		Aljawadi et al., (2019)	*Jurnal Teknologi*
14.	**Management Factor**	Ismail et al., (2012)	*Procedia - Social and Behavioral Sciences*
		Jabar et al., (2019)	*International Journal of Technology*
15.	**Payment Issues**	Nawi et al., (2017)	*AENSI Journals*
16.	**Employee Empowerment**	Alazzaz et al., (2015)	*Engineering, Construction and Architectural Management*

Factors Influencing Successful IBS Implementation

A total of 16 influencing factors were derived from the overall 73 reviewed articles. Cost of construction was discussed the most, followed by knowledge and expertise in second. Communication factor positioned at third and training resides on fourth most discussed factors influencing the IBS project performance. Government policies were fifth, integration of resources sixth, integrated processes assessment seventh, and management factor placed eighth. The other factor stays the same at ninth rank with each being cited only once per factor.

Cost Of Construction

In order to ensure optimum and continuous performance, periodical financing is one alternative to support utilization of tasks. Due to the challenging nature of the construction industry, most construction companies face poor financial status and are unable to support and fund their projects (Kamar et al., 2012; Nasir et al., 2016). To achieve a well-organized IBS project, it requires specific type of equipment and machinery to produce the required component and in some cases, projects have to limit the amount of investment because the cost is too high and unbearable (Nasir et al., 2016). Yip et al. (2019) suggested for construction companies to integrate simulation process in their design phase in the effort towards minimising costs caused by errors or any other significant factors.

Cost Estimation Models

The traditional type of cost estimation models continues to be in widespread use irrespective of their organizational type and size. An appraisal or review of the cost estimation practices in IBS construction projects is vital in order for IBS being well placed, and accordingly evolve with the various innovations that transpire within the construction industry (Shamsuddin et al., 2015). Existing appraisal must also be re-strategized to take advantage of the various benefits presented by the novel cost estimation models in cost planning and control practices. As a dynamic and unique industry, construction industry constantly requires improvements in terms of methods, materials, mechanical and electrical, information technology system, business processes, procurement methods and management techniques (Shamsuddin et al., 2015. Therefore, it is essential to develop an integrated costing method to efficiently keeping up with the constant and rapid changes. An integrated cost method will be able to provide a logical method for accurate determination of a true cost for the project (Shamsuddin et al., 2015).

Knowledge And Expertise

Lack of knowledge and expertise within the area of IBS construction can lead to financial problems pertaining to construction cost (Abas et al., 2014; Kamar et al., 2012; Tamrin et al., 2016; Zakari et al., 2017). To realize the ideal way of utilizing IBS to its maximum advantage is through educating architects and engineers in a systematic way to integrate design, technology, management, economics, as well as marketing (Aljawadi et al., 2019). Nawi et al (2015) in their study showed that most of the architects and engineers are still unaware of the basic design process to fabricate, connect, and install the elements of IBS in Malaysia. This could be due to the fact that most of the undergraduate engineering programs in Malaysia concentrate more on the traditional design process rather than IBS (Baharuddin et al., 2016). This results in the engineers and designers are more reluctant to use IBS in their projects and prone towards the conventional construction method. The syllabus of IBS design process in current degree and diploma programs, especially in universities, are very limited. Most of the programme emphasize on the traditional design process and do not focus on the design for pre-stress or precast IBS products (Nawi et al., 2015b).

Communication

Communication between members, parties, and elements of the construction supply chain are challenging because the background, references and goals of each party are different (Haron et al., 2015). When communication is poor, plans and specifications will lack of clear definition, reworks and incompliance with owners' needs may be expected (Arif and Egbu, 2010). Study conducted by Pozin et al (2019) highlighted 5 major problems that obstruct maximum performance of IBS project which are lack of Information Communication Technology (ICT), impropriated organization structure, poor understanding, lack of commitment, and ineffective communication.

Poor Communication Among Stakeholders

Meeting objective deliverables can be deterred due to poor collaboration and understanding between stakeholders. Such occurrence became a barrier towards efficient objective deliverables and in such case as discussed by Yunus et al (2019) can be caused by lack of systematic tools to incorporate collaboration among stakeholders. Strategies must be laid-down beforehand to ensure smoothness of communication among stakeholders and such strategies must be well integrated as an approach to assist designers (Yunus et al., 2019).

Training

IBS requires workers to be versatile in terms of their job scope. Under the IBS system, the demand for on-site manual labours such as carpenters, bar benders, and concreters becomes less. This is due to higher demand for machine-oriented skills, both on sites and in factories which lead to the need of acquiring human resources (Zakaria et al., 2017). The quality of training is essential in improving the skill level of workforce at all levels (Rashidi et al., 2017). Restructuring of human resources within organization need to be aligned with intensive IBS skills such as system integrating or assembling (Arif et al., 2012; Zakaria et al., 2017). This requires a tremendous education and training effort, particularly for construction practitioners who are involved in on site activities such as handling, positioning, and erecting the prefabricated components (Rashidi et al., 2017).

Government Policies

Nawi et al (2012) also confirmed that Malaysian Government policy is a critical factor that heavily influence the promotion of new techniques or products especially in the construction sector. In addition, the findings also showed that companies and agencies usually update their policies aligning with the government policy pertaining to IBS implementation in order to avoid any issues such as redundancies or delays in project delivery. The government policies are considered as the most important factor in enabling the construction teams to work in an integrated and collaborative manner (Nawi et al., 2012). Effective decision-making process strongly depends on government policies to be aligned with the vision and mission of the organization.

Integration Of Resources

The team brings together various skills and knowledge, and removes the traditional barriers between those with responsibility for design and construction in a way which improves the effective and efficient delivery of the project. Flexibility in prefabrication networks is increased by the means of process integration and cross-training multi-skilled resources as production networks will be able to

dynamically address variability in demand and resource availability (Arashpour et al., 2018). Multi-skilled resources' priority is to undertake their own operations to maintain the network logic.

Team Integration

Construction industry is well-known as complex, with its very essence, based on one-off projects and temporary relationships (Nawi et al., 2014). This situation will significantly affect the flow of communication and coordination process among team's members thus contributes to adversarial relationship. 'conflicts, inconsistencies and mismatches' between all of project team members which is possibly due to simple misunderstandings or assumptions problem is mainly caused by the current construction traditional practice (Nawi et al., 2014; Nawi et al., 2011). Key towards a successful team integration in IBS as highlighted in study conducted by Nawi et al (2011):

1. Personal Working Attitude
2. Team accountability
3. Team base organization
4. Management of leadership
5. Transparent Communication
6. Policy
7. Procurement and contracts
8. operational
9. Appropriate technology

Integrated Processes Assessment

In order for contractor to keep the pace within the industry, innovation initiative is definitely crucial to be able to remain competitive. Yunus et al (2012) further concluded that these factors were related to inappropriate planning decisions, where optimization of IBS implementation is not achievable without a well-defined, decision-making tools. Wrong decision regarding attributes of IBS will result in ultimate alteration of performance, outcomes, as well as quality of the projects (Yunus et al, 2012). Yunus et al (2012) in their study also found that cooperation among key stakeholders is another major issue in IBS approach. Conventional building methods restrict contractors and manufacturers from being involved in the design stage of a project which often results in design changes and a corresponding cost increase. Yunus et al (2012) in their study highlighted several decision-making tools with brief advantages and disadvantages towards optimal IBS implementation.

Management Factors

The construction of an IBS building has different stages according to type of project and demographic. Five processes of IBS which are initial works, components production at factory, transported to construction site, installation, and finishing (Ismail et al., 2012). The management factors are the niche of the whole supply chain system in industrialised building system (Ismail et al., 2012). It demonstrates a process of controlling and how something is done or used. In contrast to the management process of IBS, the systematic installation of each beam, column, wall or plank is carried out after the successful production of components (Ismail et al., 2012). Management factor according to Ismail et al (2012) consist of:

1. Good working collaboration
2. Effective communication channel
3. Involvement during the design stage
4. Extensive planning and scheduling
5. Risk management
6. Management of supply chain and logistic
7. Top-down commitment
8. Strategy and business approach
9. Industry marketing strategy
10. Environmentally friendly methods

Study conducted in the IBS construction industry by Jabar et al (2019) showed that effective management contribute positively towards performance of construction which can be efficiently implemented and monitored through each phase of project specifically. The phases of project are that of initial phase, planning phase, implementation phase, monitoring phase, and closing phase. The phases itself is the management being implemented, but through increase of management practice within each phase shows occurrence of additional competence besides the intended competence set beforehand (Jabar et al., 2019).

Lean Construction

Lean strategies have been proven effective in improving productivity levels (i.e., by eliminating wastes from the process) and profit (Nahmens and Ikuma, 2012). The implementation of lean strategies tends to improve the workplace, thus ensuring the health and well-being of the workforce with better layouts and organized workstations, reducing the exposure to workplace hazards. Lean construction strategies provide an excellent platform to improve not only the economic dimension, but also the social and environment

dimensions in homebuilding, primarily by improving the delivery processes of sustainable IBS construction (Nahmens and Ikuma, 2012)

Contractors' Satisfaction

Contractors' satisfaction with the merits of IBS can significantly influence the performance of an IBS project (Yunus et al., 2016). Yunus et al (2016) examined the relationship between contractors' satisfaction and project performance, and showed that satisfied contractors in the benefits of IBS has direct influence on project performance in terms of Having a clear understanding on the environmental regulations and requirement by the local authorities will enables the contractor to deliver the project with less rework. Interestingly, safety performance not only benefits the contractors in term of social but also has a potential to minimize the overall construction cost. IBS components were produced offsite and can immediately install as a structural element once delivered to the construction site. The numbers of debris or waste is also very small. This will reduce additional cost for unnecessary works such as site clearing and storage for construction materials. In Malaysia, the main factor for the delayed completion of construction projects is due to poor performance by the contractors (Yunus et al., 2016). In most cases, the contractors' satisfaction in project implementation is neglected. it is vital to investigate the contractors' satisfaction in order to ensure their performance is at the optimum level. Their motivation and cooperation should be investigated to allow them working in a conducive working environment. Poor contractor satisfaction hindered a performance-enhancing environment and degrading the quality of project outcomes. In this context, there is a need for better understanding of the satisfaction measurement for contractors to enhance the productivity for IBS implementation. Integration among the participants is important to ensure the successful of IBS projects. An effective collaboration on the key attributes and evaluation of successful factors can help the projects meet the project objectives as well as increase participant's satisfactions (Yunus et al., 2016). Motivation and cooperation among the participants can be improved by enhancing their satisfaction level. It will increase the efficiency of communication at the project and management level. At the same time, any problems that occur in the construction activity can be easily resolved.

Utilization Of Software

The software experts claimed that current BIM software is not that great for assemblies. Currently, existing software does not allow, practically and in any automated form, identification of opportunities for off-site construction more than 'in the old document and drawing-based design' and construction process. However, BIM has the potential to promote off-site construction by identifying repetition, which will enable greater cost-saving through mass customization (Vernikos et al., 2014). BIM should 'be more about information, productivity, re-usability and one input – many outputs but there should be more automation within the model to identify and promote areas for further cost reduction from economies to scale through off-site construction'.

Market Factor

The market for prefabricated components includes two categories: the upstream supply chain market and the terminal consumption market. The upstream supply chain for prefabricated products engages various industrial sectors, such as mold producers and precast component manufacturers. Upstream sectors and materials could be inadequate, or various supply chain groups could face conflicts and poor collaboration. In fact, these conditions reflect the fragmented structure of the prefabrication industry, which is common in developing countries such as Malaysia. Owners encounter difficulties in finding and establishing effective collaboration among skilled contractors or suppliers and consultants in the local market who could implement IBS (Luo et al., 2015). Therefore, the quality of prefabricated components and buildings cannot be guaranteed because of the poor labour skill and collaboration. Furthermore, the oligopoly of prefabricated techniques possessed by a few firms presents an opportunity for these firms to raise production price.

On-Site Management

Construction quality is largely based on acquired experience. Without this experience, all project stakeholders, including clients, contractors, suppliers, and consultants, work on a trial-and-error basis (Luo et al., 2015). This practice presents the risks of poor quality, safety-related accidents, time delays, cost overruns, and other risks. Due to lack of experience, clients are not confident to adopt IBS. Furthermore, the standardized procedures and production lines for producing components present no flexibility for adapting and responding to changes and uncertainties.

Technical Factor

Typical technical factors are associated with implementing IBS are "errors and defects due to poor design ability of designers", "poor skills in assembling and hoisting precast components on site," and "incompetence of technology and equipment" (Luo et al., 2015). These factors contribute to time delays and poor construction quality. "Incompetence of technology and equipment" is also considered as a typical technical factor in implementing industrialized building practices.

Payment Issues

Payment can be defined as a transaction sum of money for the purpose of good sold or service rendered. In construction, payment is referring to monetary consideration for the contractor's performance or work done (Dzulkalnine et al., 2017). Nawi et al (2017) in their study found that the Malaysian construction has been plagued with payment issue in long time period and has negatively

affect construction players particularly contractor. Flow of payment in construction project is a crucial element in order to achieve the objective of the project. Any delay in cash flow will have major influence such as project delay toward progress of the construction project. Compared to conventional method, payment issues have significantly affected productivity and development progress of Industrialized Building System project (Dzulkalnine et al., 2017). As mentioned above, the IBS system is based on prefabrication process which contractors need to purchase construction component from manufactures and this concept required them to have a strong cash flow. Payment issues not only affect the construction project itself, but also lead the company into liquidation and influenced the profitability. In general, a payment issue is hierarchical problem which affect all the construction players and overall construction process (Dzulkalnine et al., 2017). For example, one of the chronologies in payment issues, if the clients have difficulties to make payment to the main contractor and may lead to contractor unable to pay their sub-contractor in turn, the sub-contractor failed to make payments to supplier and negatively affect project progress.

Employee Empowerment

Strategies to increase labour productivity in construction are essential; as the comparative cost of human resources rises there is an increasing need to develop systems of work that lead to a growth in productivity (Alazzaz and Whyte, 2015). However, measuring such strategies is challenging. Despite the apparent simplicity of the definition of labour productivity, this indicator is difficult to track consistently, largely because of the complexity of quantifying and comparing diversified outputs in construction (Alazzaz and Whyte, 2015). The link between productivity and empowerment is the presumption that empowered employees perform better than those less empowered, such that, greater productivity arises from the empowered employee's superior ability to resolve problems at the operations level, without the delay needed to contact line-managers leading to greater productivity via localised workplace decisions that increase individual/organisational performance (Alazzaz and Whyte, 2015). Reliance on labour-intensive activities means that optimal labour productivity is a key performance indicator (Alazzaz and Whyte, 2015). With productivity being closely related to commercial viability it is necessary to better understand the factors that may foster or hamper growth in this area such as: diminishing levels of specialist skills; non-optimal craftsmanship; and, poor management practices (Alazzaz and Whyte, 2015).

Benefits Of IBS

Implementation of IBS can greatly reduce dependencies of foreign labours in this country where involvement of human interface can be reduced exponentially. Construction method of IBS highlights the ability to manufacture under industrialized production technique in a controlled environment, transported, and then installed in the site with minimum additional site workers which represents a rapid alternative construction (Taherkhani and Saleh, 2019). Rapid alternative method of constructing is the best alternative and has been taken into high consideration by construction industries worldwide (Taherkhani and Saleh, 2019). Productivity and quality also became one of the most influential traits for contractors to choose IBS over traditional method of construction where manufacturing of building components were done within a controlled environment (Azman et al., 2012). Azman et al (2012) further highlighted the benefits from implementation of IBS in the construction industry as being environmentally friendly where waste generation will be significantly diminished. It is because the manufacturing of components will be made off-site and according to specific design that will optimize usage of resources. The ranking of IBS from the most beneficial to the least beneficial characteristics (Azman et al., 2012) are as shown:

1. Minimal wastage
2. Cleaner environment
3. Less site materials
4. Reduction of site labour
5. Controlled quality
6. Faster project completion
7. Neater and safer construction sites
8. Lower total construction costs

CONCLUSION

From a total of 11376 documents generated using 'Scopus' search engine, 73 were usable after careful filtering steps were taken. Synthesis were done on all 73 documents and managed to generate 16 influencing factors towards IBS project performance with a total of 48 articles. The other remaining articles contributed towards benefits of IBS implementation in comparison with conventional method of construction as well as defining IBS in the introduction.

Factors Influencing Successful Ibs Implementation

Most literature in-regards of IBS discussed mainly on all causes why IBS cannot be implemented or why IBS cannot perform very well. Through systematic review, this paper managed to extract factors that according to studies conducted previously by researchers can directly influence well-being of IBS project performance. By going through all 73 articles, this paper synthesized a total of 16 influencing factors that can be utilized in order to increase performance of IBS projects. At the same time, this paper also contributes towards benefits of IBS project utilization in comparison with traditional construction method. The most discussed factor was cost of construction where previous studies done on IBS project showed positive result of costing towards the performance of IBS. Among all 16 factors, cost of construction is the most influential factor in order for contractor to increase performance of a particular IBS project. Throughout the years of IBS implementation, studies showed cost of construction to have significant impact towards IBS performance.

Cost of construction between conventional construction and IBS construction differs greatly due to the distinguish processes of IBS from traditional way of constructing. IBS requires bigger start-off that involves much expensive plants, machineries, materials, and so on but be beneficial through that in aspects traditional method of constructing cannot efficiently provide.

The second most influential factor is knowledge and expertise of IBS project. Based on studies done in the past, IBS require additional and specific type of knowledge and expertise in order to ensure efficient delivery of project. Before diving and striving towards an IBS construction project, being knowledgeable with the suitable expertise to guide the way is crucial so that IBS project can prosper very well in terms of performance. Having only the know-how does not cut it in the effort to deliver a high-performing IBS project performance. Knowledge can be obtained from various sources and two main source of IBS knowledge and expertise are from experience, as well as proper training. The third ranked factor was communication. Communication serve performance of IBS project almost as same as how it serves conventional method of constructing. Communication serves the same purpose for both methods of construction but weighs more within an IBS construction environment. IBS construction involves more routine procedures and processes than that of a traditional construction method which significantly causes communication to be a bit complex.

The importance of training weighs the same with the two different construction methods. Training factor in this paper refers to training of employee or mainly training of execution personnel. It is important and crucial to not just have an expert and knowledgeable leader or manager, but also a well-trained, versatile workforce in order to significantly boos performance. Government policies scored fifth in the rank of influential factors. Government being out from top 3 factors is actually quite surprising especially in the case of Malaysia's IBS construction environment. In Malaysia particularly, government plays a major role in enforcing strict implementation of IBS as well as providing support platform for IBS practitioners in terms of financial. Government is also the only entity in Malaysia that has the authority to make amendment on policies of IBS in Malaysia which technically making government as supposedly one of the most influential factor that can directly affect how well a particular IBS project performs. Integration of resources refers to the contractors being able to fully make use of all its resources efficiently. Ability to integrate resources across the construction life cycle is categorized as one of influential factor affecting IBS performance. Even though the factor itself sounded complex and crucial, but from the systematic review, it has been found that integration of resources is not as important as having financially prepared and knowledgeable. The same goes to government policies and all other factors derived from this systematic review. The other factors such as lean construction, contractor's satisfaction, utilization of software, market factor, technical factor, on-site management, integrated assessment processes, management factor, payment issues, and employee empowerment were discussed each in 1 article from all 73 articles in this systematic review.

In conclusion, through this systematic review, 16 influencing factors were derived from 73 articles with 6 of them being highly influential than the other based on the most discussed factors from all articles. The 6 highly influential factors are cost of construction, knowledge and expertise, training, communication, government policies and integration of resources. These 6 factors are the most discussed factors in 73 total articles that have significant impact towards IBS project performance. In order for a particular IBS project to efficiently perform, these are the 6 critical factors for contractors to utilize. Even so, there is still no holistic environment that can accurately shape towards maximum level of performance in reality of IBS construction. Each project is a unique endeavour undertaken through a set of tasks to achieve objective and deliverables. Uniqueness of a particular project is also a factor to be taken into careful consideration before applying measures. In other way, different project may incur different influential factors and some might be fatal in some ways while some may actually boost performance. Based on this review, 16 factors that can influence performance of IBS project were derived. Among all 16, 6 were deemed as most influential than the remaining 10 factors.

REFERENCES

Abas, A., Hanafi, M. H., & Ibrahim, F. A. (2014). Assessing the Malaysian architects' understanding of industrialized building system concept and implementation. *International Journal of Applied Engineering Research, 9*(1), 101-116.

Akmam, S. Z., S., Gajendran, T., Rose, T., & Brewer, G. (2018). Contextual, structural and behavioural factors influencing the adoption of industrialised building systems: a review. *Architectural Engineering and Design Management, 14*(1-2), 3-26. doi:10.1080/17452007.2017.1291410

Alazzaz, F., & Whyte, A. (2015). Linking employee empowerment with productivity in off-site construction. *Engineering, Construction and Architectural Management, 22*(1), 21-37. doi:10.1108/ECAM-09-2013-0083

Aljawadi, A. S., Marsono, A. K., & Ismail, C. R. (2019). Ductility of reinforced concrete sub frame for industrialized building system. *Jurnal Teknologi, 81*(2), 1-9. doi:10.11113/jt.v81.11452

Arashpour, M., Wakefield, R., Abbasi, B., Arashpour, M., & Hosseini, R. (2018). Optimal process integration architectures in off-site construction: Theorizing the use of multi-skilled resources. *Architectural Engineering and Design Management, 14*(1-2), 46-59. doi:10.1080/17452007.2017.1302406

Arif, M., & Egbu, C. (2010). Making a case for offsite construction in China. *Engineering, Construction and Architectural Management, 17*(6), 536-548. doi:10.1108/09699981011090170

Arif, M., Goulding, J., & Rahimian, F. P. (2012). Promoting off-site construction: Future challenges and opportunities. *Journal of Architectural Engineering, 18*(2), 75-78. doi:10.1061/(ASCE)AE.1943-5568.0000081

Azman, M. N. A., Ahamad, M. S. S., Hamid, Z. A., Gomez, C. P., Kamar, K. A. M., Hilmi, N. D., . . . Ismail, Z. (2012). The selection of IBS precast manufacturing plant in Malaysia using GIS. *Malaysian Construction Research Journal, 10*(1), 77-90.

Baharuddin, M. N., Bahardin, N. F., Zaidi, M. A., Lokman, I., & Nawi, M. N. M. (2016). A barriers and challenging criteria of IBS formwork: A current scenario amongs stakeholder. *Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia, 39*(9), 14-21. doi:10.21311/001.39.9.03

Dzulkalnine, N., Azman, M. N. A., Bing, K. W., & Hamid, Z. A. (2017). Payment issue of industrialised building system (IBS) in Malaysian construction industry. *Malaysian Construction Research Journal, 2*(Special Issue 2), 36-47.

Haron, A. T., Marshall-Ponting, A. J., Zakaria, Z., Nawi, M. N. M., Hamid, Z. A., & Kamar, K. A. M. (2015). An industrial report on the Malaysian building information modelling (BIM) taskforce: Issues and recommendations. *Malaysian Construction Research Journal, 17*(1), 21-36.

Ismail, F., Yusuwan, N. M., & Baharuddin, H. E. A. (2012). Management Factors for Successful IBS Projects Implementation. *Procedia - Social and Behavioral Sciences, 68*, 99-107.

Jabar, I. L., Abdul-Aziz, A. R., Suresh, S., Renukappa, S., & Enshassi, A. (2019). A project management competency framework for industrialised building system (IBS) construction. *International Journal of Technology, 10*(4), 657-666. doi:10.14716/ijtech.v10i4.2773

Kamar, K. A. M., Azman, M. N. A., & Nawi, M. N. M. (2014). IBS survey 2010: Drivers, barriers and critical success factors in adopting industrialised building system (IBS) construction by G7 contractors in Malaysia. *Journal of Engineering Science and Technology, 9*(4), 490-501.

Kamar, K. A. M., Hamid, Z. A., Ghani, M. K., Rahim, A. H. A., Zain, M. Z. M., & Ambon, F. (2012). Business strategy of large contractors in adopting industrialised building system (IBS): The Malaysian case. *Journal of Engineering Science and Technology, 7*(6), 774-784.

Lee, C. K., Yiu, T. W., & Cheung, S. O. (2016). Selection and use of Alternative Dispute Resolution (ADR) in construction projects — Past and future research. *International Journal of Project Management, 34*(3), 494-507.

Luo, L. Z., Mao, C., Shen, L. Y., & Li, Z. D. (2015). Risk factors affecting practitioners' attitudes toward the implementation of an industrialized building system a case study from China. *Engineering, Construction and Architectural Management, 22*(6), 622-643. doi:10.1108/ECAM-04-2014-0048

Musa, M. F., Yusof, M. R., Mohammad, M. F., & Samsudin, N. S. (2016). Towards the adoption of modular construction and prefabrication in the construction environment: A case study in Malaysia. *ARPN Journal of Engineering and Applied Sciences, 11*(13), 8122-8131.

Nahmens, I., & Ikuma, L. H. (2012). Effects of lean construction on sustainability of modular homebuilding. *Journal of Architectural Engineering, 18*(2), 155-163. doi:10.1061/(ASCE)AE.1943-5568.0000054

Nasir, N. M., Nawi, M. N. M., Rahim, M. K. I. A., Bahaudin, A. Y., & Tapa, A. (2016). A review of delay factors in Malaysian industrialized Building System (IBS) construction project. *ARPN Journal of Engineering and Applied Sciences, 11*(16), 9868-9873.

Nawi, M. N. M., Azman, M. N. A., Baluch, N., Kamar, K. A. M., & Abd Hamid, D. Z. (2015). Study on the use of industrialised building system in Malaysian private construction projects. *ARPN Journal of Engineering and Applied Sciences, 10*(17), 7368-7374.

Nawi, M. N. M., Lee, A., Azman, M. N. A., & Kamar, K. A. M. (2014). Fragmentation issue in Malaysian industrialised building system (IBS) projects. *Journal of Engineering Science and Technology, 9*(1), 97-106.

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2011). A critical literature review on the concept of team integration in industrialised building System (IBS) project. *Malaysian Construction Research Journal, 9*(2), 1-17.

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2012). Critical success factors for improving team integration in Industrialised Building System (IBS) construction projects: The Malaysian case. *Malaysian Construction Research Journal, 10*(1), 44-62.

Nawi, M. N. M., Shaharanee, I. N. M., Hashim, K. F., Azman, M. N. A., & Ibrahim, S. H. (2015). Qualitative Analysis on the Barriers of Industrialised Building System (IBS) Uptake in Malaysian Construction Projects. *Advanced Science Letters, 21*(6), 2134-2138. doi:10.1166/asl.2015.6233

Pozin, M. A. A., Nawi, M. N. M., Azman, M. N. A., & Lee, A. (2017). Improving communication in managing industrialised building system (IBS) projects: Virtual environment. *Malaysian Construction Research Journal, 2*(Special Issue 2), 1-13.

Pozin, M. A. A., Nawi, M. N. M., Mydin, M. A. O., Riazi, S. R. M., & Imran, A. (2019). An ability of Whatsapp usage in industrialised building system (IBS) construction project. *International Journal of Interactive Mobile Technologies, 13*(4), 188-197. doi:10.3991/ijim.v13i04.10548

Rashidi, A., & Ibrahim, R. (2017). Industrialized construction chronology: The disputes and success factors for a resilient construction industry in Malaysia. *Open Construction and Building Technology Journal, 11*, 286-300. doi:10.2174/1874836801711010286

Rubio-Romero, J. C., Suárez-Cebador, M., & Abad, J. (2014). Modeling injury rates as a function of industrialized versus on-site construction techniques. *Accident Analysis and Prevention, 66*, 8-14. doi:10.1016/j.aap.2014.01.005

Shamsuddin, S. M., Zakaria, R., Mohamed, S. F., Saleh, A. L., Utomo, C., Majid, M. Z. A., & Yahya, K. (2015). Developing methodology for cradle to grave cost planning for industrialised building system (IBS) In Malaysia. *Jurnal Teknologi, 77*(16), 37-42. doi:10.11113/jt.v77.6397

Taherkhani, R., & Saleh, A. L. (2019). Awareness and prevalence of Industrialized Building System (IBS) in Iran. *Jurnal Teknologi, 81*(6), 13-23. doi:10.11113/jt.v81.13364

Tamrin, N., Nawi, M. N. M., & Nifa, F. A. A. (2016). Readiness in knowledge and ability for implementation of industrialised building system (IBS) in Malaysian construction industry. *Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia, 39*(9), 47-53. doi:10.21311/001.39.9.07

Vernikos, V. K., Goodier, C. I., Broyd, T. W., Robery, P. C., & Gibb, A. G. F. (2014). Building information modelling and its effect on off-site construction in UK civil engineering. *Proceedings of Institution of Civil Engineers: Management, Procurement and Law, 167*(3), 152-159. doi:10.1680/mpal.13.00031

Xue, H., Zhang, S., Su, Y., Wu, Z., & Yang, R. J. (2018). Effect of stakeholder collaborative management on off-site construction cost performance. *Journal of Cleaner Production, 184*, 490-502. doi:10.1016/j.jclepro.2018.02.258

Yip, C. C., Wong, J. Y., & Hor, K. W. (2019). A nonlinear finite element analysis of precast industrialised building system beam under flexural test. *Jurnal Teknologi, 81*(3), 73-82. doi:10.11113/jt.v81.12486

Yunus, R., Abdullah, A. H., Yasin, M. N., Masrom, M. A. N., & Hanipah, M. H. (2016). Examining performance of Industrialized Building System (IBS) implementation based on contractor satisfaction assessment. *ARPN Journal of Engineering and Applied Sciences, 11*(6), 3776-3782.

Yunus, R., Hamid, A. R. A., & Noor, S. R. M. (2019). An integrated approach for sustainability in the application of Industrialised Building System (IBS). *International Journal of GEOMATE, 17*(61), 115-121. doi:10.21660/2019.61.4810

Yunus, R., & Yang, J. (2012). Critical sustainability factors in industrialised building systems. *Construction Innovation, 12*(4), 447-463. doi:10.1108/14714171211272216

Zakari, I., Awal, A. S. M. A., Zakaria, R., Abdullah, A. H., & Hossain, M. Z. (2017). Application of industrialized building system: A case study in Kano State, Nigeria. *International Journal of GEOMATE, 13*(39), 80-86. doi:10.21660/2017.39.19788

Zakaria, S. A. S., Majid, T. A., & Nazri, F. M. (2017). Adoption of industrialised building system (IBS): Exploring competitive advantages from a technology valuation perspective in northern Malaysia. *Malaysian Construction Research Journal, 22*(2), 1-17.

AUTHORS' BIOGRAPHY

Yusmin Jaffar is an administrative executive assistant under Industrial and Community Network (ICoN) department in University Malaysia Pahang. Yusmin Jaffar has a bachelor degree in Project Management with honors and is currently a full-time research-based postgraduate student pursuing master's degree in University Malaysia Pahang.

Dr. Chia Kuang LEE is a Senior Lecturer in Project Management, with more than 10 years of experience in R&D works specifically in construction management and project management. He has worked as the Head of Program for Project Management Degree Course in Universiti Malaysia Pahang, and has been recognized with several teaching and research awards during his career, such as the the Most Promising Academician Award 2018. Dr. Lee is currently the Head of Research Cluster (Project Management). Dr. Lee has managed several research projects as research leader, overseen the development of project management degree program, and pioneered the course towards full PMI GAC accredited status by the Project Management Institute (PMI), USA. He has several professional qualifications and credentials, such as :Certified in Quantitative Risk Management (CQRM) by International Institute of Professional Education & Research (IIPER) , Project Management Professional (PMP) by Project Management Institute (PMI), Certified as Professional Technologist by the Malaysia Board of Technologists (MBOT), and Train the Trainers (TTT) by HRDF. Dr. Lee has a Bachelor Degree in Quantity Surveying (B.Q.S) and Master of Science (MSc Construction Contract Management) from Universiti Teknologi Malaysia. He earned a PhD in Civil Engineering from The University of Auckland, New Zealand in 2017, focusing mainly on the field of Construction Alternative Dispute Resolution (ADR) method.

International Journal of Construction Management

ISSN: 1562-3599 (Print) 2331-2327 (Online) Journal homepage: http://www.tandfonline.com/loi/tjcm20

Predicting intention to use alternative dispute resolution (ADR): an empirical test of theory of planned behaviour (TPB) model

Chia Kuang Lee, Tak Wing Yiu & Sai On Cheung

To cite this article: Chia Kuang Lee, Tak Wing Yiu & Sai On Cheung (2018): Predicting intention to use alternative dispute resolution (ADR): an empirical test of theory of planned behaviour (TPB) model, International Journal of Construction Management, DOI: 10.1080/15623599.2018.1505026

To link to this article: https://doi.org/10.1080/15623599.2018.1505026

Published online: 24 Sep 2018.

INTERNATIONAL JOURNAL OF CONSTRUCTION MANAGEMENT
https://doi.org/10.1080/15623599.2018.1505026

Predicting intention to use alternative dispute resolution (ADR): an empirical test of theory of planned behaviour (TPB) model

Chia Kuang Lee[a], Tak Wing Yiu[b] and Sai On Cheung[c]

[a]Faculty of Industrial Management, Universiti Malaysia Pahang, Gambang, Kuantan, Pahang, Malaysia; [b]Department of Civil and Environmental Engineering, Faculty of Engineering, The University of Auckland, Auckland, New Zealand; [c]Department of Architecture and Civil Engineering, City University of Hong Kong, Hong Kong, Hong Kong

ABSTRACT

Alternative dispute resolution (ADR) has gained prevalent interests among practitioners and researchers. To better explain the factors underpinning the use of ADR, Theory of planned behaviour (TPB) model was applied to predict behavioural intention to use ADR. In general, the TPB model posits that attitude, subjective norm and perceived behavioural control explain actual behaviour. Therefore, this study investigates the role of attitude, subjective norm and perceived behavioural control towards the prediction of intention in ADR use. Data were collected from 128 ADR decision makers from Malaysian contractor firms. Both measurement and structural assessment of the model were performed by using Partial Least Squares (PLS) modelling. The results showed that TPB model provides excellent predictive accuracy and relevance for intention. The model was again examined in two distinctive scenarios. Attitude was found to be the sole predictor of intention in the occurrence of dispute; and before negotiation fails. The findings indicate a plausible future empirical investigation in the attitudinal dimension.

KEYWORDS

ADR use; attitude towards ADR; theory of planned behaviour

Introduction

Disputes remain inevitable in construction projects (Haugen and Singh 2015). Conventional method such as litigation involves technical adversities, various parties and tedious documentations (Abdou et al. 2016). To resolve disputes effectively without the route of litigation, alternative dispute resolution (ADR) has been used prominently to resolve dispute issues. Understanding selection and use of ADR nevertheless have gained interests from both practitioners and researchers over the past three decades. Previous studies have shown that the wide range of factors influencing ADR use can be largely categorized into utilities factors, normative factors and self-efficacies. Utilities factors include the benefits of ADR process (Chong and Mohamad Zin 2012), flexibilities of ADR proceedings (Cheung 1999; Cheung and Suen 2002), positive outcomes of ADR to both disputants (Cheung et al. 2002). These utility factors were depicted to influence ADR use in a way that disputants form decisions based on the consideration of costs of ADR, speed and confidence in the ADR methods (Brooker and Lavers 1997). Then again, normative factors stem from social factors such as legal structures (Chan et al. 2006), and cultural orientations (Tsai and Chi 2009). These social pressures and social actors would oblige the disputants to comply with certain use of ADR. Finally, self-efficacies factors include financial capacities, strength of facts (Marzouk et al. 2011) and knowledge of ADR (Brooker and Lavers 1997). These factors indicate disputants' ability to carry out the use of ADR.

Lee et al. (2016) further substantiated that although the factors influencing ADR use have been largely identified, the relationship factors influencing selection and use of ADR were not empirically examined. The issues that influence decisions are likely to differ with the ADR methods and individual perspectives.

Intention-based models such as theory of planned behaviour (TPB) overall provide better insights in understanding decision making process (Taylor and Todd 1995; Lin 2007). The virtues of TPB have been tested in numerous studies in construction. For example, TPB was found to provide superior explanation in: behavioural intentions to form project partnering (Cheng 2016), knowledge sharing intentions in construction firms (Zhang and Ng 2013), cognitive

CONTACT Chia Kuang Lee chiakuang85@gmail.com Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia

factors influencing safety behaviour (Goh and Sa'adon 2015), attitude and behavioural factors in waste management (Ara Begum et al. 2009; Teo and Loosemore 2010).

Thus, to better understand decision making in ADR use, this study aims to test TPB model in explaining and predicting behavioural intention to use ADR. TPB model posits that 'behavioural intention' is the result of decision making process. Data were gathered from 128 project decision makers in the Malaysian contracting firms specializing in building and civil engineering works. Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to evaluate these two conceptualized models. Theoretical implications of the model were then presented and discussed.

Research objective

This study aims to test TPB model in explaining and predicting intention to use ADR. The study further examines the relationship between attitude, subjective norm, perceived behavioural control and intention to use ADR.

Theoretical framework and hypotheses

TPB posits that behaviour is jointly determined by behavioural intention and perceived behavioural control (Ajzen 1991). Intentions are the culmination of decision making process (Sheeran et al. 2005; Ajzen and Manstead 2007). A person's decision to act is equivalent to the decision to act (Fife-Schaw et al. 2007). Given sufficient perceptions of degree of control over the behaviour, the stronger should be the person's intention to act (Fishbein and Ajzen 2010).

Intention is an indication of how much of an effort people are willing to put in to perform a behaviour (Ajzen 1991). It is formed by the combination of attitude, subjective norm and perceived behavioural control (Ajzen 2011). Attitude refers to one's personal evaluation of a behaviour based on the positive and negative outcomes associated with it (Zemore and Ajzen 2014). It reflects generated feelings of favourable or unfavourable towards performing a behaviour (Taylor and Todd 1995). Subjective norm refers to beliefs about the expectations of important referents (Ajzen 1999). It can refer to social pressure felt by the person with regard to a particular intended act, or not performing that act (Ajzen 1991). Meanwhile, perceived behavioural control (PBC) refers to perceived ease or difficulty of performing a behaviour (Ajzen 2002). Overall, the more favourable the attitude and subjective norm, and greater perceptions of control over the behaviour, the higher would be a person's intention to perform the behaviour (Ajzen 2006).

Decision to select and use ADR for dispute resolution involves careful deliberation. Each behaviour involves a choice, even if the choice is between performing the behaviour or otherwise (Ajzen 2015). Based on TPB, the choice over the use of an ADR method is posited to be guided by these functions (Equation (1)). The conceptualized model is further portrayed in Figure 1.

Intention to use ADR = W1 (Attitude towards ADR use) + W2 (Subjective Norm with Regard ADR use) + W3 (Perceived Behavioural Control over ADR use); where W1, W2, and W3 are empirical determined weights.

The hypothesized paths in this model are formulated as below:

H_1: Attitude towards ADR (ATT) use relates positively to intention to use ADR (INT).

H_2: Subjective Norm with regard ADR use (SN) positively relates to intention to use ADR (INT)

H_3: Perceived Behavioural Control over ADR use (PBC) positively relates to intention to use ADR (INT)

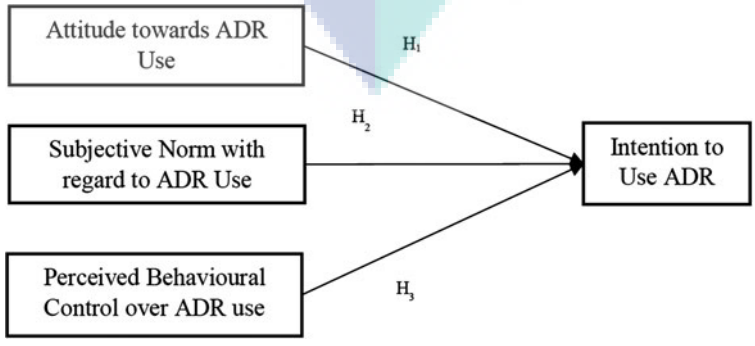


Figure 1. TPB model in ADR selection behaviour.

Research methodology

Development of questionnaire

A structured questionnaire which consists of 3 major sections was designed and used for data collection. The first section of the questionnaire consists of 4 different scenarios (A, B, C and D). The respondents would be asked to select a scenario that best describes one of the on-going projects in their respective organizations, as shown in Table 1.

Then, based on the selected scenario, the respondents were required to provide dispute or claim details in section 2. With reference to claim and dispute taxonomies developed by Love et al. (2010), Kumaraswamy (1997), and Charoenngam and Mahavarakorn (2011), the respondents were required to select one of the 15 types major categories of disputes or claims as depicted in Table 2.

Following that, the respondents were further simulated with these hypothetical scenarios with guided instructions as shown in Table 3.

The respondents were offered a list of 7 major types of dispute resolution methods: i) Arbitration, ii) Mediation, iii) Adjudication (Under Construction Industry Payment and Adjudication Act) CIPAA 2012, iv) Adjudication (Contractual), v) Expert Determination, vi) Dispute Review Board (DRB) and vii) Dispute Adjudication Board (DAB). Finally in Section 3 of the questionnaire, the respondents were further required to respond to the instruments based

Table 1. Section 1 – choice of scenario.

Scenario	Summarized description
A	There is a major dispute in one of the projects; unable to reach settlement; still in the stage of deciding on which ADR method to be used for settling the dispute.
B	Recently settled a major dispute in one of the projects with an ADR method.
C	There is a major dispute in one of the projects; Currently using an ADR method to settle the dispute. (Settlement in progress).
D	There is a major claim in one of the projects; in the stage of negotiating the claim.

Table 2. Section 2 – type of dispute/claim.

Category	Types of dispute/claim encountered in project
1	Change/variation order
2	Errors in drawings, specifications and quantities
3	Differing site conditions
4	Payment (e.g.: Delayed progress payment/ non-payment related dispute, etc.)
5	Delay (e.g.: Extension of time & disruption related dispute, etc.)
6	Ambiguity in contract terms/contract interpretation
7	Quality related (e.g.: Defects, workmanship, etc.)
8	Performance related (e.g.: Supply of goods, materials, execution of work, suspension issue, issue of 'regularly and diligently' etc.)
9	Information & administrative related dispute
10	Awards & decisions (e.g.: Dispute about adjudication/arbitration awards, etc.)
11	Professional negligence
12	Personal injuries
13	Property damages
14	Nomination & re-nomination (e.g.: Appointment of replacement person, etc.)
15	Compliance with instruction (e.g.: Compliance with instruction by s.o/ architect, etc.)

Table 3. Section 2 – selection of ADR methods.

Previously chosen scenario	Simulating hypothetical scenario (Time)	ADR selection
A	Note: No further instruction given - This implies that the current on-going dispute requires settlement.	Select only one ADR method to settle the dispute.
B	'If you have previously selected Scenario B, **imagine** this similar dispute would reoccur in the **future** (when negotiation fails) in your project'.	Select only one ADR method to settle this similar dispute
C	'Imagine if your current ADR method fails to settle the current dispute'.	Select only one ADR method to settle the dispute
D	'Imagine if this negotiation breaks down and turns into a major dispute; and the Superintending Officer/ Engineer / Architect/ Officer/ Contract Administrator's decision fails to satisfy either party (If applicable)'.	Select only one ADR method to settle the dispute

Table 4. Measurement items.

Model construct	Item code	Sample of measurement item	Source for item development
Attitude (3 Items)	ATT_1	Using this ADR method to settle the dispute would be a good idea	Adapted from Ajzen and Driver (1991); Taylor and Todd (1995)
	ATT_2	Using this ADR method to settle the dispute would be a wise idea	
	ATT_3	Using this ADR method to settle the dispute would be desirable	
Subjective norm (3 Items)	SN_1	Most people who influence my behaviour would think that I should use this ADR method	Adapted from Ajzen and Driver (1991); Taylor and Todd (1995)
	SN_2	Most people who are important to me would think that I should use this ADR method	
	SN_3	Most people whose opinions I value would approve of me using this ADR method	
Perceived behavioural control (3 Items)	PBC_1	Using this ADR method would be entirely within my control.	Adapted from Taylor and Todd (1995)
	PBC_2	I would be able to use this ADR method	
	PBC_3	I have the resources and the knowledge and the ability to make use of this ADR method.	
Intention (4 Items)	INT_1	I intent to use this ADR method	Adapted from Fishbein and Ajzen (2010)
	INT_2	I plan to use this ADR method	
	INT_3	I will use this ADR method	
	INT_4	I am willing to use this ADR method	

on seven-point Likert Scale, ranging from '1- Strongly Disagree, 2- Moderately Disagree, 3- Somewhat Disagree, 4- Neutral, 5- Somewhat Agree, 6- Moderately Agree and 7- Strongly Agree'. Intention was based on Ajzen and Driver (1991) and Taylor and Todd (1995). Subjective norm captures social pressures felt by the respondents with regard to the use of ADR method, and was adapted based on Ajzen and Driver (1991) and Taylor and Todd (1995). Perceived behavioural control captures respondents' perceived confidence and ability to use the selected ADR method, and was measured based on Taylor and Todd (1995). Intention captures the willingness of the respondents to use ADR to settle dispute, and was based on Fishbein and Ajzen (2010). The measurement items were based on previous suggestions and studies, reworded and rendered to suit relevantly to the context of ADR use. The samples of measurement items for the constructs were shown in Table 4.

Survey administration

To achieve the objective, this study targets construction professionals in building and civil engineering contracting companies with high decision making authority for their organizations. After the constructs and their operationalized measurement items were developed, the questionnaire was first pre-tested by 3 construction experts specializing in building and civil engineering works using face interviews. The wordings and structure of the questionnaire were revised and amended accordingly. To further enhance the psychometric properties of the scales, the questionnaire was pilot tested by 20 construction professionals. The measurement properties of the final items were confirmed. Overall, the feedbacks on the questionnaire were favourable and positive. The finalized questionnaire was then set to be sent for main survey.

The study's main sample was contractors specializing in building and engineering works. 57,519 contractors were registered with the Construction Industry Development Board (CIDB) from October 2015 until December 2015. Contractors were selected as the respondents, as their propensity to dispute is considered to be the highest compared to the other categories of project professionals. Studies have shown that contractors have been plagued with various contractual issues and disputes, for example, non-payment disputes (Abdul-Rahman et al. 2014). Nevertheless, the population size of the contractors in Malaysia can be identified and determined systematically. These contractors were classified into 7 categories (G1–G7) according to their tendering capacities. In studies where large populations are involved, samples between 1000 and 2000 are deemed appropriate to provide information about most population. This study adopts stratified random sampling techniques. According to Gideon (2012), stratified sampling is a sampling method in which a population is divided into mutually exclusive groups (called strata), followed by a selection of simple random samples or systematic samples from each of the groups (each

Table 5. Stratified samples.

	Grade1		Grade 2		Grade 3		Grade 4		Grade 5		Grade 6		Grade 7	
Location (States)	Total pop	S.	Total pop	S.	Total pop	S.	Total pop	S.	Total pop	S.	Total pop	S.	Total pop	S.
Johor	2623	91	976	34	765	27	285	10	300	10	111	4	386	13
Kedah	1959	68	432	15	214	7	103	3	108	4	54	2	181	6
Kelantan	1966	68	493	17	202	7	84	3	106	3	61	2	119	4
Labuan	137	4	21	1	15	1	2	1	1	0	0	0	1	0
Melaka	985	34	275	10	213	7	108	4	106	4	37	1	130	5
Negeri Sembilan	1756	61	522	18	258	9	107	4	132	4	41	1	95	3
Pahang	2089	73	561	19	317	11	176	6	152	5	60	2	122	4
Perak	2415	84	592	21	397	14	191	7	226	8	83	3	156	5
Perlis	864	30	105	4	46	2	15	0	27	1	6	0	31	1
Pulau Pinang	1118	39	232	8	329	11	139	5	176	6	81	3	328	11
Sabah	5302	184	1215	42	561	20	136	5	186	7	74	3	445	16
Sarawak	1971	69	777	27	358	12	132	5	169	6	78	3	436	15
Selangor	3493	122	1150	40	1359	47	609	21	916	32	262	9	1252	44
Terengganu	2257	79	570	20	248	9	152	5	196	7	85	3	186	7
Wilayah P.	1307	45	411	14	859	30	418	14	890	31	243	8	1312	46
Total		**1051**		**290**		**214**		**93**		**128**		**44**		**180**

Table 6. Contractors' classification.

Grade	Tendering capacities	Paid up capital/ net capital worth	Contractor categories (Size)
G7	No limit	750,000.00	Large
G6	Not exceeding 10 million	500,000.00	Medium
G5	Not exceeding 5 million	250,000.00	Medium
G4	Not exceeding 3 million	150,000.00	Medium
G3	Not exceeding 1 million	50,000.00	Small
G2	Not exceeding 500,000	25,000.00	Small
G1	Not exceeding 100,000	5,000.00	Small

stratum). As shown in Table 5, a total of 2000 samples were randomly stratified for the main survey. The size of the sample was determined in this equation (Abdul-Rahman et al. 2014), where $n/N = 2000/57519 = 0.035$; where n is the size of sample and N is the size of population. Table 6 shows the contractors' classification according to their tendering capacities.

The survey was administered through email invitations. Contractors were invited to respond to the attached survey link provided in the invitation e-mail message. The survey was distributed in total of two waves. The contractors were first invited to respond to the survey (first wave), and the data collection period opened for 8 weeks. Following that, the same respondents were again reminded to respond to the survey, and the collection period opened for another 8 weeks (2nd Wave).

Results

The data were analyzed using Smart PLS (Partial Least Squares) version 2.0. PLS modelling technique offers various merits. It has been credited with its capabilities to deal with wider range of sample size, complex models, and less restrictive assumptions about research data (Hair et al. 2011). Thus, PLS was used to analyze latent variables and verify hypotheses in the hypothesized model. This section presents the analysis of sample characteristics such as response rate, non-response bias assessment, respondents' background, project details and evaluations of both measurement and structural model.

Response rate and non-response bias assessment

114 responses were received in the first wave, while another 14 responses were received in the second wave. A total of 128 surveys were completed online, representing a response rate of 6.4%. To ascertain the responses were free from non-response bias, this study adopts recommendations of Rogelberg and Stanton (2007) and Armstrong and Overton (1977). Wave analysis was used, where the late respondents (Wave 2) were compared to early respondents (Wave 1). Two groups were compared in terms of respondents' demographic backgrounds such as years of experience in construction, contractor's grade, organisation positions, decision making authority; and project details such as project locations, project characteristics, decision making authority, and responses for each measurement items. Two-sample independent sample t-tests was employed to assess non-response bias. There was no evidence to support a significant difference of demographic variables and key items between early respondents and late respondents at a 0.05 alpha level. This suggests a

Table 7. Respondent's background ($N = 128$).

Designation used in organization	Frequency	%
President	**4**	3.1
Executive Director	**11**	8.6
Managing Director	**29**	22.7
Chief Executive Officer	**7**	5.5
Director	**29**	22.7
Others	**48**	37.5
Assistant Vice President	*2*	
Project Manager	*6*	
Assistant Project Manager	*1*	
Project Coordinator	*1*	
Contract Manager	*2*	
Assistant Contract Manager	*1*	
General Manager	*4*	
Site Engineer	*1*	
Site Manager	*2*	
Project Engineer	*3*	
Project Executive	*1*	
Executive Manager	*2*	
Admin Manager	*1*	
Senior Executive	*1*	
Engineer	*1*	
Manager	*12*	
Assistant Manager	*2*	
Assistant Managing Director	*1*	
Contract Executive	*2*	
Quantity Surveyor	*2*	
Authorized to make decisions for ADR use in projects		
1. Strongly disagree	–	–
2. Moderately disagree	–	–
3. Somewhat disagree	–	–
4. Neutral	–	–
5. Somewhat agree	91	71.1
6. Moderately agree	21	16.4
7. Strongly agree	16	12.5
Contractor's grade		
Grade 1	6	4.7
Grade 2	34	26.6
Grade 3	23	18.0
Grade 4	18	14.1
Grade 5	11	8.6
Grade 6	4	3.1
Grade 7	32	25.0
Years of experience in the construction industry		
1–5 years	34	26.6
6–10 years	27	21.1
11–15 years	28	21.9
16–20 years	12	9.4
21–25 years	7	5.5
26-30 years	9	7.0
31-35 years	4	3.1
More than 35 years	7	5.5
Experience in ADR use		
Arbitration	16	12.5
Mediation	10	7.8
Adjudication (CIPAA 2012)	9	7.0
Adjudication (Contractual)	16	12.5
Expert determination	5	3.9
Dispute review board	2	1.6

plausible conclusion that no indication of any non-response-bias in the data set exists.

The minimum sample size for PLS path model estimation should at least be equal or larger than (1) 10 times the largest number of formative indicators used to measure one construct (Hair et al. 2011, 2014); or 10 times the largest number of structural paths directed at a particular construct in the model (Hair et al. 2011, 2014). The largest number of structural paths in the conceptual ADR decision making behavioural model is 3, which implies a minimum sample size of 30. The total cases obtained in this study are 128, thus exceeding the minimum requirement of sample size for PLS path model.

Table 8. Overall scenario (Main survey).

Scenario	Description	Frequency	Percentage%
A	There is a major dispute in one of the projects; unable to reach settlement; still in the stage of deciding on which ADR method be used for settling the dispute.	37	28.9
B	Recently settled a major dispute in one of the projects with an ADR method.	13	10.2
C	There is a major dispute in one of the projects; Currently using an ADR method to settle the dispute. (Settlement in progress).	14	10.9
D	There is a major claim in one of the projects; in the stage of negotiating the claim.	64	50

Respondents' background

This section presents an analysis of all 128 respondents' background. Table 7 shows the profiles of the respondents.

All respondents hold important managerial positions in their organizations and have high decision making authorities in their organization. 71.1% respondents somewhat agree; 16.4% moderately agree; while 12.5% strongly agree that they are authorized to make decisions for ADR use in their respective projects. Top three positions in the organizations include directors (22.7%, $n = 29$), managing directors (22.7%, $n = 29$) and executive directors (8.6%, $n = 11$). 12.5% ($n = 16$) of the respondents have experience in arbitration and adjudication (contractual). 7.8% ($n = 10$) in mediation, followed by 7% ($n = 9$) with experience in Adjudication (CIPAA 2012), and 3.9% ($n = 5$) in expert determination.

Project details

37 respondents reported to have a major dispute in one of the projects, and still in the stage of deciding which ADR method to be used (Scenario A). 13 respondents reported to have just recently settled a major dispute in one of the projects with an ADR method (Scenario B). 14 respondents reported to have settlement in progress (Scenario C), and finally 64 respondents were negotiating a major claim in one of the projects. Table 8 shows the type of scenarios faced by the respondents.

Table 9. Overall project details.

Project details	A (*N* = 37)		B (*N* = 13)		C (*N* = 14)		D (*N* = 64)		Total (*N* = 128)	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
Type of project										
1. Residential	**12**	32.4	**1**	7.7	**3**	21.4	**16**	25.0	**32**	25
2. Commercial	**10**	27.0	**1**	7.7	**1**	7.1	**13**	20.3	**25**	20
3. Cultural	–	–	–	–	–	–	**1**	1.6	**1**	1
4. Sporting	–	–	**2**	15.4	–	–	–	–	**2**	2
5. Healthcare	–	–	–	–	–	–	**2**	3.1	**2**	2
6. Civil & infrastructure	**9**	24.3	**8**	61.5	**9**	64.3	**27**	42.2	**53**	41
7. Industrial	**6**	16.2	**1**	7.7	**1**	7.1	**5**	7.8	**13**	10
Project location										
1. Johor	**5**	13.5	**1**	7.7	**2**	14.3	**7**	10.9	**15**	12
2. Kedah	**1**	2.7	**2**	15.4	**1**	7.1	**2**	3.1	**6**	5
3. Kelantan	**3**	8.1	**1**	7.7	**1**	7.1	**4**	6.3	**9**	7
4. Melaka	**1**	2.7	–	–	**1**	7.1	**2**	3.1	**4**	3
5. Negeri Sembilan	–	–	–	–	–	–	**3**	4.7	**3**	2
6. Pahang	**3**	8.1	**1**	7.7	**1**	7.1	**5**	7.8	**10**	8
7. Perak	**1**	2.7	–		**1**	7.1	**3**	4.7	**5**	4
8. Perlis	–	–	**1**	7.7	–	–	–	4.7	**1**	1
9. Penang	**4**	10.8	–		–	–	**3**	4.7	**7**	5
10. Sabah	**2**	5.4	**1**	7.7	–	–	**6**	9.4	**9**	7
11. Sarawak	**5**	13.5	**1**	7.7	**1**	7.1	**4**	6.3	**11**	9
12. Selangor	**5**	13.5	**2**	15.4	**4**	28.6	**17**	28.6	**28**	22
13. Terengganu	**1**	2.7	**2**	15.4	**2**	14.3	**3**	4.7	**8**	6
14. Kuala Lumpur	**6**	16.2	**1**	7.7	–	–	**5**	7.8	**12**	9
Type of project dispute/Claim										
Change/variation order	**8**	21.6	**5**	38.5	**2**	14	**15**	23	**30**	23
Errors in drawings, specifications and quantities	**6**	16.2	**1**	7.69	**1**	7.1	**4**	6.3	**12**	9
Differing site conditions	**2**	5.4	–	–	**1**	7.1	**4**	6.3	**7**	5
Payment (e.g.: Delayed progress payment/ non-payment related dispute, etc.)	**10**	27.0	**4**	30.8	**5**	36	**20**	31	**39**	30
Delay (e.g.: Extension of time & disruption related dispute, etc.)	**5**	13.5	–	–	–	–	**7**	11	**12**	9
Ambiguity in contract terms/contract interpretation	**1**	2.7	**1**	7.69	-	–	**1**	1.6	**3**	2
Quality related (e.g.: Defects, workmanship, etc.)	**2**	5.4	–	–	**1**	7.1	**2**	3.1	**5**	4
Performance related (e.g.: Supply of goods, materials, execution of work, suspension issue, issue of 'regularly and diligently' etc.)	**1**	2.7	–	–	**1**	7.1	–	–	**2**	2
Information & administrative related dispute	–	–	–	–	**1**	7.1	**4**	6.3	**5**	4
Awards & decisions (e.g.: Dispute about adjudication/ arbitration awards, etc.)	–	–	**1**	7.69	**1**	7.1	–	–	**2**	2
Professional negligence	**1**	2.7	**1**	7.69	–	–	–	–	**2**	2
Personal injuries	–	–	–	–	–	–	**1**	1.6	**1**	1
Property damages	–	–	–	–	–	–	–	–	–	–
Nomination & re-nomination (e.g.: Appointment of replacement person, etc.)	**1**	2.7	–	–	–	–	**1**	1.6	**2**	2
Compliance with instruction (e.g.: Compliance with instruction by s.o/ architect, etc.)	–	–	–	–	**1**	7.1	**5**	7.8	**6**	5
Contract Sum										
Contract sum less than 10 million	**25**	67.6	**9**	69.2	**12**	85.8	**59**	92.2	**105**	82
10 million ≤ Contract sum <50 million	**6**	16.2	**1**	7.7	–	–	**4**	6.3	**11**	9
50 million ≤ Contract sum <100 million	**2**	5.4	**3**	23.0	–	–	**1**	1.6	**6**	5
100 million ≤ Contract sum <150 million	**2**	5.4	–	–	**1**	7.1	–	–	**3**	2
150 million ≤ Contract sum <200 million	–	–	–	–	–	–	–	–	–	–
200 million ≤ Contract sum <250 million	–	–	–	–	–	–	–	–	–	–
250 million ≤ Contract sum	**2**	5.4	–	–	**1**	7.1	–	–	**3**	2
Standard form of contract used										
PWD 203 (Rev 1./2010) – Drawing and specification forms part of contract	**3**	8.1	**2**	15.4	**1**	7.1	**5**	7.8	**11**	9
PWD 203A(Rev 1./2010) – Bills of quantities forms part of contract	**5**	13.5	**1**	7.69	–	–	**15**	23	**21**	16
PWD 203 (Rev 10/83) – Drawing and specification forms part of contract	–	–	**1**	7.69	**1**	7.1	**2**	3.1	**4**	3
PWD 203A (Rev 10/83) – Bills of quantities form part of the contract	**2**	5.4	**2**	15.4	–	–	**2**	3.1	**6**	5
PWD DB/T Rev 2002 (Turnkey)	–	–	–	–	–	–	–	–	–	
PWD DB Rev 2007 (Design & build)	**1**	2.7	–	–	**1**	7.1	**1**	1.6	**3**	2
PWD FORM DB (Rev.1/2010)	**1**	2.7	–	–	–	–	–	–	**1**	1
PWD 203N (Nominated sub contract)	**2**	5.41	**3**	23.1	**3**	21	**3**	4.7	**11**	9
FIDIC conditions of contract for construction (Red Book)	–	–	–	–	–	–	**1**	1.6	**1**	1

(*continued*)

Table 9. Continued.

Project details	A (*N* = 37)		B (*N* = 13)		C (*N* = 14)		D (*N* = 64)		Total (*N* = 128)	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%
FIDIC conditions of contract for plant and design/ Build (Yellow)	–	–	–	–	–	–	–	–	–	
FIDIC conditions of contract for EPC Turnkey Projects (Silver)	1	2.7	–	–	–	–		–	1	1
FIDIC short form of contract (the Green Book)	–	–	–	–	–	–	–	–	–	
PAM contract 2006 (With Quantities)	9	24.3	2	15.4	–	–	9	14	20	16
PAM contract 2006 (Without Quantities)	1	2.7	–		1	7.1	3	4.7	5	4
PAM sub-contract 2006	3	8.11	–		–	–	1	1.6	4	3
CIDB standard form of contract for building works (2000 Edition)	5	13.5	1	7.69	2	14	7	11	15	12
CIDB sub-contract form [CIDB.B(NSC)/2002]	1	2.7	1	7.69	2	14	2	3.1	6	5
CIDB model terms of construction contract for sub contract work	–	–	–	–	1	7.1	2	3.1	3	2
IEM.CE 2011: IEM form of contract for civil engineering works	–	–	–	–	–	–	–	–	–	
IEM.CES 1/90: IEM standard conditions of sub-contract for use in conjunction with the IEM conditions of contract for civil engineering works	1	2.7	–	–	1	7.1	5	7.8	7	5
In house	2	5.4	–	–	1	7.1	4	6.3	7	5
PAM 1998	–	–	–	–	–	–	2	3.1	2	2
Intended choice of ADR to settle hypothetical dispute/ claim scenario										
1. Arbitration	15	40.5	10	76.9	4	28.6	30	46.9	59	46.1
2. Mediation	7	18.9	1	7.7	4	28.6	9	14.1	21	16.4
3. Adjudication under CIPAA 2012	8	21.6	1	7.7	3	21.4	15	23.4	27	21.1
4. Adjudication (Contractual)	3	8.1	–	–	1	7.1	3	4.7	7	5.5
5. Expert determination	3	8.1	1	7.7	1	7.1	5	7.8	10	7.8
6. Dispute review board	–	–	–	–			1	1.6	1	0.8
7. Dispute adjudication board	–	–	–	–			1	1.6	1	0.8
8. Other: (Facilitated negotiation)	1	2.7	–	–	1	7.1	–	–	2	1.6

Table 9 shows the overall project details in accordance to the selected scenario. Type of projects reported in this study include civil & infrastructure projects (53 projects, 41%), followed by residential (32 projects, 25%), commercial (25 projects, 20%), industrial (13 projects, 10%), healthcare (2 projects, 2%), sporting (2 projects, 2%) and cultural (1 project, 1%). Most of the projects take place in Selangor (28 projects, 22%), while there is only one project in Perlis (1 project, 1%). East Malaysia region reports almost equal number of projects, where 11 projects (9%) commenced in Sarawak, and 9 projects (7%) commenced in Sabah.

As for reported dispute/claim issues, most of the respondents had payment issues (39 cases, 30%). Personal injuries (1 case, 1%) were the least reported issues. Majority of the projects (105 projects, 82%) had contract sum value less than 10 million. 11 projects (9%) were reported to have value between 10 and 50 million, 6 projects (5%) between 50 million and 100 million, 3 projects (2%) between 100 million and 150 million and another 3 projects more than 250 million ringgit.

PWD 203A (Rev1/2010) was the most used contract (used in 21 projects, 16%), while PWD Form DB (Rev1/2010), FIDIC (Red Book) and FIDIC (Silver Book) were the least used contract (each used in 1 project, 1%).

Overall, most respondents ($n = 59$, 46.1%) selected arbitration as the intended choice of settling the hypothetical dispute issues, seconded by Adjudication CIPAA 2012 ($n = 27$, 21.1%), followed by mediation ($n = 21$, 16.4%), expert determination ($n = 10$, 7.8%) and contractual adjudication ($n = 7$, 5.5%). 2 respondents (1.6%) chose facilitated negotiation. The least preferred choice was dispute review board ($n = 1$, 1%) and dispute adjudication board ($n = 1$, 1%).

Measurement model (N = 128 cases)

Firstly, the model was assessed in terms of its reliability and validity. In this measurement model, all constructs of the conceptual ADR decision making behavioural model were assessed reflectively. There are two types of reliability assessment: internal consistency reliability and indicator reliability. Internal consistency reliability is assessed with composite reliability, where it should be higher than 0.70; while indicator reliability is assessed with indicator loadings, where they should be higher than 0.70 (Hair et al. 2011, 2014). On the other hand, there are two types of validity assessments: convergent validity and discriminant validity. Convergent

Table 10. Measurement Model Assessment ($N = 128$).

Constructs	Items	Loadings	Composite reliability	Average variance extracted (AVE)
Attitude (ATT)	ATT_1	0.9646	0.9749	0.9284
	ATT_2	0.9762		
	ATT_3	0.9497		
Intention (INT)	INT_1	0.974	0.9817	0.9306
	INT_2	0.974		
	INT_3	0.965		
	INT_4	0.944		
Perceived behavioural control (PBC)	PBC_1	0.922	0.9483	0.8594
	PBC_2	0.956		
	PBC_3	0.902		
Subjective norm (SN)	SN_1	0.9474	0.9657	0.9038
	SN_2	0.9663		
	SN_3	0.9380		

Table 11. Analysis of cross loading.

Items	ATT (Attitude)	INT (Intention)	PBC (Perceived behavioural control)	SN (Subjective norm)
ATT_1	**0.9646**	0.8362	0.7328	0.7568
ATT_2	**0.9762**	0.8478	0.7298	0.748
ATT_3	**0.9497**	0.8178	0.7625	0.7705
INT_1	0.8683	**0.9743**	0.7362	0.7534
INT_2	0.8112	**0.9743**	0.7297	0.7391
INT_3	0.8469	**0.9655**	0.7158	0.7375
INT_4	0.8116	**0.9442**	0.6974	0.7148
PBC_1	0.735	0.7031	**0.922**	0.8186
PBC_2	0.7328	0.7323	**0.9561**	0.7629
PBC_3	0.6693	0.6351	**0.9021**	0.7192
SN_1	0.7409	0.7084	0.74	**0.948**
SN_2	0.7502	0.7417	0.815	**0.9671**
SN_3	0.7531	0.7264	0.805	**0.9367**

Table 12. Fornell-Larcker criteria.

	Attitude	Intention	Perceived behavioural control	Subjective norm
Attitude	**0.9635**			
Intention	0.8656	**0.9647**		
Perceived behavioural control	0.7695	0.7463	**0.927**	
Subjective norm	0.7869	0.7634	0.828	**0.9507**

validity is assessed with the average variance extracted (AVE), and the value should be higher than 0.50. Discriminant validity is assessed by comparing the square root of AVE of each latent construct with the construct's correlation with any other latent construct (Fornell-Larcker Criterion), and by comparing the indicators' loading with their respective cross loadings. To achieve discriminant validity, the square root of AVE of each construct should be higher than the construct's correlation with any other latent construct; while the indicators' loadings should be higher than all of their cross loadings (Hair et al. 2011, 2014). The validity and reliability results of the measurement model are presented in Table 10, while the results of cross loadings and Fornell-Larcker criterion are each shown in Tables 11 and 12.

Structural model assessment

After reliability and validity of the items have been confirmed, the next step involved the evaluation of the structural model. Before proceed to the other interpretations, collinearity issues should be first addressed (Hair et al. 2014). Absence of correlations between independent variables in regressions should be met as multicollinearity would cause difficulty to determine the separate effects of individual variables (Saunders et al. 2012). The level of collinearity can be measured by tolerance value and variance inflation factor (VIF). In the context of PLS-SEM, a tolerance value of 0.20 or lower, and a Variance Inflation Factor of 5 or higher would indicate serious collinearity issues (Hair et al. 2011). To assess the presence of collinearity in this study, variance inflation factors (VIF) values for all predictors (independent variables) are determined and further presented in Table 13. The results showed that all VIF values are less than 5 and are within the acceptable range. Thus, collinearity is not an issue in the data sets.

A bootstrapping procedure with 128 cases and 5000 subsamples has been conducted to assess the followings: evaluation of R^2 value, hypothesis testing,

assessment of effect sizes f^2 and assessment of predictive relevance Q^2. The overall results are shown in Table 14.

The results showed that the model (pooled scenario, $N = 128$) explains 77.1% of the variance explained in intention to use ADR. The cross validated redundancy (Q^2) value (0.7113) of intention confirmed the model has satisfactory predictive relevance. Predictive redundancy Q^2 value above 0.5 indicates a predictive model (Chin 2010).

The bootstrapping results indicate that attitude is positively related to intention ($\beta = 0.6597$, $t = 6.8035$, $p < 0.01$). Attitude has a significant large effect on intention ($f^2 = 0.64$, $q^2 = 0.491$). In contrast, no significant relationship exists between subjective norm and intention ($\beta = 0.1160$, $t = 1.3319$), and no significant relationship exists between perceived behavioural control and intention ($\beta = 0.1482$, $t = 1.5494$).

Role of Scenario

The data were collected based on four distinctive scenarios that were embedded in the questionnaire survey. At this end, Scenario A, B, C and D each recorded samples of 37, 13, 14 and 64 respondents. Although PLS-SEM offers plausible merits to data, the requirement of data sets in the model should be considered. The largest numbers of structural paths in the TPB model are 3, which imply a minimum sample size of 30 should be met. Only both Scenario A ($N = 37$) and D ($N = 64$) fulfils the minimum requirement of sample size. Both scenario B ($N = 13$ cases) and scenario C ($N = 14$ cases) were not part of the scenario based evaluation due to their limitation to meet 10 times rule.

In scenario A, 37 respondents were facing disputes in their projects and were in the stage of deciding on which ADR method to be used for dispute settlement; while in Scenario D, 64 respondents were in the stage of negotiating claims in their projects. Respondents in scenario A were required to select an ADR to settle their corresponding disputes; while respondents in Scenario D were instructed to select an ADR method to settle their manifested dispute when negotiation fails.

Measurement model (Scenario A and D)

Overall, the validity and reliability results of Measurement Model for Scenario A and D were presented in Table 15; while the results of cross loadings and Fornell-Larcker criterion are shown in Tables 16 and 17.

The result shows that all loadings of all items and composite reliability (CR) for all constructs were

Table 13. Collinearity assessment.

Model		Collinearity statistics	
		Tolerance	VIF
1	(Constant)		
	ATT	0.336	2.972
	PBC	0.278	3.591
	SN	0.259	3.858

Independent variable: Intention (INT)

Table 14. Pooled assessments.

Construct/Path	Path coefficient (β)	*t*-statistics	f^2 effect size	q^2 effect size	R^2	Q^2
Intention					**0.771**	**0.7113**
H_1: Attitude ⟶ Intention	0.6597***	6.8305	0.64	0.491		
H_2: Subjective norm ⟶ Intention	0.1160	1.3319	–	–		
H_3: Perceived behavioural control ⟶ Intention	0.1482	1.5494	–	–		

***Significant $p < 0.01$.

Table 15. Validity and reliability results of measurement model (Scenario A and D).

Constructs	Items	Loadings (Scenario		Composite reliability (Scenario)		Average variance extracted (AVE) (Scenario)	
		A	D	A	D	A	D
Attitude (ATT)	ATT_1	0.9713	0.9731	0.9840	0.9801	0.9536	0.9427
	ATT_2	0.9740	0.9817				
	ATT_3	0.9843	0.9578				
Intention (INT)	INT_1	0.9797	0.9713	0.9793	0.9819	0.9221	0.9312
	INT_2	0.9681	0.9746				
	INT_3	0.9401	0.9667				
	INT_4	0.9528	0.9471				
Perceived behavioural control (PBC)	PBC_1	0.9584	0.9206	0.9725	0.9556	0.9218	0.8776
	PBC_2	0.9712	0.9642				
	PBC_3	0.9505	0.9251				
Subjective norm (SN)	SN_1	0.9651	0.9611	0.9768	0.9714	0.9334	0.9189
	SN_2	0.9661	0.9732				
	SN_3	0.9671	0.9412				

Table 16. Cross loading assessments (Scenarios A and D).

Scenario A	ATT	INT	PBC	SN	Scenario D	ATT	INT	PBC	SN
ATT_1	**0.9731**	0.8516	0.8116	0.7826	ATT_1	**0.9731**	0.8516	0.8116	0.7826
ATT_2	**0.9817**	0.8505	0.7863	0.774	ATT_2	**0.9817**	0.8505	0.7863	0.774
ATT_3	**0.9578**	0.82	0.7865	0.7559	ATT_3	**0.9578**	0.82	0.7865	0.7559
INT_1	0.8762	**0.9713**	0.7573	0.7552	INT_1	0.8762	**0.9713**	0.7573	0.7552
INT_2	0.8016	**0.9746**	0.7647	0.7653	INT_2	0.8016	**0.9746**	0.7647	0.7653
INT_3	0.8399	**0.9667**	0.724	0.7241	INT_3	0.8399	**0.9667**	0.724	0.7241
INT_4	0.8228	**0.9471**	0.7417	0.7508	INT_4	0.8228	**0.9471**	0.7417	0.7508
PBC_1	0.7884	0.7591	**0.9206**	0.8414	PBC_1	0.7884	0.7591	**0.9206**	0.8414
PBC_2	0.744	0.7244	**0.9642**	0.7551	PBC_2	0.744	0.7244	**0.9642**	0.7551
PBC_3	0.7666	0.6878	**0.9251**	0.7554	PBC_3	0.7666	0.6878	**0.9251**	0.7554
SN_1	0.7172	0.6989	0.7725	**0.9611**	SN_1	0.7172	0.6989	0.7725	**0.9611**
SN_2	0.7655	0.7571	0.8235	**0.9732**	SN_2	0.7655	0.7571	0.8235	**0.9732**
SN_3	0.7961	0.7711	0.8123	**0.9412**	SN_3	0.7961	0.7711	0.8123	**0.9412**

Table 17. Fornell Larker criterion assessment (Intervention framework) scenarios A and D.

	Scenario A						Scenario D					
	ATT	INT	NP	PA	PE	TR	ATT	INT	NP	PA	PE	TR
ATT	**0.9765**						**0.9709**					
INT	0.9085	**0.9603**					0.8663	**0.965**				
NP	0.6094	0.6759	**0.9000**				0.5684	0.5888	**0.9416**			
PA	0.671	0.7243	0.8366	**0.9519**			0.7511	0.7003	0.7385	**0.9321**		
PE	0.7733	0.7689	0.8411	0.8797	**0.9746**		0.6712	0.5501	0.6011	0.779	**0.9902**	
TR	0.735	0.7707	0.8402	0.881	0.8788	**0.9329**	0.6505	0.6417	0.6496	0.7029	0.7137	**0.9614**

above 0.7 which shows significant results of reliability (both Scenarios). AVE of all constructs exceeds the threshold 0.5, and confirms a satisfactory degree of convergent validity.

Next, the discriminant validity of the constructs was examined. Tables 16 and 17 show that no indicator loadings were higher than the opposing constructs, and the square root of each constructs' AVE was higher than the constructs' correlation with the other constructs in the model (both scenarios). The overall results confirm that the discriminant validity of all constructs was satisfactory met.

Structural model assessment (Scenario A & D)

Similarly, before evaluating the structural model for both Scenario A and D, the collinearity issues are first addressed and presented in Table 18. The results show that the VIF values are less than 5.0 and within the acceptable range. Collinearity issues are thus not an issue in the data sets for both scenarios. Both PLS Algorithm (path weighting scheme) with maximum iterations of 300 and a bootstrapping procedure of 37 cases for scenario A and 64 cases for scenario D and 5000 resamples were undertaken to evaluate R^2 value, hypothesis testing, effect sizes f^2, predictive relevance Q^2 and q^2 effect sizes.

The hypotheses for both scenarios were examined by evaluating the path coefficient and t-statistics. As shown in Table 19 above, the findings show that the

Table 18. Collinearity assessments (Scenarios A & D).

Model (Scenario A) Constant	Collinearity statistics		Model (Scenario B) Constant	Collinearity	
	Tolerance	VIF		Tolerance	VIF
ATT	0.242	4.132	ATT	0.291	3.438
PBC	0.260	3.591	PBC	0.234	4.280
SN	0.234	3.858	SN	0.262	3.820

TPB model is structural good (R^2 = 0.832 for Scenario A, and R^2 = 0.773 for Scenario D) and sufficient in predicting behavioural intention to use ADR (selection behaviour). All hypotheses were rejected, except H_1 Attitude −> Intention ($\beta = 0.8930$, $t = 7.1973$, $p < 0.01$) for Scenario A; while $\beta = 0.39804$, $t = 3.9804$, $p < 0.01$ for scenario D). Apparently, the effect size of attitude on intention is substantially large ($f^2 > 0.35$). This shows supporting evidence H_1, where attitude plays a prominent role in influencing intention in both scenarios. Next, the model's predictive relevance for both scenarios is examined with Stone-Geisser's Q^2 value by using blindfolding procedure. With respect to intention, Q^2 for scenarios A & D has predictive relevance value of 0.7604 and 0.7183. Both values exceed 0.5 and are indicative of a predictive model (Chin 2010). The Q^2 values are considerably above zero, providing support for both model's predictive relevance related to the endogenous construct (intention). The q^2 effect sizes are interpreted as substantially large (>0.35). This

Table 19. Path significance testing results.

Construct/Path (Scenario A)	Path coefficient (β)	*t*-statistics	f^2 effect size	q^2 effect size	R^2	Q^2
Intention					0.832	0.7604
H_1: Attitude ⟶ Intention	0.8930	7.1973***	1.142	0.8505	–	–
H_2: Subjective norm ⟶ Intention	−0.1298	0.9802	–	–	–	–
H_3: Perceived behavioural control ⟶ Intention	0.1515	1.0664	–	–	–	–
Construct/Path (Scenario D)	**Path coefficient (β)**	***t*-statistics**	**f^2 effect size**	**q^2 effect size**	**R^2**	**Q^2**
Intention					0.773	0.7183
H_1: Attitude ⟶ Intention	0.6407	3.9804***	0.524	0.4178	–	–
H_2: Subjective norm ⟶ Intention	0.1955	1.3507	–	–	–	–
H_3: Perceived behavioural control ⟶ Intention	0.0855	0.5880	–	–	–	–

path confirms attitude has a large predictive relevance for intention in both Scenarios A and D.

Discussion

This study aims to test TPB model in explaining intention to use ADR. The model was conceptualized to examine the influence of attitude, subjective norm and perceived behavioural control on intention to use ADR. The first hypothesis H_1 of positive relationship between attitude and intention is confirmed by PLS bootstrap results. It shows that decision maker's deliberative selection behaviour in choosing ADR methods actually maximizes the expected utilities of ADR methods that would probably exhibit superior utilities, advantages and usefulness. Decision makers would generate their attitude towards the attributes of the behaviour that follow this equation: $\sum_{i=1}^{n} B_i a_i$, where it is a sum of beliefs about the consequences of performing a given act (B_i), times the evaluation of the consequences (a_i). The outcome of using ADR would exist in the form of 'Using this ADR method would enhance the quality of dispute settlement', while the evaluation of this outcome (a_i) would exist in this form 'Using this ADR method to enhance quality of dispute settlement is desirable/good/bad/wise'. This finding implies that decision makers would have greater intention to use ADR when they have more favourable attitudes on the ADR method.

On the contrary, the findings show insufficient evidence to support the relationship between subjective norm and intention, as well as perceived behavioural control and intention. ADR users do not necessary feel motivated to comply with the expectations of the important referents. Perceived behavioural control is not an important predictor in explaining intention to use ADR. According to Ajzen (1991), attitudes, subjective norms and perceived behavioural control may make independent contributions to the predictions of intentions. In some situations, only attitudes are significant on intentions, in others both attitudes and perceived behavioural control influence intention. The relative contributions of attitude, subjective norm and perceived behavioural control towards intention are expected to differ across behaviour and situations (Ajzen 1991). In contrast to negotiation phase (Scenario D), attitude makes a stronger contribution to the prediction of intention when dispute occurs (Scenario A). Feelings of favourable or unfavourable towards ADR methods would lead to the formation of selection behaviour. Overall, the research model evidently confirms that only attitude make independent contribution to intention (Selection behaviour).

Conclusion

TPB model posits intention can be jointly explained by attitude, subjective norm and perceived behavioural control. Based on this, this study conceptualizes selection behaviour in ADR (intention to use ADR) can be explained by attitude towards ADR, subjective norm with regard to ADR use and perceived behavioural control over ADR use. Accordingly, the study empirically tests TPB model in predicting intention to use ADR. 128 Contractors specializing in building and civil engineering in Malaysia responded to the TPB survey. The findings confirmed the explanatory power of TPB model, and showed a positive linear relationship between attitude and intention. The consistency of attitude towards intention was further tested at 2 different scenarios (dispute phase – Scenario A and negotiation phase – Scenario D). Both subjective norm and perceived behavioural control are not significant determinants of intention to use ADR. This aligns with Ajzen (1991)'s claim that not all predictors in TPB Model would contribute to the prediction of intention. This study theoretically contributes to the explanatory power of TPB in ADR selection behaviour. The significance of attitudinal dimensions of TPB always opens for further decomposition and extension (Taylor and Todd 1995). TPB model computes for additional amount of variance

with additional variables (Dumitrescu et al. 2011). Researchers may consider to extend and expand the existing TPB model in ADR use. As behavioural intention is the culmination of decision-making process, researchers may consider and investigate any macro forces that may deem to influence micro level decision-making process. While making progress theoretically, the maturity of TPB model in ADR selection could be empirically tested and compared across different projects and countries. On top of that, researchers may also examine the behavioural model in ADR use from the lens of different project professionals and other parties such as the clients, and the consultants.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Abdou A, Haggag M, Khatib OA. 2016. Use of building defect diagnosis in construction litigation: case study of a residential building. J Leg Aff Dispute Resolut Eng Constr. 8(1):C4515007.

Abdul-Rahman H, Kho M, Wang C. 2014. Late payment and nonpayment encountered by contracting firms in a fast-developing economy. J Prof Issues Eng Educ Pract. 140(2):04013013.

Ajzen I. 1991. The theory of planned behavior. Organ Behav Hum Decis Process. 50(2):179–291.

Ajzen I. 1999. Dual-mode processing in the pursuit of insight is no vice. Psychol Inq. 10(2):110–112.

Ajzen I. 2002. Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. J Appl Soc Psychol. 32(4):665–683.

Ajzen I. 2006. Constructing a TPB questionnaire. Conceptual and methodological considerations. [cited 1 January 2015]. Available from: people.umass.edu/aizen/pdf/tpb.measurement.pdf

Ajzen I. 2011. Behavioral interventions: design and evaluation guided by the theory of planned behavior. In: Social psychology for program and policy evaluation. New York: Guilford; p. 74–100.

Ajzen I. 2015. Consumer attitudes and behavior: the theory of planned behavior applied to food consumption decisions. Riv Econ Agr. 70:121–138.

Ajzen I, Driver BL. 1991. Prediction of leisure participation from behavioral, normative, and control beliefs: an application of the theory of planned behavior. Leisure Sci. 13(3):185–204.

Ajzen I, Manstead ASR. 2007. Changing health-related behaviors: an approach based on the theory of planned behavior. In: The scope of social psychology: theory and applications. New York: Psychology Press. p. 43–63.

Ara Begum R, Siwar C, Pereira JJ, Jaafar AH. 2009. Attitude and behavioral factors in waste management in the construction industry of Malaysia. Resour Conserv Recycl. 53(6):321–328.

Armstrong JS, Overton TS. 1977. Estimating nonresponse bias in mail surveys. J Market Res. 14(3):396–402.

Brooker P, Lavers A. 1997. Perceptions of alternative dispute resolution as constraints upon its use in the UK construction industry. Constr Manag Econ. 15(6):519–526. 1997/11/01

Chan E, Suen H, Chan C. 2006. MAUT-based dispute resolution selection model prototype for international construction projects. J Constr Eng Manag. 132(5):444–451.

Charoenngam C, Mahavarakorn W. 2011. Collaborative negotiation behaviors in Thai construction projects. J Legal Affairs Dispute Resolution in Eng Constr. 3(3):109–115.

Cheng EWL. 2016. Intentions to form project partnering in Hong Kong: application of the theory of planned behavior. J Constr Eng Manag. 142(12):0:04016075.

Cheung S, Suen H, Lam T. 2002. Fundamentals of alternative dispute resolution processes in construction. J Constr EngManag. 128(5):409–417.

Cheung SO. 1999. Critical factors affecting the use of alternative dispute resolution processes in construction. Int J Project Manag. 17(3):189–194. 6//

Cheung SO, Suen HCH. 2002. A multi-attribute utility model for dispute resolution strategy selection. Constr Manag Econ. 20(7):557–568.

Chin W. 2010. How to write up and report PLS analyses. In: Handbook of partial least squares. Berlin Heidelberg: Springer. p. 655–690.

Chong HY, Mohamad Zin R. 2012. Selection of dispute resolution methods: factor analysis approach. Eng Constr Archit Manag. 19(4):428–443.

Dumitrescu AL, Wagle M, Dogaru BC, Manolescu B. 2011. Modeling the theory of planned behavior for intention to improve oral health behaviors: the impact of attitudes, knowledge, and current behavior. J Oral Sci. 53(3):369–377.

Fife-Schaw C, Sheeran P, Norman P. 2007. Simulating behaviour change interventions based on the theory of planned behaviour: Impacts on intention and action. Br J Soc Psychol. 46(1):43–68.

Fishbein M, Ajzen I. 2010. Predicting and changing behavior: the reasoned action approach. New York: Psychology Press-Taylor and Francis Group.

Gideon L. 2012. Handbook of survey methodology for the social sciences. New York: Springer.

Goh YM, Sa'adon NFB. 2015. Cognitive factors influencing safety behavior at height: a multimethod exploratory study. J Constr Eng Manag. 141(6):04015003.

Hair JF, Hult GTM, Ringle CM, Sarstdet M. 2014. A primer on partial least squares structural equation modeling (PLS-SEM). Thousand Oaks, California: SAGE Publications, Inc.

Hair JF, Ringle CM, Sarstedt M. 2011. PLS-SEM: indeed a silver bullet. J Market Theory Pract. 19(2):139–152.

Haugen T, Singh A. 2015. Dispute resolution strategy selection. J Leg Aff Dispute Resolut Eng Constr. 7(3):05014004.

Kumaraswamy M. 1997. Conflicts, claims, and disputes in construction. Eng Constr Archit Manag. 4(2):95–111.
Lee CK, Yiu TW, Cheung SO. 2016. Selection and use of alternative dispute resolution (ADR) in construction projects-past and future research. Int J Project Manag. 34(3):494–507.
Lin H-F. 2007. Predicting consumer intentions to shop online: an empirical test of competing theories. Electron Commerce Res Appl. 6(4):433–442.
Love P, Davis P, Ellis J, Cheung SO. 2010. Dispute causation: identification of pathogenic influences in construction. Eng Constr Archit Manag. 17(4):404–423.
Marzouk M, El-Mesteckawi L, El-Said M. 2011. Dispute resolution aided tool for construction projects in Egypt. J Civil Eng Manag. 17(1):63–71.
Rogelberg SG, Stanton JM. 2007. Introduction: understanding and dealing with organizational survey nonresponse. Org Res Methods. 10(2):195–209.
Saunders M, Lewis P. Thornhill 2012. Research methods for business students. Harlow: Prentice Hall.
Sheeran P, Milne S, Webb TL, Gollwitzer PM. 2005. Implementation intentions and health behaviour. Bibliothek der Universität Konstanz.
Taylor S, Todd PA. 1995. Understanding information technology usage: a test of competing models. Inf Syst Res. 6(2):144–176.
Teo MMM, Loosemore M. 2001. A theory of waste behaviour in the construction industry. Constr Manag Econ. 19(7):741–751.
Tsai J, Chi C. 2009. Influences of Chinese cultural orientations and conflict management styles on construction dispute resolving strategies. J Constr Eng Manag. 135(10):955–964.
Zemore SE, Ajzen I. 2014. Predicting substance abuse treatment completion using a new scale based on the theory of planned behavior. J Subst Abuse Treat. 46(2):174–182.
Zhang P, Ng F. 2013. Explaining knowledge-sharing intention in construction teams in Hong Kong. J Constr Eng Manag. 139(3):280–293.

Understanding Decisions to Suspend Works: When Employers Do Not Pay

Chia Kuang Lee[1*]

[1]Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Malaysia.

Abstract. The construction industry propels Malaysia's economic growth. Payment is the livelihood of the construction industry. Many contractors have suffered badly from payment issues in Malaysia, especially non-payment. To remedy non-payment, unpaid contractors have the right to suspend works if the construction contracts express such rights. However, this self-help remedy is less to be instigated and the reasons remained under explored. The aims of this paper are threefold: (1) to understand contractors' reluctance to suspend works, (2) to predict contractors' decision to suspend works from the lens of Theory of Planned Behaviour (TPB) model, and (3) to propose intervention strategies based on Institutional Theory. 44 Contractors specializing in building and civil engineering works participated in this study. The results show that *Perceived obligations to others* and *tolerance factor* underpinned their reluctance. Step-wise regression analysis also shows that *subjective norm* is the predictor of intention. To intervene in the decisions effectively, the TPB model was further extended with isomorphic pressures: *Normative*, *Mimetic*, and *Coercive Pressures* by drawing on Institutional Theory. These isomorphic pressures could be useful in influencing intention through *subjective norm*. The outcome of study is beneficial for both project practitioners and researchers, especially in improving payment issues in the Malaysian construction industry. Suspension of work can be seen as one of an effective self-help remedy that can be intervened in a macro framework.

1 Introduction

Payment is the essential constituent that propels the Malaysian construction industry. The industry has been troubled with serious payment problems that seriously affect contractors' cash flow [1, 2]. This causes drawbacks not only to the key players, but also serious delay to the projects [3].

Non-payment is regarded as one of the major unethical conduct evidenced by the contractors [4]. Unpaid contractors often face the risk of bankruptcy [5]. To countenance against non-payment, unpaid contractors can choose to dispute and resolve through litigation, adjudication, mediation, or arbitration. Nevertheless, contractors have the right to remedy non-payment. Such rights include termination, summary judgment, go slow, suspension of

* Corresponding author: chia@ump.edu.my

works, or claim for interest. Despite the rights available, unpaid contractors would still continue working on projects without opting the route of termination [6].

Recently, construction professionals are highlighting the virtues of suspension of work as a self-help remedy as one of the avenues in remedying unpaid issues. Suspension of work gives contingencies for unpaid contractors to halt construction works lawfully until the employer duly honours the payment [7]. However, unpaid contractors are not granted any common law rights to suspend works. To suspend works, contractors have to rely on contractual express provisions. Main contracts such as Construction Industry Development Board 2000 (CIDB 2000), Pertubuhan Arkitek Malaysia 2006 (PAM 2006), and Public Works Department 203 (A) [PWD 203(A)] provide such avenues. Despite this self-help remedy, suspension of work was found to be less favourable among other avenues [5].

The study first investigated the underlying reluctance factors through cross sectional surveys. Drawing on Theory of Planned Behaviour (TPB), the study then examined the predictors of the decision to use suspension of work clause. Following that, the study recommended institutional theory as potential strategies to intervene in the use of suspension of work against non-payment.

2 Factors underpinning contractor's reluctance to suspend works

Despite the convenience of suspending works, contractors may somehow reluctant to use this provision against employer's non-payment. Early works done by [5] showed that the local contractors did not favour the right to suspend works as the best alternative remedy for securing payment debt. The possible arguments underpinning their reluctance to suspend works may include:

2.1 Absence of suspension clause

Contractors have to rely on the express provisions in construction contracts to suspend works. Contractors who suspend works without relying any express clauses in the contracts may invoke repudiatory breach.

In the case of ***Kah Seng Construction Sdn Bhd vs Selsin Development Sdn Bhd***, the court held that:

"...Even if the plaintiff can establish that the defendant is in repudiatory breach of contract, the plaintiff would have no right to suspend works, but instead would have had to elect to either terminate the contract or insist on due performance. By suspending works without valid legal cause, the plaintiff has in fact repudiated its contractual obligations."

This case evidenced that the contractor is not allowed to suspend works and left with the option to terminate the contract.

Similarly, in ***Canterbury Pipe Lines Ltd Vs The Christchurch Drainage Board***, the contractor has suspended works when the engineer withheld payment certificates. The court held that the contractor repudiated the contract by doing so. The virtues of relying express contractual rights to suspend works were further echoed in ***Channel Tunnel Group Ltd vs Belfour Beatty Construction Ltd & others***, ***DR Bradley (Cable Jointing) Ltd vs Jefco Mechanical Services,*** *as well as* ***Jia Min Building Construction Pte Ltd vs Ann Lee Pte Ltd***, where the contractor can only determine the contract in the absence of suspension clause in the contract.

Suspension of work is a breach of condition that may lead to a repudiatory breach as there is no common law that entitles the contractor to suspend works. Without express terms

and clauses of suspension of works, the contractor cannot suspend works if otherwise the contractor can be held to have breached the contract.
In Malaysia, the right to suspend works is envisaged in clause 30.7 Pertubuhan Arkitek Malaysia (PAM) 2006 and clause 42.10 CIDB 2000. Generally, the contractor's suspension of work shall lapse when the employer eventually pays the amount due including interest to the contractor. The contractor shall resume normal working as soon as is reasonably possible.

The employer can only lift the suspension period by honouring the payment with interest to the contractor. As soon as the payment is made, the contractor shall perform his contractual obligations diligently.

2.2 Lack of awareness

Knowledge and awareness of an innovation would lead to actual use through information-seeking and information-processing activities by the user [8]. Awareness is essential in achieving a viable and capable construction industry. In fact, the pace of actions towards subjugating the challenges in the construction sector heavily relies on the awareness of the significance of the corresponding actions [9]. Awareness is able to jumpstart constructive movements in the construction sector [9, 10]. Similarly, suspension of works is meaningless if the contractor himself is not aware and mindful of this right, even though this right is enshrined in the construction contracts. Without this awareness, it is almost impossible for a contractor to have interest to instigate this contractual right on the first place.

2.3 Preferences on alternative actions against non-payment

Other alternatives could be seen as more plausible in securing payment. Unpaid contractors would rely on the other alternatives such as arbitration, adjudication, mediation, winding up company, summary judgment, determination of contract, and claim for interest [11]. Avenues such as speedy dispute resolution mechanisms, interests on late payment, creation of trusts accounts for retention sums, were found to be favoured compared to suspension of works [5].

2.4 Intimidation

A contractor may be intimidated by the sub-contractor not to instigate the right to suspend works. When the sub-contract is subjected to pay-when paid clauses, the sub-contractor loses his leverage and end up for not being paid as well. For the sub-contractors, the main contractor's act of suspending works is possibly an offending action towards the employer and a must-avoid act. Therefore, it is logical to assume that the sub-contractors would profusely intimidate the contractor not to suspend works at all in the face of non-payment. Nevertheless, intimidation could have been emanated from the employer. Such unethical act warrants further investigations.

2.5 Legal challenges

Previous court case has shown that the unpaid contractors are frequently challenged on the grounds of wrongful suspension. Contractors who wrongfully suspend works might be challenged by the employer and end up determining his own employment. These potential challenges may deter a contractor's interest in deploying his right to suspend works. Nevertheless, contractors may be challenged based on the following grounds:

2.5.1 Vexatious and unreasonable notice

Suspension of works in construction is generally coined as stopping construction works before the completion of all contractual activities in the contract [12]. Although the works are suspended, all rights and obligations under the contract still remains [7]. Clause 30.7 in PAM 2006 states that:

"Without prejudice the Contractor's right to determine his own employment under Clause 26.0, if the Employer fails or neglects to pay the contractor the amount due as shown in the payment certificate (less any Liquidated Damages and set-off which the Employer is expressly entitled to make under the contract) and continue such default for fourteen (14) days from the receipt of a written notice delivered by hand or by registered post from the Contractor stating that if payment is not made within the fourteen (14) Days, the Contractor may by a further written notice delivered by hand or by registered post, forthwith suspend the execution of the works until such time payment is made. Provided always that ***such notice shall not be given unreasonably*** *or* ***vexatiously".***

The contractor must adhere to the strict procedures by giving notice to suspend works. Submission of notice is a condition precedent to suspension of works. The contractor shall be mindful that the notice shall not be given unreasonably, or vexatiously. The Courts have defined both "unreasonable and vexatious" effectively. In ***J.M Hill and Sons Ltd vs London Borough of Camden,*** the court defined "unreasonable" as the act of taking advantage on the employer. In ***John Jarvis vs Rockdale Housing Association Ltd***, the court defined "vexatious" as the act of ulterior motive to oppress, harass or to annoy. Followed by that, in ***Reinwood Ltd v Brown & Sons Ltd***, the court defined "unreasonable" as disproportionately disadvantages the employer, and "vexatious" as the ulterior motive or purpose of oppressing, harassing or annoying the employer".

Evidently from these cases, the notice to suspend works should free from any motive to oppress, harass, annoy, and disproportionately disadvantage the employer.

2.5.2 Absence of back to back provisions

Although the main contracts stipulate the right to suspend works, contractors should also make sure that the sub-contracts must incorporate back-to back suspension clauses. In ***Chandler Bros Ltd vs Boswell***, the main contractor was not empowered by the sub-contract to remove the contractor. The court of appeal held that the main contractor was guilty of a breach of the sub-contract. Similarly, the contractor must be aware that the subcontracts itself must contain the back to back clause to enable his capability to streamline suspension to sub-contractors.

2.6 Uncertainty in loss & expense claims and extension of time

Uncertainty over the payables and entitlements in extension of time may influence contractors' decision to suspend works. According to Sheridan [13], a contractor may be uncertain over the adequacy of compensation payable and entitlement of extension of time following his suspension of works.

Unpaid contractors who suspend works are entitled for extension of time and loss and expenses entitlement, subject to the stipulations in the contract [7]. For an example, clause 23.8 (v) PAM 2006 stipulates that if the contractor suspends his works due to non-payment, he is entitled for an extension of time. According to clause 23.1(a), if the contractor opines that suspension of work would delay the completion of works beyond the completion date, he shall issue the architect a written notice of his intention to claim for such extension of time together with an initial estimate of the extension of time he may require supported with all

causes of delay. The written notice shall be condition precedent to an entitlement of extension of time.

Nevertheless, the contractor is entitled to claim loss and expense. According to clause 24.3(m) PAM 2006, the contractor may be reimbursed with any loss and expenses if the work progress has been adversely influenced by the suspension of works. The contractor shall issue a notice to the architect for claiming loss and expenses with supporting documents such as initial estimates and causes of delays. Similarly, any contractor who suspends works under CIDB 2000 contract is entitled for extension of time [clause 42.10 (c) ii], and loss and expenses [clause 42.10(c) (iii)].

2.7 Distressing obligations

When a contractor suspends works, he is ceasing his construction works obligations until being paid by the employer. Unless the contract specifies, the contractor is entitled to leave the site in safe conditions, and the duty to insure ends with his other obligations as well. This implies that, when the contractor exercises his rights to suspend, the safety of the site is left with the employer. All problems associated with the cessation of the construction site belong to the employer [14].

However, Clause 30.9 PAM 2006 states that the contractor shall secure and protect the works during the period of suspension and ensure that there is a separate cessation insurance cover for all the risks specified in clause 19.0 (Insurance against injury to person and loss/or damage of property), clause 20. A (Insurance of new building works by the contractor), or clause 20. B (Insurance of New Building works-by the employer), or clause 20.C (Insurance of existing Building or extension–by the employer). Similarly, in CIDB 2000, the contractor who suspend works must not withdraw his entire workforce from the site, as he is obliged under clause 42.10 (c) (i) to protect and secure the works during the period of suspension.

Eventually, these obligations following suspension of work would influence contractor's interest to suspend works. When such contracts require the contractor to secure the site, the contractor has to ensure all works are protected from possible damages on the site.

In addition to that, contractors are made responsible to prevent and reduce delays. Stipulated in clause 23.6 PAM 2006, *"the contractor shall constantly use his* ***best endeavour*** *to prevent, or reduce delay in the progress of the works, and to do all that may* ***reasonably*** *be required to the satisfaction of the architect to prevent and reduce delay or further delay in the completion of the Works beyond the completion date"*. The court held in the case of ***IBM UK Ltd vs Rockware Glass Ltd*** that "best endeavour" implies prudent, determined and reasonable steps which must be taken, in order to achieve the desired result.

2.8 Tolerance

Kho and Abdul Rahman [15] contended that certain contractors in Malaysia have the culture of tolerating paymaster's late payment. The contractors overall can tolerate a minimum of 3 days and a maximum of 45 days of late payment. This could imply that contractors do not instigate the right to suspend is partly due to their tolerance towards paymaster. Contractors might perceive that paymaster's non-payment would just occur once in a while and they choose to tolerate and wait. Besides that, contractors might speculate that the share price would plunge drastically in case suspension of work has been initiated. Since the employer do not repeatedly at fault and pose repeated amount of failure to pay in time, the contractors would tend to proceed with their work without suspending their works.

Besides that, contractors who find themselves capable of sustaining the current project will tend to tolerate with the employer's poor financial status. Poor financial control leads to insufficient capital [16]. Kho and Abdul Rahman [15] asserted that the causes for employer's

poor financial management include his lack of management skills, ineffective utilization of funds, improper process implementation, underestimate & overlook the ripple effect of economic downturn on cash flow, client's failure to finance to project due to lack of cash flow, and paymaster's own dilemma in bankruptcy or winding up of his own other business activities. Paymasters own crippling financial status is detrimental to the working performance, time management, and working morale in the organization. However, contractors may have other subsidiary projects that can help to complement the existing ones, and does not jeopardize any cash flows.

Also, contractors tend to tolerate and withhold their suspension so that the relationship with the paymaster can be prolonged and maintained, even in the face of non-payment. Especially in government projects, it is speculated that contractors tend to avoid possible conflicts that may put their future business at stake.

Part of contractor's tolerance could be contributed to their understanding towards bad economic situations. According to Coulter and Kelley [17] , bad economic conditions cause undue distress among paymasters. Clients are unable to issue pay checks to the contractors at the end of the day due to financial difficulties. It could lead to short of current year project. Fikri Hasmori, Ismail [18] stated that short of current year project occurs mostly in government projects when the value of the work done exceeds the budget for the current year. Late payment easily occur when the releasing of corresponding funds faces impediments by the related government's agency [18]. Such repercussion would lead to non-payment by the employer.

2.9 Dispute with employer

Dispute between the employer and contractor is one of the reasons for non-payment [18]. Employers and contractors may dispute over the valuations done on site. Nevertheless, employers may hold several grounds against contractors and therefore their payment are held. Contractors in the process of negotiating with employers for dispute settlement would probably delay their intention to suspend works. The employer may hold their payment based on these grounds:

2.9.1 Invalid interim certificates

In ***Gunung Bayu Sdn Bhd vs Syarikat Pembinaan Perlis Sdn Bhd***, the appellant's architect was responsible for the issuance of interim certificates. The interim certificate was argued to be invalid as the certificate was signed by a graduate architect. The appellants claimed that certificate was not valid and refused to honour the payment.

2.9.2 Fraudulent certificates

In ***Ling Heng Toh Co vs Borneo Development Corporation Sdn Bhd***, the contractor contended that the payment certificate has been impartially certified under the influence of the employer. The trial judge however found that there was no fraud between the respondents and the engineers over the issuance of interim certificates.

In practice, the employer could allegedly apply the same ground for claiming that the certifier has been acting impartially under the influence of contractors, and refuse to honour the payment. In ***Lazarus Estates Ltd vs Beasley***, Lord Denning stated that:

"No court in this land will allow a person to keep an advantage which he obtained by fraud. No judgment of a court, no order of a minister can be allowed to stand if it has been obtained by fraud…fraud unravels everything."

2.9.3 Inaccurate interim certificate

In ***Gunung Bayu Sdn Bhd vs Syarikat Pembinaan Perlis Sdn Bhd***, the appellant's Employers can challenge the accuracy of interim certificates and refuse to pay. In ***C.M Pilings & Co Ltd vs Kent Investments Ltd***, the accuracy of the interim certificate was contended by the employer, and refused to honour the payment. The court eventually held that the employer had the right to challenge the accuracy of interim certificates, and ordered a stay of the application for summary judgement for the sum certified and referred to arbitration.

2.9.4 Set-offs

Persistent attempts by the employer to rely on set-off has caused financial stress on contractors [19]. In ***Token Construction Co Ltd v Charlton Estates Ltd,*** the court held that deductions can be made from interim certificate if the contract expressly allows it. There are several circumstances which allow the employer to set off the payment due to the contractors. In ***Woo Kam Seng vs Vong Tak Kong***, the court held that the employer was allowed to set off the amount payable to the contractor, as the contractor failed to perform in accordance to the specifications required.

In ***Mahkota Technologies Sdn Bhd (Formerly known as the General Electric Co (M) Sdn Bhd vs BS Civil Engineering Sdn Bhd***, the contractors' works were argued to be defective and failed to complete the contract within the stipulated time. The court held that the employer's counterclaim eventually exceeded the plaintiff's claim for payment.

In ***Kemayan Construction Sdn Bhd vs Prestara Sdn Bhd***, the court held that the respondent was entitled to withhold payment when the petitioner failed to rectify the defects according to the architect's instruction.

In Malaysia, extend of set-off was eventually dictated in PAM 2006 standard form of contract. Under the Principle of "***expressio unius est exclusion alterius***", the mechanism of set-off is distinguished from common law and is only limited to what is dictated and laid out in the standard form of contract. The employer shall not be entitled to set-off any amount unless the amount has been agreed by the contractor, or the decision has been issued by the adjudicator.

3 Framework underpinning decision making: theory of planned behaviour

Theory of Planned Behaviour (TPB) postulates that human actions are guided by behavioural/attitudinal beliefs, normative beliefs, and control beliefs on the performance of a behaviour [20]. The most proximal predictor of actual behaviour is behavioural intention (*BI*) [21, 22]. Behavioural intention (*BI*) indicates the level of effort people are willing to exert [22]. According to Sheeran, Milne [23], behavioural intention (*BI*) is the result of decision making-process.

In turn, behavioural intention (*BI*) is determined by attitude (*A*), subjective norm (*SN*), and perceived behavioural control (*PBC*) [22]. Beliefs about the likely consequences of a behaviour give rise to attitude (*A*); beliefs about normative expectations of others produce subjective norm (*SN*); while beliefs about the factors that enables or inhibits the performance of the behaviour contributes to perceived behavioural control (*PBC*) [24]. In general, the combination of attitude (*A*), subjective norm (*SN*), and perceived behavioural control (*PBC*) predicts behavioural intention (*BI*) [25]. Behavioural Intention (BI) in suspending works can thus be represented with the following equation:

$$\textit{Behavioural Intention (BI)}_{\text{suspension of work}} = W_1\,\textit{Attitude}_{\text{towards suspending works}} + W_2\,\textit{Subjective Norm}_{\text{with regard to suspension of work}} + W_3\,\textit{Perceived Behavioural Control}_{\text{over the use of suspension of work,}}$$
where W_1, W_2, and W_3 are empirically determined weights. (1)

The decision-making in the use of suspension of work when non-payment occurs is illustrated in Fig.1 below:

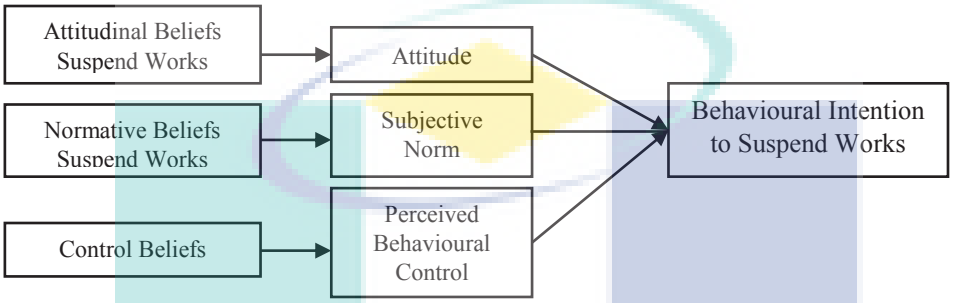


Fig. 1. Decision-Making in Suspension of Works (When Employer Fails to Pay)

It is thus reasonable to hypothesize that:
Hypothesis 1 (H_1): Attitude (***A***) towards Suspension of Work has a significant influence on Behavioural Intention (***BI***) to suspend works when non-payment occurs.
Hypothesis 2 (H_2): Subjective Norm (***SN***) with regards to suspension of work has a significant influence on Behavioural Intention (***BI***) to suspend works when non-payment occurs.
Hypothesis 3 (H_3): Perceived Behavioural Control (***PBC***) over the use of suspension of work has a significant influence on Behavioural Intention (***BI***) to suspend works when non-payment occurs.
The more favourable contractors' attitude and subjective norm towards suspension of work, and the greater perceived control towards suspending works, the stronger the contractor's intention in suspending works against non-payment.

4 Research objectives

This study has three objectives. Firstly, the study aims to investigate the factors underpinning unpaid contractors' reluctance in suspending works. Secondly, the study aims to identify the predictors that predict contractors' intention to suspend works based on Theory of Planned Behaviour (TPB). Thirdly, the study aims to intervene in the decision to suspend works with Institutional Theory.

5 Research methodology

To achieve objective 1 of the study, cross sectional survey in the form of questionnaires were administered to 1250 Grade 7 contractors specializing in building and civil engineering works in Malaysia. Grade 7 contractors are selected for this study as they have no limitation for tendering capacities and their net capital worth is the highest among the other grades (RM 750,000) [26].

The respondents were required to fill in their demographic details. Following that, the respondents would be required to rate the degree of importance of each factor which constitute to their reluctance in suspending works.

The Relative Importance Index (RII) will be calculated as such:

$$I = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i} \quad (2)$$

i = Response category index; whereby 1=not important, 2= slightly important, 3= moderately important 4= very important, 5= extremely important
W_i = Weight assigned to ith response =1, 2, 3, 4, 5 respectively.
X_i = Frequency of the ith response given as percentage of the total responses for each factors.

To achieve objective (2), the study draws on Theory of Planned Behaviour (TPB), the contractors were asked to assess their *behavioural intention (**BI**) to suspend works*, *attitude towards suspension of works (**A**)*, *subjective norm with regards to suspension of work (**SN**)*, and *perceived behavioural control with regards to suspension of work* (***PBC***) if the employer fails to pay. The items measuring *behavioural intention* (***BI***), *attitude* (***A***), *subjective norm* (***SN***), and *perceived behavioural control* (*PBC*) were adopted and modified based on previous studies, e.g. Taylor and Todd [21], Ajzen and Driver [27], and Ajzen [20].

Behavioural Intention (*BI*) was assessed with 3 items, attitude (A) was assessed with 4 items, subjective norms (*SN*) was assessed with 3 items, while perceived behavioural control (*PBC*) was assessed with 4 items. Prior to the main survey, the constructs and items were pre-tested by 3 construction professionals (with more than 7 years of experiences). Necessary modifications were made on the constructs and items based on the expert's recommendations. All items were assessed with Likert Scales (1- Strongly Disagree to 7- Strongly Agree). There are a total of 3 hypothesis posited in this study. They were tested with stepwise regression carried out with ***Risk Simulator RS2012***.

To achieve objective 3, predictor of Behavioural intention (*BI*) was further extended with variables supported by Institutional Theory. The intervention framework was further proposed based on theoretical groundings of *normative*, *coercive*, *mimetic* pressures drawing on institutional theory.

6 Results and discussions: objective 1

This section presents the (i) demographic background of the respondents, and (ii) results from the survey of reluctance factors.

6.1 Demographic details

A total 44 contractors responded in the reluctance survey. The response rate was 3.52%. Understandably, the response rate was low due to the fact that the prospective respondents were sensitive towards payment issues, and not interested in providing controversial feedbacks. Overall, Table 1 shows the demographic background of the respondents.

Table 1. Demographic Background of Contractors

Description	Frequency	Percentage
Experience in Construction Industry		
Less than 2 years	2	4.5%
Between 2-4 years	5	11.4%
Between 4-6 years	6	13.6%
Between 6-8 years	4	9.1%
More than 10 years	27	61.4%

Experience of Suspending works against non-payment	3	6.8%
Amount of Non-Payment Reported (Ringgit)		
More than 30 Million	1	2.3%
10-15 Million	2	4.5%
5-9 Million	3	6.8%
1-4 Million	3	6.8%
Below 1 Million	1	2.3%
Unreported	34	77.3%
Suspension of work selected as top choice remedy (reported)	5	11.4%

Based on Table 1 above, majority of the contractors (61.4%), have more than 10 years of experience in the construction industry. 13.6% of them have 4-6 years of industry experience, followed by 9.1% with 6-8 years of experience. 4.5% of the respondents reported less than 2 years of experience in the construction field.

6.8% of the respondents (3 companies) experienced non-payment which was resolved with suspension of works. And the survey also shows a daunting level of preference on suspension of work as a mechanism against non-payment, whereby only 11.4% of the respondents (5 companies) chose suspension of work as their top choice in remedying non-payment.

When probed for the amount of non-payment occurred, 34 companies (77.3%) of the respondents left it unanswered. Notably, 2.3% (1 company) records a staggering amount of more than RM 30 Million worth of amount overdue. 4.5% (2 companies) experienced a range of RM 10-15 Million worth of payment remained unpaid. Followed by that, another 6.8% (3 companies) recorded RM 5-9 Million, and RM 1-4 Million worth of payment remained overdue respectively. Only 1 company (2.3%) reported an amount which is classified as less than 1 Million worth of payment remained owed by the paymaster.

With the virtues of relative importance index, the rankings and index for each possible factor are tabulated in Table 2 below.

Table 2. Relative Importance Index (RII) of Reluctance in Suspension of Work.

Criteria	Sub Factors		Main Factors	
	Index	**Ranking**	**Index**	**Ranking**
Absence of Suspension Clause				
A1. No Suspension clause	3.25	11	**3.25**	3
Awareness Factor			**2.19**	9
B1. Unaware of right	2.23	33		
B2. Do not understand the procedures	2.14	34		
Preference on other ADR			**3.16**	4
C1. Preference on Arbitration	3.37	6		
C2. Preference on Adjudication	3.05	15		
C3. Preference on Mediation	3.26	9		
C4. Preference on Winding up Company	2.53	29		
C5. Preference on Determining own Contract	3.02	17		
C6. Preference to Claim for Interest	3.26	10		
C7. Preference on Conciliation	3.65	3		

Intimidation			**2.14**	10
D1. Intimidated by paymaster	2.26	32		
D2. Intimidated by sub-contractors	2.02	35		
Legal Challenges			**2.66**	8
E1. Constitute Breach of Contract.	2.86	26		
E2. Notice of suspension of works is vexatious and unreasonable.	2.91	25		
E3. Losing legal cases when suspend works.	2.47	30		
E4. Faces Legal challenges when suspending works.	2.39	31		
Uncertainty			**2.97**	6
F.1 Uncertain over adequacy payable and EOT(Extension of Time)	2.97	21		
More Obligations			**3.40**	1
F'.1 More obligations preventing delay	3.32	7		
F'.2 More endeavour in mitigating losses	3.47	5		
Tolerance Factor			**3.25**	2
G.1 Capable of tolerate culture	2.93	24		
G.2 Wait patiently	3.18	13		
G.3 Tolerate and understand financial status	2.75	28		
G.4 Capable of negotiate and convince employer of payment	3.61	4		
G.5 Tolerate non-payment because it occurs once in a while	3.65	2		
G.6 Prevent Share price drop	2.95	22		
G.7 Maintain good relationship with paymaster	3.88	1		
G.8 Understanding of bad economic situation	3.05	16		
Contract Related Disputes			**3.07**	5
H.1 In the process of disputing/negotiating with employers on valuations works done	3.23	12		
H.2 Disputing accuracy and amount of payment certificate	3.30	8		
H.3 Payment was withheld on the claim of setting off.	3.07	14		
H.4 Payment was held with the claim that interim certificates were not valid.	3.02	18		
H.5. Interim Certificates were claimed to be result of impartial and fraudulent	2.80	27		
H.6. Previous interim certificate was modified with a later interim certificate	2.98	19		
Insufficient Grounds for Suspending Works			**2.96**	7
1.1 Absence of back to back basis to suspend sub-contractor	2.93	23		
1.2 Suspend works would cause more disputes	2.98	20		

Depicted in Table 2 above, "Maintain good relationship with paymaster" was ranked the highest (RII 3.88), followed by "Tolerate non-payment because it occurs once in a while"

(RII 3.65), and thirdly "Preference on conciliation (RII 3.65). The least prominent factor was "Intimidated by Sub-contractors" (RII 2.02), followed by "Do not Understand Procedures" (RII 2.14), and "Unaware of Right" (RII 2.23).

Overall, the most prominent influencing main factors was "More Obligations" **RII 3.40**, followed by "Tolerance Factor" **RII 3.25, "**Absence of Suspension Clause" **RII 3.25**, "Preference on other ADR" **RII 3.16**, "Contract Related Disputes" **RII 3.07**, "Uncertainty" **RII 2.97, "**Insufficient Grounds for Suspending Works**" RII 2.96, "**Intimidation by Legal Challenges" **RII 2.66**, "Awareness Factor" **RII 2.19**, "Intimidation by Employer" **RII 2.14.**

For the RII that reaches below than 3.0, it can be deduced that contractors do not find themselves uncertain of the adequacy payable and extension of time claimable, neither do they find any insufficient grounds for suspending works, or feel intimidated by legal challenges, employer, and subcontractors.

7 Results and discussions: objective 2

This section presents the results of step-wise regression in order to determine the predictors of intention. Prior to the hypotheses tests, Cronbach's alpha was used to test the internal consistency of the set of items measuring the constructs depicted in the model. The results showed that all Cronbach's alpha value exceeds the value of 0.7, indicating that the internal consistency was met and guaranteed.

Next, all three hypotheses were tested with multiple regression analysis. Table 3 below shows the step-wise multiple regression analysis by Risk Simulator RS 2012. Stepwise regression was utilised in this study, as the combination of both forward and backward selection strategies of this technique assures parsimony of the model in predicting intention. Depicted in Table 3 below, the R-Squared or Coefficient of Determination indicates that 0.46 of the variation in "Intention to suspend works" can be explained and accounted for by the independent variables in this regression analysis. However, in a multiple regression, the Adjusted R-Squared takes into account the existence of additional independent variables or regressors and adjusts this R-Squared value to a more accurate view of the regression's explanatory power. Hence, only 0.41 of the variation in the "Intention to suspend works" can be explained by the regressors.

Table 3. Step-Wise Multiple Regression Analysis

Regression Statistics				
R-Squared (Coefficient of Determination)	0.4565			
Adjusted R-Squared	0.4136			
Multiple R (Multiple Correlation Coefficient)	0.6756			
Standard Error of the Estimates (SEy)	1.1325			
Number of Observations	42			
Regression Results	**Intercept**	***Attitude*** (A)	***Subjective Norms (SN)***	***Perceived Behavioural Control (PBC)***
Coefficients	0.2825	0.1983	0.4806	0.2460
Standard Error	0.8419	0.1406	0.1719	0.2125
t-Statistic	0.3355	1.4102	2.7962	1.1574
p-Value	0.7391	0.1666	**0.0081**	0.2543
Lower 5%	-1.4219	-0.0864	0.1327	-0.1843
Upper 95%	1.9868	0.4830	0.8286	0.6762

Notably, based on the report generated by Risk Simulator software, the multiple Correlation Coefficients (Multiple R) measure the correlation between the actual dependent variable (Y) and the estimated or fitted (Y) based on the regression equation. This is also the square root of the Coefficient of Determination (R-Squared). The Coefficients provide the estimated regression intercept and slopes. For instance, the coefficients are estimates of the true; population b values in the following regression equation $Y = b0 + b1X1 + b2X2 + ... + bnXn$. The Coefficient (0.4806) with the p-Values bolded 0.0081 indicate that it is statistically significant at the 90% confidence or 0.10 alpha levels. Hence this means that Behavioural intention (BI) to suspend works can be explained by subjective norm (SN), while attitude (A) and perceived behavioural control (PBC) have to be discarded from the equation. Hypothesis 2 (H2) is supported, while Hypothesis 1 & 3 (H1 and H3) are rejected.

Table 4 shows the analysis of variance (ANOVA). It provides an F-test of the regression model's overall statistical significance. The larger the F-Statistic, the more significant the model. If the p-Value is smaller than the 0.01, 0.05, or 0.10 alpha significance, then the regression is significant. The same approach can be applied to the F-Statistic by comparing the calculated F-Statistic with the critical F values at various significance levels. In summary, Behavioural Intention (BI) to suspend works = 0.4806 Subjective Norm (SN) + 0.2825.

Table 4. Analysis of Variance

Analysis of Variance						
	Sums of Squares	**Mean of Squares**	**F-Statistic**	**p-Value**	**Hypothesis Test**	**Value**
Regression	40.93	13.64	10.64	0.0000	Critical F-Statistic (99% confidence with df of 3 and 38)	4.3430
Residual	48.74	1.28			Critical F-statistic (95% confidence with df of 3 and 38)	2.8517
Total	89.67				Critical F-statistic (95% confidence with df of 3 and 38)	2.2339

8 Results and discussions: objective 3

Based on the supported hypothesis (Objective 2), this section presents the development of a framework to intervene in the use of suspension of work when non-payment occurs. The proposed framework draws on Institutional Theory. Institutional theory posits that organizations tend to structure and behave in accordance to institutional environment [28]. Three types of isomorphic pressures influence organisational behaviour, namely *coercive*, *mimetic*, and *normative* pressures. Coercive pressures stem from formal regulations and mandates; mimetic pressures stem from the need to imitate and benchmark successful organizations; while normative pressures derives from professionalization, where expectations are diffused through shared norms within professional bodies [29, 30].

Regression analysis shows that subjective norm is the only factor that influence contractors' decision to suspend works when non-payment occurs. Subjective norm stem from motivation to comply with the perceptions of others who are significant to the decision maker [31]. To encourage compliance, subjective norm can be intervened through isomorphic coercive, normative, and mimetic pressures.

Legal professionals, and regulatory bodies could nevertheless make suspension of work as a legislative right when employers did not pay. Coercive pressures through the epitome of regulatory forces are capable of influencing users' perceptions of compliance to suspend works. When motivation to comply these regulatory bodies are strong, unpaid contractors would have higher intention to suspend works when non-payment occurs.

Nevertheless, professional associations in the Malaysian construction industry such as the Construction Industry Development Board (CIDB), Masters of Builders Association Malaysia (MBAM), and professional bodies such as Board of Engineers, Architects, and Surveyors could play their role in disseminating the do's and don'ts in suspending works against non-payment. Universities could play their role as well. Through education, professional consultations, and academic conferences, this right can be reached and diffused to a wider audience effectively. Diffusion is possible when users encapsulate these right through shared norms and expectations. The intervention framework is shown in Figure 2 below:

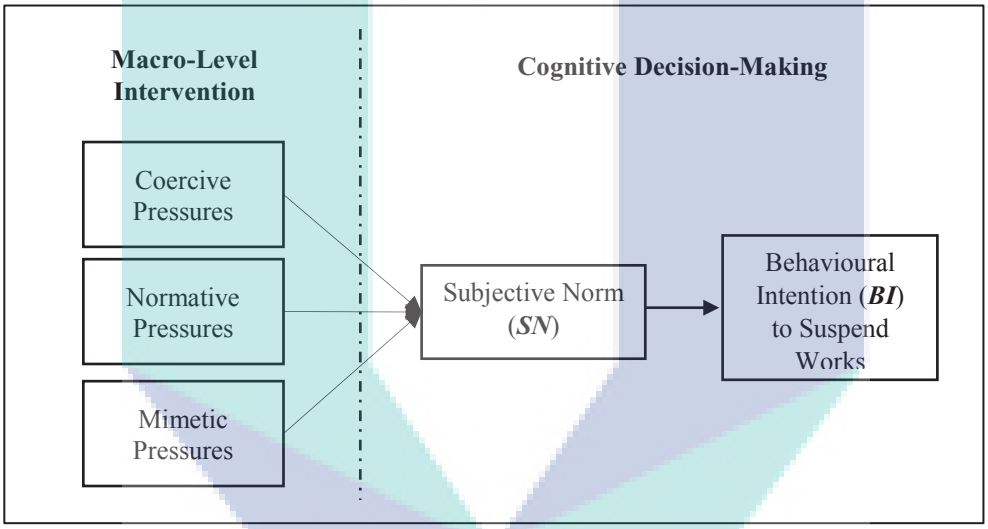


Fig. 2. Intervention Framework

9 Conclusion

Suspension of work has been regarded as a self-help remedy against non-payment. Construction professionals have been promoting this avenue to countenance against non-payment. However, there is no common law that allows unpaid contractor to walk away from site when the employer fails to pay. To suspend works without facing the risk of repudiating the contract, unpaid contractors can only rely expressed contract provisions. Despite the virtues of this right, previous studies however found that this right to be less preferred and instigated.

To overall improve the use of suspension of work, this paper has three objectives. Firstly, this paper identified the factors influencing unpaid contractors' decision-making. Drawing on theory of planned behaviour, step-wise regression analysis shows that subjective norm (***SN***) has a significant positive influence on intention. Thirdly, the paper proposed an intervention framework by drawing on Institutional theory. Coercive, normative and mimetic pressures was conceptualized to influence intention through subjective norm. Macro

intervening factors (coercive, normative and mimetic) could influence micro-level of decision making process. This study is not without its limitations. Future studies can seek to explore the relationship between intention and actual use behaviour. Secondly, the influence of macro forces on behavioural intention can be further investigated. Nevertheless, the effectiveness level of this clause could be explored, following the enforcement of the CIPAA 2012 (Construction Industry Payment and Adjudication Act 2012) in Malaysia.

The author would like to express their gratitude to Universiti Malaysia Pahang for funding this study through RDU 120340, and RDU 1703296.

References

1. Pettigrew, R., *Payment under construction contracts legislation* (Thomas Telford, London, 2005).
2. Wu, J., M. Kumaraswamy, and G. Soo, J Prof Iss Eng Ed Pr **134**, 4 (2008).
3. Sambasivan, M. and Y.W. Soon, Int J Proj Manag, **25**, 5(2007).
4. Hamimah, A., et al., Procedia Soc Behav Sci **35,** (2012).
5. Che Mu naaim, M.E., M.S. Mohd Danuri, and H. Abdul-Rahman, J.D.B.E **3**, 1 (2007).
6. Lim, C.F., Master Builders **4th Quarter**, (2005).
7. Harbans Singh, K.S., *Engineering and Construction Contracts Management Post Commencement Practice* (Malaysia, Malayan Law Journal Sdn Bhd, 2003).
8. Rogers, E.M., *Diffusion of Innovations* (New York, Free Press, 2003).
9. Zainul Abidin, N., Habitat Int **34** (2010).
10. Tran, K.C., Ocean Coast Manag **49** (2006).
11. Judi, S.S. and R. Abdul Rashid, JSCP **1** (2010).
12. Chow, K.F., *Construction Contracts Dictionary* (Sweet and Maxwell Asia, Singapore, 2006).
13. Sheridan, P. *Suspension of work* (Available from: http://www.sheridangold.co.uk/articles/suspension_of_work.pdf, 2012).
14. Chappel, D., *Construction Contracts& Answer* (USA, Taylor and Francis, 2006).
15. Kho, M. and H. Abdul Rahman, *Risk of Late Payment in the Malaysian Construction Industry* (WASET **41** , 2010).
16. Liu, Z., IJBM **5,** 2 (2010).
17. Coulter, C. and C.A. Kelley, *Contractor Financial Management and Construction Productivity Improvement: Phase 1* (University of Florida, School of Building Construction, 1992).
18. Fikri Hasmori, M., I. Ismail, and I. Said. *Issues of Late and Non-Payment among Contractors in Malaysia*. in *3rd International Conference on Business and Economic Research (3rd ICBER 2012) Proceeding* (Golden Flower Hotel, Bandung, Indonesia, 2012).
19. Tan, E., *The Common Law Right of Set-off in Construction Contracts* (Lexis Nexis The Malayan Law Journal Article, 1995).
20. Ajzen, I., *Constructing a TPB Questionnaire. Conceptual and Methodological Considerations* (2006).
21. Taylor, S. and P.A., Inf. Syst. Res **6,** 2 (1995).
22. Ajzen, I., Organ. Behav. Hum. Decis. Process **50,** 2(1991).
23. Sheeran, P., et al., *Implementation Intentions and Health Behaviour* (Bibliothek der Universität Konstanz, 2005).
24. Ajzen, I., Pers. Soc. Psychol. Rev **6,** 2 (2002).
25. Ajzen, I., Psychol Health Med **26,** 9 (2011).

26. CIDB, *Registration Requirement and Procedure* (CIDB Malaysia, 2016)
27. Ajzen, I. and B.L. Driver, Leis Sci, 1991 **13,** 3 (1991).
28. DiMaggio, P.J. and W.W. Powell, Am. Sociol. Rev **48,** 2 (1983).
29. Cao, D., H. Li, and W. Guangbin J Constr Eng Manag **140**, 40 (2014).
30. Teo, H.H., K.K. Wei, and I. Benbasat, Manag. Inf. Syst. Q **27,**1(2003).
31. Lee, C.K., T.W. Yiu, and S.O. Cheung, Int J Proj Manag **34,** 3 (2016).

COURT CASES

Canterbury Pipe Lines Ltd vs The Christchurch Drainage Board [1979]16 BLR 76
Channel Tunnel Group Ltd vs Belfour Beatty Construction Ltd & others [1992] 2ALL ER 609DR Bradley (Cable Jointing) Ltd vs Jefco Mechanical Services
Chandler Bros Ltd vs Boswell [1936] 3 ALL ER 179
C.M Pillings & Co Ltd vs Kent Investments Ltd [1986] 4 Con LR 1
Gunung Bayu Sdn Bhd vs Syarikat Pembinaan Perlis Sdn Bhd [1987] 2 MLJ 332
IBM UK Ltd vs Rockware Glass Ltd [1980] FSR 335
Jia Min Building Construction Pte Ltd vs Ann Lee Pte Ltd [2004] 3 SLR 288
J.M Hill and Sons Ltd vs London Borough of Camden [1980] 18 BLR 31
John Jarvis vs Rockdale Housing Association Ltd [1987] 36 BLR 48
Kah Seng Construction Sdn Bhd vs Selsin Development Sdn Bhd [1997]1 CLJ Supp
Kemayan Construction Sdn Bhd vs Prestara Sdn Bhd [1997] 5 MLJ 608
Lazarus Estates Ltd vs Beasley [1956] 1 All ER 341
Mahkota Technologies Sdn Bhd (Formerly known as the General Electric Co (M) Sdn Bhd vs BS Civil Engineering Sdn Bhd [2000] 6 MLJ 505
Reinwood Ltd v Brown & Sons Ltd [2006] TCC 9 November 2006
Token Construction Co Ltd v Charlton Estates Ltd [1973] 1 Build LR 48
Woo Kam Seng vs Vong Tak Kong [1968] 2 MLJ 244

KnE Social Sciences

FGIC2019
FGIC 2nd Conference on Governance and Integrity 2019
Volume 2019

Knowledge E
enriching | engaging | empowering

Conference Paper

Status and Barriers Impeding Utilization of Project Management Tools: Epidemic for Tripartite Construction Parties in Malaysia

Chia Kuang Lee[1], Tak Wing Yiu[2], Wei Xin Lim[3], Adekunle Qudus Adeleke[1], and Tien Choon Toh[4]

[1]Senior Lecturer, Faculty of Industrial Management, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang
[2]Senior Lecturer, Faculty of Engineering, Department of Civil and Environmental Engineering, The University of Auckland, Private Bag 92019, Auckland 1142, New Zealand
[3]Graduated Student, Project Management Programme, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Malaysia
[4]Assistant Professor, Department of Surveying, Lee Kong Chian Faculty of Engineering and Science, Sungai Long Campus, Jalan Sungai Long, Bandar Sungai Long Cheras 43000, Kajang, Selangor

Abstract

Project management tools have been widely used in construction project life cycles to monitor progress, evaluate payments/claims, and manage construction works worldwide. Despite their capability in helping project managers to achieve specific objectives within time, budget, and standards, not every construction organization in Malaysia would fully utilize these tools due to several challenges. As numerous studies substantiate the importance and of project management tools, lackluster adoption rates have led to productivity problems, project delays, and maturity problems at both project and enterprise levels in the construction industry. This study investigates the level of implementation and addresses the significant barriers that impede the utilization of project management tools. A survey was administered to well-known construction companies in Malaysia. This study revealed that the implementation level was discouragingly low, and the top 5 barriers were: (1) financial considerations, (2) restrictions on human capital, (3) high annual turnover, (4) lack of technology awareness, and (5) organizational culture. These findings suggest that the Malaysian construction industry should: overhaul financial and human resource limitations, increase assistance for users, and boost the partial implementation of basic techniques of project management to the maximum extent possible. The practitioners can understand the dynamics and causes of predicaments to the full implementation of project management tools in their respective companies. As for academicians, these findings help theoretical development and literature arguments on our current construction industry as a whole and optimistically help finds ways to make the Malaysian construction industry more efficient.

Keywords: barriers, project management tools, Malaysian construction industry

Corresponding Author:
Chia Kuang Lee
chia@ump.edu.my

Received: 5 August 2019
Accepted: 14 August 2019
Published: 18 August 2019

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the FGIC2019 Conference Committee.

1. Introduction

A Project is a temporary endeavour that has a beginning and end date. Project management, on the other hand, is “the application of knowledge, skills, tools, and techniques to project activities to meet project requirements” (PMI, 2013). Project-based organizations, often defined as “various organizational forms that create a temporary system for carrying out their work” (PMI, 2013), require management tools to initiate, plan, execute, monitor and control activities. Notably, the tools are numerous and continue to grow (Jonsdottir, Ingason, & Jonasson, 2014). Project Management Tools have a significant effect on project productivity on an enterprise level, directly as well as indirectly, depending on the sectors analysed (Devaraj & Kohli, 2003; Gilchrist, Gurbaxani, & Town, 2001; Gordon, 2000; Gretton, Gali, & Parham, 2004). Worth note-taking, adequacy of methods and tools are nevertheless the antecedents of project maturity (Spalek, 2014). The assessment of project management maturity has been done in the form of assessing project management practice (Sanjuan & Froese, 2013). Both maturity and productivity have been el9inked to the use of project management tools.

Several studies have substantiated the virtues of PM Tools. A study by Ika, Diallo, and Thuillier (2010) which involved empirical survey to 600 project coordinators in Africa demonstrated a strong correlation between the use of project monitoring & evaluation tools and project management success. Another empirical study which involved 154 project professionals working in the UAE by Mir and Pinnington (2014), showed investment in project management practices increases project management performance and enhances overall project success by several measures, including project efficiency, positive impact on the team and customer, business success and future preparation. Asserted by Mutesi and Kyakula (2011), the benefits derived from the use of technology tools are reduced mistakes in documents, easiness of complex tasks, time-saving, and increased productivity. On the whole, the investments in management technologies and tools contribute to the growth of productivity on an enterprise level, through the direct effects derived from the intensification of the capital, as well as to the overall effect on the factor contributing to productivity (Ollo-Lopez & Aramendia-Muneta, 2011).

Despite the advancement and availability of project management tools available to the industry, project success was not significantly improved (Mir & Pinnington, 2014). This notion asserts that tools are without its use if underutilized in organizations. The types and level of usage of the available project management practices and tools are

often overlooked and unheeded among the overgrowing interests of academics and practitioners (Ika et al., 2010).

Weak project management practices seem to be a plague within project owner organizations (Sanjuan & Froese, 2013). Despite the benefits of project management tools, White and Fortune (2002) showed that only a small number of tools and techniques of project management were deployed in project-based organizations. They observed among the limitations and drawbacks impart on the tools include inadequate for complex projects, difficult to model real-world, time-consuming, fail to predict future, constrained in views, not cost-effective, lack of training, unsuitability, immature, too much emphasis on standard, no lessons learned. In another research by Murphy and Ledwith (2007) in Irish high technology Small Medium Enterprise (SME) companies also suggested that project management tools have been used to a limited extent. In Malaysia, particularly, investigation done by Ibrahim, Roy, Ahmed, and Imtiaz (2010) have depicted that low productivity in the industry has significantly been associated with low usage of technology.

2. Epidemic of Underutilized Pm Tools

Information & Communication Technologies (ICT) has benefited the construction industry. In Malaysia, Abdul Kareem and Abu Bakar (2011) reported that among the major benefits of ICT to the Construction Industry were client satisfaction, cost reduction, management improvement, competitiveness advantages, improvement in business success criteria (i.e. efficiency, effectiveness and performance), information quality, organizational growth, work relations, and also increment in response rate, work flexibility, market share, reduction of working time.

The inclination and development of ICT have consequently developed various compute based tools to aid construction projects. Lately, Building Information Modelling (BIM), has been gaining widespread attention and interest in the construction industry. Academic wise, BIM allow students to experience practice project management in real projects (Peterson, Hartmann, Fruchter, & Fischer, 2011). However, the debut of BIM depends on the intended level of usage of information and communication technology (ICT) (Lee, Yu, & Jeong, 2013).

Given the fact that most project management tools are in the form of ICT, this assertion greatly implies that the utilization of project management tools reflects both the maturity and the readiness of BIM acceptance in the industry. The advancement and progression of tools need to be aligned with the management processes to maximize its potential

(Froese, 2010). Arguably, construction management tools are challenging to learn in the first place. Organization and technology need to work together. The involvement of project managers must be robust to ensure the coherence of tools and technologies utilizations in the organization (Hartmann, van Meerveld, Vossebeld, & Adriaanse, 2012). Effectiveness in project management can be increased, provided awareness coupled with training in a tool is adequate and lackluster of tools to manage projects is overcome (Papadaki et al., 2014; Pereira, Tenera, & Wemans, 2013).

According to Sanjuan and Froese (2013), lackluster of awareness and low confidence level of the value of project management are the pitfalls of project management practices and delivery in organizations. This explains the shortcomings of tools utilization in construction companies. It is a fact that not every construction companies will fully utilize project management tools. According to Ahuja, Yang, and Shankar (2009), construction organizations are slow in adopting technology tools. Without full utilization of Project Management Tools, these benefits may not be sustained in the long run. Research by Aouad, Kagioglou, Hinks, and Sexton (1999) suggested that technology tools are blockers rather than enablers of process improvement. There are assertions that the utilization of project management tools has both positive and negative effects. The first asserts that the higher adoption and use of the technology tools, the higher the productivity of the companies; while the latter implies that technological tools could have a negative impact due to the fact of great investment effort in the tools, and the high rate of capital depreciation of already installed or implemented tools is not compensated by earnings in productivity (Gilchrist et al., 2001; Greenan, Mairesse, & Topio-Bensaid, 2001; Gretton et al., 2004; Lehr & Lichtenberg, 1999).

Despite the contrary allegations of project management tools, the industry still heavily relies on these means of tools in managing multi-billion and mega projects. It is imperative that project managers understand the barriers that impede the full utilization of such tools in the organization. There is a need to address this issue, and the industry should leap forward to fix the quandaries underpinning utilization of project management tools. Once these factors of barriers are apparent, the project managers can eventually (1) overhaul the problems in tools adaptation in companies, (2) fostering acceptance of project management tools, (3) enhance project delivery process, (4) upgrade and enhance the existing project management tools as effective means in managing contractual claims and governance

3. Development of Project Management Tools (the Year 1950-1990's)

Modern project management has its roots back in the late 1950s with the development of Critical Path Method (CPM), and Program Evaluation Review Technique (PERT) (Hebert & Deckro, 2011). Since the 1950s, network-based techniques are commonly applied in project management (Shtub, 1997). With the merits of CPM, PERT, and PDM, two different professional project management institutes were formed. International Project Management Association or known as IPMA was formed in North Europe back in 1965, followed by the Project Management Institute (PMI) establishment in the USA and Canada in 1969 (Stretton, 2007). Following that, project management tools continue to propagate (Hebert & Deckro, 2011).

4. Development of Project Management Tools (the Year 2000's)

The Project Management Institute (PMI) particularly has continued to grow significantly. This institute advocates, develop and supports the use of project management tools to project success (Ika et al., 2010). Empirical research in 236 companies by White and Fortune (2002) showed that popular project management tools used included Critical Path Method (CPM), Work Breakdown Structure (WBS), Gantt Charts, Graphical Evaluation and Review Technique (GERT), Programme evaluation and review technique (PERT), and Project Management Software. The top 3 tools used were Project Management software, Gantt Charts, and Work Breakdown Structure. Another research by Besner and Hobbs (2004) also demonstrated that 753 project management practitioners extensively utilize PM software, Gantt chart, and work breakdown structure.

Research by Murphy and Ledwith (2007) showed that 40 respondents from small and medium project enterprise reported that Microsoft Project, Gantt chart and Critical Path Method are envisaged as the top 3 tools used in managing projects. Recent surveys among 50 project management practitioners covering construction industry by Jugdev, Perkins, Fortune, White, and Walker (2013) also confirms that project management tools include Gantt Charts, Work Breakdown Structures, Critical Path Method, Program Evaluation and Review Technique (PERT), strengths weakness, opportunities and threats (SWOT). The software used specifically includes Microsoft Project, Primavera, and Excel. Microsoft Project software invariably has been a hot debut since the 1990's. This software has consolidated all the essence of Activity on Node (AON) format, compliments

the precedence diagramming method and display the progress and relationships of activities in Gantt Chart View (Hebert & Deckro, 2011). Microsoft project software took its earliest form in 1992 and had several versions until 2010. Besides Microsoft Project Software, Primavera Software has incorporated the elements of project scheduling and networking and took various versions since the 1990's. It has been considered as one of state of the art tools in contemporary project management. Primavera software is similar to Microsoft Project; however, it is more advanced and more superior in terms of complexity and functionality. It enables multiuser access and incorporates various multiple projects at once (Salas-Morera, Arauzo-Azofra, García-Hernández, Palomo-Romero, & Hervás-Martínez, 2013).

5. Potential Barriers Underpinning Utilizations

The term "barriers" refer to the several certain factors that affect or hinder adoption and implementation of project management tools in construction companies. Overall, the barrier discussed in this paper is organized as follows, namely: financial considerations, organizational culture, attitude, lack of technological awareness, infrastructure, annual turnover, and restriction of human capital.

5.1. Financial constraints

Financial considerations pose a major constraint on the technology tools investments decision (Peansupap & Walker, 2005). Investments cost and unfavorable financial condition such as the high price of technology, the requirement on large investment, liquidity constraints, and so on are the potential barriers to technology tools investment (Hollenstein, 2004). Besides, hiring qualified personnel would also be costly (Ssewanyana & Busler, 2007). Asserted by Mutesi and Kyakula (2011), technology tool is constrained by the high cost of investment and recruitment of professionals. Construction firms are not providing enough caveats in investing in ICT systems development and skilled personnel (Alaghbandrad, Nobakht, Hosseinalipour, & Asnaashari, 2011).

5.2. Organizational culture

Organizational culture can be described as a set of norms, beliefs, principles, and ways of behaving that together give each organization a particular character (Brown, 2002). A firm's decisions are limited by its structural characteristics, which affect its ability

to adopt innovations in accordance with the benefits and costs involved (Moriones & Lopez, 2007). Once a company decides to implement new project management tools, there might occur some cultural changes in the organization. Cultural changes of the organization itself are more difficult and time consuming compared to technical changes because culture affecting every facet of the organization, including management styles, attitudes, standards, adaptability to change and power equilibrium (Milis & Mercken, 2002; Turner, 2008).

At the organizational level, the technology tools implementation constraints include basic levels of computer experience, time available to learn, and the identification of clear benefits of technology tools used. It also includes time available to share information, quality of personal contact, and geographical distance. Notably, it is not easy to accustom those practitioners with the technology tools, convince them to trust and use the new tools, as some of them may have been adapted with paper-based systems in their work over the years. It is believed that the best way to accustom construction practitioners with technology tools is to let them experience the benefits themselves (Alaghbandrad et al., 2011).

In reality, firms have different ways of organizing their activities and resources, and their decisions for technology tools adoption vary accordingly. Organizational factor influences not only the firm's innovative capability but also in the tool's contribution to the organizational principles followed by the firm (Moriones & Lopez, 2007).

5.3. Attitude

Behaviour is the action or reaction of a person in response to external or internal stimulation. It is believed that personal attitudes always contribute to shaping and affecting behaviour at work. New project management tools, change of technology, or culture may cause confusion, panic, and resistance among every individual in the organization (Milis & Mercken, 2002). Due to the expected resistance, management chooses to keep the users out of the project for as long as possible, which would probably result in mistakes or miscomprehension among the users (Milis & Mercken, 2002). Thus, this has become a barrier that impedes the full utilization of technology tools among companies.

In predicting technology use, the salient constructs underlining attitudes include perceived ease of use, perceived usefulness, and complexity (Taylor & Todd, 1995). Perceived ease of use refers to the degree of difficulty in understanding and operating (Rogers, 2003). Perceived usefulness, on the other hand, refers to the capability of

the system/ tool would enhance job performance. Later in 2008, another noticeable construct of attitudinal beliefs includes “computer anxiety,” which refers to an individual apprehension in using computers (Ventakesh & Bala, 2008).

The introduction of innovations can be intimidating for employees, mainly if it requires them to change their current practices or acquire new skills (Beatty, Shim, & Jones, 2001). There are varieties of people who have been using their methods successfully for many years, and this might encounter resistance to change when introducing the new project management tools. This is due to the lack of understanding in the new tools function, the benefits of using the tools and even believes that the tools will create more work. Besides, Alaghbandrad et al. (2011) stated that there are managers indicated that they had experienced resistance from ‘older’ workers whenever modern technology has been implemented. User resistance also occurs lackluster when inexperience senior managers introduce the applications to the organization (Peansupap & Walker, 2005).

Since the improvement or enhancement of technology tools often lead to changes in the physical or technological environment, people should get acquainted with their changing working environment. They have to learn to work with new or changing technologies in an altered environment (Turner, 2008). As if this happens in a project team, the team members should be cohesive, well-motivated, and committed to the project, as a way trying to adapt to the introduced project management tools.

5.4. Restrictions of human capital

The human capital restriction is another barrier that impedes full utilization of project management tools in construction companies. Adoption of these technology tools may be fraught by human capital restrictions, for example, a general shortage of highly skilled workers, lack of tools specialists, insufficient training, and so on (Hollenstein, 2004). An inadequate number of trained workers implies fewer innovations. Shortages of staff cause insufficient time for the use of software project management tools forces companies to limit the utilization of management tools in practice (Sukhoo, Barnard, Eloff, & Van der Poll, 2004).

Apart from that, individual characteristics do play a crucial role in the implementation of new technologies and management tools in an organization (Mahmood, Hall, & Swanberg, 2001; Venkatesh & Morris, 2000). Notably, qualified and highly educated workers would increase organizational readiness for innovation (Moriones & Lopez, 2007). Plants with advanced technologies eventually would require high-skilled workers (Doms, Dunne, & Troske, 1997). High-skilled workers enhance the tools and thus making

the investments in project management tools worthy and more accessible (Morgan, Colebourne, & Thomas, 2006).

Another daunting factor in human capital is to explain worker disagreement over the introduction of new work practices between younger workforce and senior age personnel. In organizations with a younger workforce, managers seem to have more enthusiastic towards technology tools adoption. The opposite occurs with older and more experienced workers, where they will be more reluctant to accept innovation because they would consider themselves experienced and established (Moriones & Lopez, 2007).

5.5. Lack of technological awareness

Lack of technology awareness is depicted to have impeded full utilization of project management tools (Pamulu & Bhuta, 2004). New technologies enable construction organizations to process and store their information easily, and huge amount of data can be transferred quickly (Alaghbandrad et al., 2011); however, current workloads deviate their focus on emerging new tools. Thus, awareness deficiency might lead to productivity problems and deter technology tools investments decision and obscure the technology tools investment opportunity (Peansupap & Walker, 2005). Limited awareness and understanding of potential gains by using these project management tools can be a significant loss (Adriaanse, Voordijk, & Dewul, 2010).

5.6. Infrastructure deficiency

Infrastructure deficiency is one of the barriers that hinder technology tools implementation (Gichoya, 2012). Infrastructure is an underlying base or foundation for an organization or system. Malaysia is currently facing infrastructure deficiency, where the full potential of the internet has not been utilized by Malaysian construction companies (Abdul Kareem & Abu Bakar, 2011). Technology tools infrastructure at project sites is one of the important factors and need improvement in the construction industry (Ahuja et al., 2009). Among the drawbacks in implementing and managing technology management tools were identified as, inefficient use of software, ill-defined processes, and infrastructure-related problems (Isikdag, J.Underwood, Kuruoglu, Goulding, & Acikalin, 2009). Without a widespread and high-quality infrastructure, it is not possible to exploit technological power completely (Alaghbandrad et al., 2011).

5.7. Insufficient annual turnover

It is depicted that insufficient annual turnover of a company might become a barrier that impedes the utilization of project management tools. Previous studies by Ahuja et al. (2009) showed that SMEs with higher turnover have higher adoption of ICT. These organizations can handle the initial cost, cost of updating and maintenance cost of the technology tools, mainly for effective adoption of the tools for building project management. The basic stumbling block of full implementation of project management tools is the lack of genuine value (ROI). Arguably annual turnover of a company does have impacts on the implementation of technology tools.

6. Research Objectives

This paper presents two objectives. The first objective is to investigate the status quo of project management tools implemented in construction companies, and the second objective is to solicit the respondents' perception on the barriers that impede full utilization of the tools in their respective companies. To propagate the importance of project management tools convincing and compelling to the practitioners, it will be interesting to know the implementation level and the barriers to allow the practitioners to elevate the predicaments and improve the status quo.

7. Methodology

A questionnaire was developed and administered to 135 different well known major construction companies in Malaysia. These targeted companies handled more than 20 million ringgit Malaysia (USD 6 Million) worth of projects in Malaysia. The questionnaire consists of three parts. The first part intends to obtain the demography of respondents; the second part focused on the implementation level; while the third part investigates the barriers that impede the utilization of project management tools in their respective companies. To solicit the users' perception on the implementation level, two scales namely "Implemented/Utilized", and "Not implemented/Not utilized" were probed. To obtain the degree of the barriers, a five-point scale range from 1 (not important) to 5 (extremely important) was adopted to determine the relative degree of importance and relative Importance Index (RII) of the barriers in impeding the utilization of tools. Previous studies by Kometa, Olomolaiye, and Harris (1994) in identifying the relative importance of various causes and effects of construction delay have utilized RII. Research by

Sambasivan and Soon (2007) also adopted RII in soliciting the relative importance of factors that causes delay and prioritizing the ranks of causes and effects of project delay. Overall, the relative importance (I) for each factor was calculated as follows:

$I = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i}$, where

i = Response category index; whereby 1=not important, 2= slightly important, 3= moderately important 4= very important, 5= extremely important

W_i = Weight assigned to *i*th response =1, 2, 3, 4, 5 respectively.

X_i = Frequency of the *i*th response given as a percentage of the total responses for each cause.

The Relative Important Index (RII) had a range from 1 until 5; the higher value of index implies the higher degree of barriers. The average index for the main barrier is the average of all the indexes of their respective barrier elements. The computed index was then used to rank the different sub-barriers and the main barrier as perceived by the contractors. About 42 Companies comprising of Grade-7 Contractors, Developers and Charted Consultants responded to this survey, which achieved a response rate of 31.1%. A separate Spearmen's Rank correlation was done to test the agreement between the tripartite parties. The spearman rank correlation coefficient can be tested to measure statically the degree of agreement related to the rankings of barriers perceived by contractors, developers, and chartered consultants. The higher the correlation coefficient at a significant level, 0.05 would indicate a stronger agreement between the groups of respondents (Hwang, Zhao, & Toh, 2014; Sambasivan & Soon, 2007).

8. Results and Discussions

The primary data were analyzed from the perspective of consultants, contractors, and developers. The implementation level of project management tools is analysed collectively. The status of implementation was probed based on a "yes"/"no" on "Implemented, not implemented" column, while each respondent's perceptions on barriers were computed by RII (Relative Importance Index). The demographics of respondents is portrayed in Table 1 below. Table 2 denotes the status of implementation, Table 3 depicts the ranking of barriers perceived (Overall); Table 4 shows the RII and ranking of barriers according to categories of respondents; and Table 5 describes the Spearman's Rank Correlation Coefficients of the ranking of Consultants, Developers, and Contractors.

Referring to Table 1, the characteristics of the subjects are discussed. Of the 135 different construction companies surveyed, 42 surveys were returned. All responses were complete and usable. Majority of the respondents were Company Managers

Table 1: Demographic Characteristics of Respondents.

Description	Frequency	Percentage (%)
Positions		
Company Director	11	26.20
Company Manager	12	28.60
Project Manager	6	14.30
Project Engineer	9	21.40
Project Coordinator	1	2.40
Senior Architect	1	2.40
Senior Quantity Surveyor	2	4.80
Type of Organizations		
Developer	16	38.10
Contractor	18	42.90
Consultant	8	19.00
Experience in Construction Industry		
5-10 years	14	33.33
11-15 years	12	28.57
16-20 years	7	16.67
More than 20 years	9	21.43
Types of Projects Involved		
All more than RM 20 Million (USD 6 Million) worth of projects.		

(28.6%), followed by Directors (26.2%), Project Engineers (21.4%), and Project Managers (14.3%), Senior QS (4.8%), and having both project coordinator and architect being the least (2.4%). The company background consists of tripartite companies, namely the Contractor companies (42.90%), Developers (38.1%), and followed by Consultants (19%). A noticeable 21.43 % of the respondents have more than 20 years of experience, and all respondents have at least 5 years minimum of working experience in the construction industry.

First, the paper discusses the current status quo of the implementation level of project management tools. Next, top 5 (FIVE) highest rank sub barriers, and 1(ONE) lowest-ranked sub barrier are presented. Followed by that, the significant level of agreement between the contractor and consultant obtained through the analysis of Spearman Rank Correlation over the seven major barriers will be discussed. Based on the rankings, prescriptions that could overhaul these barriers are discussed.

Referring to Table 2, “Excel” is the most implemented tool used (85.7%), followed by Microsoft Project (40.5%), Gantt Chart (38.1%), Critical Path Method (38.1%), Work Break Down Structure (21.4%), Web-Based tools (14.3%), Other Technology Tools (14.3%), Precedence Diagramming Method (9.5%), Program Evaluation and Review Technique, (PERT)

Table 2: Implementation of Project Management Tools.

Project Management Tools	Implemented Frequency	%	Not Implemented Frequency	%
Microsoft Project	17	40.5	25	59.5
Primavera P6 Professional Project Management (or other versions of Primavera E.g. Primavera Portfolio Management, Primavera P6 Analytics etc.)	2	4.8	40	95.2
Web-based tools	6	14.3	36	85.7
Gantt Chart	16	38.1	26	61.9
Critical Path Method (CPM)	16	38.1	26	61.9
Program Evaluation and Review Technique (PERT)	3	7.1	39	92.8
Graphical Evaluation Review Technique (GERT)	2	4.8	40	95.2
Activity-On-Arrow (AOA)	3	7.1	39	92.9
Activity-On-Node (AON)	2	4.8	40	95.2
Work Breakdown Structure (WBS)	9	21.4	33	78.6
Precedence Diagramming Method (PDM)	4	9.5	38	90.5
Microsoft Excel	36	85.7	6	14.3
Other technology tools (e.g., UBS, Microsoft Access)	6	14.3	36	85.7

(7.1%), Activity-on-Arrow (AOA) (7.1%), Graphical Evaluation Review Technique (4.8%), Primavera P6 Packages (4.8%), and Activity on Node (AON) (4.8%). The figures denote that the overall implementation level of project management tools is devastatingly low.

Based on the sub-barrier elements depicted in Table 3, **lack of corporate budget** (RII = 3.641) was ranked the highest. The respondents felt that the management does not have adequate funding for management tools, and it is almost impossible to have funding reconciliation for such purpose. Given the fact that managing projects heavily rely on managing people, reliance on management tools would imply managing software and tools itself.

TABLE 3: Relative Important Index (I) for Barriers.

Factors	Sub-Barrier Elements		Major Factors	
	Index (I)	Rank	Index (I)	Rank
Financial Considerations			**3.553**	**(1)**
Lack of Corporate Budget	3.641	1		
Expensive Tools	3.512	3		
Expensive Experts	3.507	4		
Organizational Culture			**3.116**	**(5)**
Cultural Changes	3.419	7		
Aversion of New Technology	3.391	8		
Acceptance of Employees	2.815	17		
Predicaments in Convincing Employees	2.840	16		
Attitude			**2.963**	**(6)**
Computer anxiety (Confusion & Panic)	3.333	9		
Perceived Lack of Usefulness	2.810	18		
Perceived Lack of Ease of Use (User's Lack of Confidence)	2.745	21		
Restriction on Human Capital			**3.32**	**(2)**
Human Capital Problems	3.421	6		
Shortages of Staffs	3.558	2		
Unskilled personnel	2.981	13		
Lack of Technology Awareness			**3.145**	**(4)**
Slow Adoption	2.917	14		
Senior Managers Unaware	3.236	12		
Bad investments in wrong tools	3.282	10		
Deficiency in Infrastructure			**2.741**	**(7)**
Quality problems of existing infrastructures	2.688	22		
Unable to expand new infrastructure	2.757	20		
Unsatisfied Infrastructure	2.778	19		
Poor Annual Turnover			**3.218**	**(3)**
Poor level of Turnover	2.917	15		
Lack of return of investments in new management tools	3.479	5		
Inability of Company to Support and upgrade software/hardware	3.257	11		

Followed by that, **shortage of staffs** was ranked second, with RII =3.558. Worth note-taking, Malaysian Construction Industry is still facing challenges in recruiting expertise that can manage sophisticated project management tools such as Primavera or Microsoft Project software effectively and efficiently.

Table 4: RII and ranking of Main Barriers.

Major Barriers	Developer		Consultant		Contractor	
	RII	Rank	RII	Rank	RII	Rank
Financial Considerations	3.211	4	3.500	1	3.889	1
Organization Culture	3.360	3	3.031	4	2.958	5
Attitude	3.000	6	3.000	5	2.889	6
Human Capital Restriction	3.438	1	3.208	3	3.315	2
Lack of Technology Awareness	3.375	2	2.875	6	3.185	4
Infrastructure	2.917	7	2.750	7	2.555	7
Poor Annual Turnover	3.084	5	3.292	2	3.278	3

Table 5: Spearman's Rank Correlation Coefficients.

Ranking		Consultant	Developer	Contractor
Consultant	Correlation Coefficient	1.000	0.286	0.857**
	Significance	-	0.535	0.014
	N (Number of Barriers)	22	232	22
Developer	Correlation Coefficient	0.286	1.000	0.607
	Significance	0.535	-	0.148
	N (Number of Barriers)	22	22	22
Contractor	Correlation Coefficient	0.857**	0.607	1.000
	Significance	0.014	0.148	-
	N (Number of Barriers)	22	22	22
**Correlation is significant at the 0.05 level of significance.				

The third highest barrier was an **expensive tool,** with RII=3.512. Understandable, project management tools such as Primavera, Oracle Software could be severely expensive. However, Microsoft based interfaces applications such as Excel, or Microsoft Project comes in handy and could be further implored.

Next, **expensive experts** were ranked the fourth highest rank, with RII reaching=3.507. Nevertheless, the respondents felt that real experts in management software and tools are not easily up for grabs. As much as the software itself, full-time experts are expensive to hire and recruit.

Ranked as fifth, the factor **lack of return of investments in new management tools** reached RII of 3.479. Lack of ROI in these tools would hinder the management to further uptake new tools. Although not further discussed, this paper speculates that investments made on the purchased tool/model did not seem to have to yield profitable returns. Moreover, the fundamental fault is on the workforce itself, as heartfelt by the respondents mentioned above –lack of experts to fully utilize these tools.

While all the major five sub barriers have been depicted above, the least ranked barrier would be **quality problems of existing infrastructures**. Ranked as 22 with RII =

2.688, it does not seem to be major presuppositions of barrier that need to be taken care.

Overall, depicted in Table 5, the Spearman rank correlation test was used to examine the agreement level between consultants, developers, and contractors. The result shows that both consultants and contractors share the same perception over 22 barriers, with a correlation coefficient of 0.857 at a significant level of 0.05. By only looking at the main barriers themselves, both consultant and contractor categories agreed that **financial consideration** poses major concern; while **infrastructure** poses the least concern (Table 4. On the other hand, for developers, the **human capital restriction** is their primary concern, with infrastructure being their least concern.

Based on the summary ranking in Table 3, the important barriers as perceived by the overall respondents were: (1) **financial constraints** [RII =3.553], (2) **restrictions on human Capital** [RII = 3.320], (3) **poor annual turnover** [RII =3.218], (4) **lack of technology awareness** [RII= 3.145], (5) **organizational culture** [RII = 3.116], (6) **attitude** [RII =2.963], (7) **deficiency in infrastructure** [RII =2.741].

8.1. Prescriptions to overhaul barriers

Notably, the survey involves construction companies that handle more than USD 6 Million worth of construction projects. The survey above suggests a low implementation of project management tools in these respective construction companies. Besides Excel, the survey indicates no more than 50% implementation in all subsequent project management tools. More attention should be given to financial constraints, restrictions on human capital, poor annual turnover, lack of technology awareness, and organizational culture. Both attitude and deficiency in infrastructure, however, were perceived as not crucial (RII below 3.00).

The respondents were prompted earlier on their willingness to uptake new and enhanced management tools to their existing tools. 85.7% of the respondents agreed that their company has the urgency to uptake and enhance their existing project management tools; while the remaining 14.3% are pessimistic on improving and enhancing new tools in their organizations.

Besides managing the triple constraints such as time, cost, and quality of a project, the expectations of the tripartite parties (namely the developers, consultants, and contractors) need to be managed ideally. While selecting contractors in their prequalification process, the selected contractors in the tender evaluation process must exhibit robust capabilities in technicality aspects, and thus mitigating the probability of impeding

potential utilization of management tools on construction sites. On the other hand, developers and consultants (mostly working for the client in contemporary construction contract) should promptly assure the cash flow of the contractor by paying on time, and thus reducing any predicaments of project management tools in projects.

During the initiation phase, where expectations of all stakeholders are discussed, the project sponsor should take into account of the need and urgency of enhancing, or up taking new management tools in projects. And thus, the project team could savour the required budget for the development of project management tools. To overhaul lack of expertise in the organizations, management should emphasize on giving adequate in house training that would enhance tools usage and knowledge. Propagation of such knowledge should be then reinforced with management commitment from top-down. Attitude problems can be overcome with an increasing experience that diminishes computer anxiety, given that the users experience the enjoyment of using tools in day to day work. This heavily relies on organizational management support through helpdesk, and off the job training (Ventakesh & Bala, 2008).

Government Malaysia plays an important role as well in helping the industry to progress. Hand-in-hand with the Construction Industry Development Board (CIDB Malaysia), awareness and proper training program can be held to promote project management practices in the industry. Incentive alignment strategy as the post-implementation stage of tools takes place is one of the key factors that enhance user acceptance in technology usage (Todd & Benbasat, 1999). Particularly for the use of project management tools, Malaysian Construction Industry Development Board particularly can opt to cooperate with the Multimedia Development Corporation, or known as MDEC, which is an agency that oversees the implementation of multimedia and information infrastructures in Malaysia, and Project Management Institute Malaysian Chapter (PMIMY). In Malaysia, formal project management courses and the education training such as Certified in Project Management Professional (PMP®), or Certified Associate in Project Management (CAPM®) are delivered as means of formal training and pre-requisites for industrial practitioners in getting project management credentials, and the most predominant certification nevertheless is PMP®. In practice, MDEC, serving as the backbone of the Malaysian multimedia corridor, has been actively providing rebates up to RM 2,500 (USD 600) for individual project management exam and course takers. Incentives such as grants, rebates can be provided via these tripartite agencies such as this can be implemented to increase awareness and knowledge of practitioners of the use of project management methodologies and PM tools in the companies.

In the macro level, the Malaysian Construction Industry has been depicted to have faced predicaments in exercising the policies set out by the government, especially the contractors themselves in using and benefit from the state of the art technologies in managing projects (Ibrahim et al., 2010). Cautiously optimistic, this paper suggests that the Malaysian Government through CIDB should tackle the fundamental issues of formal project management education among practitioners. Application of new technologies requires fundamental project management knowledge, which can be strictly emphasized in the next Malaysian Construction Industry Master (CIMP 2016-2025). By advocating and propagating the need of formal project management practices aligned with its previous strategic thrust, further recommendations can be reinforced in fourth Strategic Thrust – "*Develop Human Resource Capabilities and Capacities in the Construction Industry*"; and sixth strategic Thrusts – "Leverage on information and communication technology in the construction industry". Development of human resource requires fundamental realignment of skill in project management knowledge and the development of tools and technologies that the industries have to offer.

9. Conclusion

Project management tools have been a cornerstone in the operations of construction activities. Numerous studies have proved the use of PM tools in planning, monitoring, and controlling construction projects effectively. Besides increasing construction productivity, PM Tools are capable of circumventing delays, enhancing the delivery value of projects, and increases project management maturity in organizations. Using a survey design and Relative Importance Index (RII) methodology, this study investigated the implementation level of project management tools and the barriers that impede project management tools adoption in construction companies. The first findings suggest a low implementation level of project management tools. Although Microsoft Excel was ranked the highest being adopted, the other core PM tools such as WBS and Microsoft Project are devastatingly low. The second findings assert financial considerations and lack of human resource in exercising these tools to be two highest barriers that impede PM Tool's adoption and substantiating the other main factors such as reduced annual turnover, lack of technology awareness, organizational culture, attitude, and infrastructure barriers equally being the stumbling block of adoption. The third finding concludes a consistent agreement on the barriers among), private contractors, and private consultants. To overcome these barriers, incentives alignment can be instigated by the Government sectors such as CIDB, MDEC, and non-profit organizations such as

the Project Management Institute for the propagation of project management training. Having the tools is never adequate without knowledge advancement. Through formal training, it reinforces a positive attitude and increases adoption.

Cautiously optimistic, this paper reveals the current status quo of project management practices and standard PM tools adoption in Malaysia, so that the key players can give proper attention on the important factors and make dynamic efforts to reduce barriers of project management tools utilization in projects. The practitioners can understand the dynamics and causes of predicaments to the full implementation of project management tools in their respective companies. As for academicians, it helps theoretical development and literature arguments on our current construction industry as a whole and optimistically finds ways to take the Malaysian Construction Industry for better improvements.

Acknowledgement

We would like to thank Faculty of Industrial Management and FIM's Governance and Integrity Centre, Universiti Malaysia Pahang for the financial support by sponsoring this paper to be presented in the FGIC 2nd Conference on Governance and Integrity 2019.

References

[1] Abdul Kareem, H. I., & Abu Bakar, A. H. (2011). Identifying IT Benefits for Malaysian construction companies. *Journal of Information Technology in Construction, 16*(2011), 477-492.

[2] Adriaanse, A., Voordijk, H., & Dewul, G. (2010). The use of interorganisational ICT in United States construction projects. *Automation in Construction, 19*(1), 73-83.

[3] Ahuja, V., Yang, J., & Shankar, R. (2009). Study of ICT Adoption for Building Project Management in the Indian Construction Industry. *Automation in Construction, 18*(4), 415-423.

[4] Alaghbandrad, A., Nobakht, M. B., Hosseinalipour, M., & Asnaashari, E. (2011). *ICT Adoption In The Iranian Construction Industry: Barriers And Opportunities*. Paper presented at the The 28th International Symposium on Automation and Robotics in Construction, IAARC

[5] Aouad, G., Kagioglou, M., Hinks, R., & Sexton, M. (1999). Technology Management of IT in Construction: A Driver or an Enabler? *Journal of Logistics Information Management, 12*(½), 130-137.

[6] Beatty, R., Shim, J. P., & Jones, M. C. (2001). Factors Influencing Corporate Web Site Adoption: A Time-Based Assessment. *Information and Management, 38*(6), 337–354.

[7] Besner, C., & Hobbs, B. (2004). An empirical investigation of project management practice: In reality what tools do practitioners use? In D. P. Slevin, D. I. Cleland, & J. K. Pinto (Eds.), *Innovations: Project Management Research* (pp. 337-351). Newton Square: Project Management Institute.

[8] Brown, A. (2002). *Organisational Culture*. London: Pitman Publishing.

[9] Devaraj, S., & Kohli, R. (2003). Performance Impacts of Information Technology: Is Actual Usage the missing link. *Management Science, 49*(3), 273-289.

[10] Doms, M., Dunne, T., & Troske, K. (1997). Workers, wages and technology. *The Quarterly Journal of Economics, 112*(1), 253–290.

[11] Froese, T. M. (2010). The impact of emerging information technology on project management for construction. *Automation in Construction, 19*(5), 531-538. doi: http://dx.doi.org/10.1016/j.autcon.2009.11.004

[12] Gichoya, D. (2012). Factors Affecting the Successful Implementation of ICT Projects in Government. *The Electronic Journal of e-Government, 3*(4), 175-184.

[13] Gilchrist, S., Gurbaxani, V., & Town, R. (2001). *PCs and the Productivity Revolution. Working Paper, Center for Research on Information Technology and Organizations*. Retrieved from Irvine:

[14] Gordon, R. J. (2000). Does the “New Economy” Measure up to the Great Inventions of the Past. *Journal of Economic Perspectives, 14*(4), 49-74.

[15] Greenan, N., Mairesse, J., & Topio-Bensaid, A. (2001). *Information Technology, Productivity and Economic Growth: International Evidence and Implications for Economic Development*. Cambridge: Oxford University Press.

[16] Gretton, P., Gali, J., & Parham, D. (2004). The effects of ICTs and Complementary Innovations on Australian Productivity Growth. In OECD (Ed.), *The Economic Impact of ICT. Measurement, Evidence and Implication* (pp. 105-130). Paris.

[17] Hartmann, T., van Meerveld, H., Vossebeld, N., & Adriaanse, A. (2012). Aligning building information model tools and construction management methods. *Automation in Construction, 22*(2012), 605-613. doi:http://dx.doi.org/10.1016/j.autcon.2011.12.011

[18] Hebert, J. E., & Deckro, R. F. (2011). Combining contemporary and traditional project management tools to resolve a project scheduling problem. *Computers & Operations Research, 38*(1), 21-32. doi: http://dx.doi.org/10.1016/j.cor.2009.12.004

[19] Hollenstein, H. (2004). Determinants of the adoption of Information and Communication Technologies (ICT), An empirical analysis based on firm-level data for the Swiss business sector. *Structural Change and Economic Dynamics, 15*(3), 315-342.

[20] Hwang, B.-G., Zhao, X., & Toh, L. P. (2014). Risk management in small construction projects in Singapore: Status, barriers and impact. *International Journal of Project Management, 32*(1), 116-124. doi: http://dx.doi.org/10.1016/j.ijproman.2013.01.007

[21] Ibrahim, A. R., Roy, M. H., Ahmed, Z., & Imtiaz, G. (2010). An investigation of the status of the Malaysian Construction Industry. *Benchmarking: An International Journal, 17*(2), 294-308.

[22] Ika, L. A., Diallo, A., & Thuillier, D. (2010). Project management in the international development industry. *International Journal of Managing Projects in Business, 3*(1), 61-93.

[23] Isikdag, U., J.Underwood, J., Kuruoglu, M., Goulding, J., & Acikalin, U. (2009). Construction informatics in Turkey: strategic role of ICT and future research directions. *Journal of Information Technology in Construction (ITcon), 14*(2009), 412-428.

[24] Jonsdottir, S., Ingason, H. T., & Jonasson, H. I. (2014). Continuous Improvement Projects in Certified Organizations in Iceland: Traditional Projects or not? *Procedia - Social and Behavioral Sciences, 119*(2014), 142-151. doi: http://dx.doi.org/10.1016/j.sbspro.2014.03.018

[25] Jugdev, K., Perkins, D., Fortune, J., White, D., & Walker, D. (2013). An exploratory study of project success with tools, software and methods. *International Journal of Managing Projects in Business, 6*(3), 534-551.

[26] Kometa, S., Olomolaiye, P., & Harris, F. (1994). Attributes of UK construction clients influencing project consultants' performance. *Construction Manage Econ, 12*, 433-443.

[27] Lee, S., Yu, J., & Jeong, D. (2013). BIM Acceptance Model in Construction Organizations. *Journal of Management in Engineering*. doi:doi:10.1061/(ASCE)ME.1943-5479.0000252

[28] Lehr, B., & Lichtenberg, F. (1999). Information Technology and its Impact on Productivity: Firm-level evidence from government and private data sources. *The Canadian Journal of Economics, 32*(2), 335-362.

[29] Mahmood, M. A., Hall, L., & Swanberg, D. L. (2001). Factors Affecting Information Technology Usage: A Meta-Analysis Of The Empirical Literature. *Journal of Organizational Computing and Electronic Commerce, 11*(2), 107–130.

[30] Milis, K., & Mercken, R. (2002). Success factors regarding the implementation of ICT investment projects. *Int. J. Production Economics, 80*(1), 105–117.

[31] Mir, F. A., & Pinnington, A. H. (2014). Exploring the value of project management: Linking Project Management Performance and Project Success. *International Journal of Project Management, 32*(2), 202-217. doi: http://dx.doi.org/10.1016/j.ijproman.2013.05.012

[32] Morgan, A., Colebourne, D., & Thomas, B. (2006). The Development Of ICT Advisors For SME Businesses: An Innovative Approach. *Technovation, 26*(8), 980–987.

[33] Moriones, A. B., & Lopez, F. L. (2007). A firm-level analysis of determinants of ICT adoption in Spain. *Technovation, 27*(6), 352–366.

[34] Murphy, A., & Ledwith, A. (2007). Project Management Tools and Techniques in High-Technology SMEs. *Management Research News, 30*(2), 153-166.

[35] Mutesi, E. T., & Kyakula, M. (2011). Application of ICT in the Construction Industry in Kampala. *Second International Conference on Advances in Engineering and Technology*, 263-269.

[36] Ollo-Lopez, A., & Aramendia-Muneta, M. E. (2011). ICT impact competitiveness, innovation and environment. *Telematics and Informatics, 29*(2), 204-210.

[37] Pamulu, M. S., & Bhuta, C. (2004). *Managing Information Technology in Construction Industry: the Indonesian Experience*. Paper presented at the CIB World Building Congress 2004..

[38] Papadaki, M., Gale, A. W., Rimmer, J. R., Kirkham, R. J., Taylor, A., & Brown, M. (2014). Essential Factors that Increase the Effectiveness of Project/Programme Risk Management. *Procedia - Social and Behavioral Sciences, 119*(2014), 921-930. doi: http://dx.doi.org/10.1016/j.sbspro.2014.03.103

[39] Peansupap, V., & Walker, D. H. T. (2005). Factors Enabling Information And Communication Technology Diffusion And Actual Implementation In Construction Organisations. *Itcon, 10*(2005), 193-218.

[40] Pereira, L., Tenera, A., & Wemans, J. (2013). Insights on Individual's Risk Perception for Risk Assessment in Web-based Risk Management Tools. *Procedia Technology, 9*(2013), 886-892. doi: http://dx.doi.org/10.1016/j.protcy.2013.12.098

[41] Peterson, F., Hartmann, T., Fruchter, R., & Fischer, M. (2011). Teaching construction project management with BIM support: Experience and lessons learned. *Automation in Construction, 20*(2), 115-125. doi: http://dx.doi.org/10.1016/j.autcon.2010.09.009

[42] PMI. (2013). *A Guide to the Project Management Body of Knowledge (5th Edition)*. Newton Square, PA.: Project Management Institute.

[43] Rogers, E. M. (2003). *Diffusion of Innovations*. New York: Free Press.

[44] Salas-Morera, L., Arauzo-Azofra, A., García-Hernández, L., Palomo-Romero, J. M., & Hervás-Martínez, C. (2013). PpcProject: An educational tool for software project management. *Computers & Education, 69*(2013), 181-188. doi: http://dx.doi.org/10.1016/j.compedu.2013.07.018

[45] Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management, 25*(5), 517-526. doi: http://dx.doi.org/10.1016/j.ijproman.2006.11.007

[46] Sanjuan, A. G., & Froese, T. (2013). The Application of Project Management Standards and Success Factors to the Development of a Project Management Assessment Tool. *Procedia - Social and Behavioral Sciences, 74*(2013), 91-100. doi: http://dx.doi.org/10.1016/j.sbspro.2013.03.035

[47] Shtub, A. (1997). Project segmentation—a tool for project management. *International Journal of Project Management, 15*(1), 15-19. doi: http://dx.doi.org/10.1016/S0263-7863(96)00017-8

[48] Spalek, S. (2014). Does investment in project management pay off? *Industrial Management & Data Systems, 114*(5), 832-856.

[49] Ssewanyana, J., & Busler, M. (2007). Adoption and Usage of ICT in Developing Countries: Case of Ugandan Firms. *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 3*(3), 49-59.

[50] Stretton, A. (2007). A short history of modern project management. *PMI World Today, 9*(10), 1-18.

[51] Sukhoo, A., Barnard, A., Eloff, M. M., & Van der Poll, J. A. (2004). *A Survey Of Project Management Tools, Techniques And Methodologies Used In Mauritius: The Current Status.* Paper presented at the Global Knowledge for Project Management Professionals.

[52] Taylor, S., & Todd, P. A. (1995). Understanding Information Technology Usage: A Test of Competing Models. *Information Systems Research, 6*(2), 144-176.

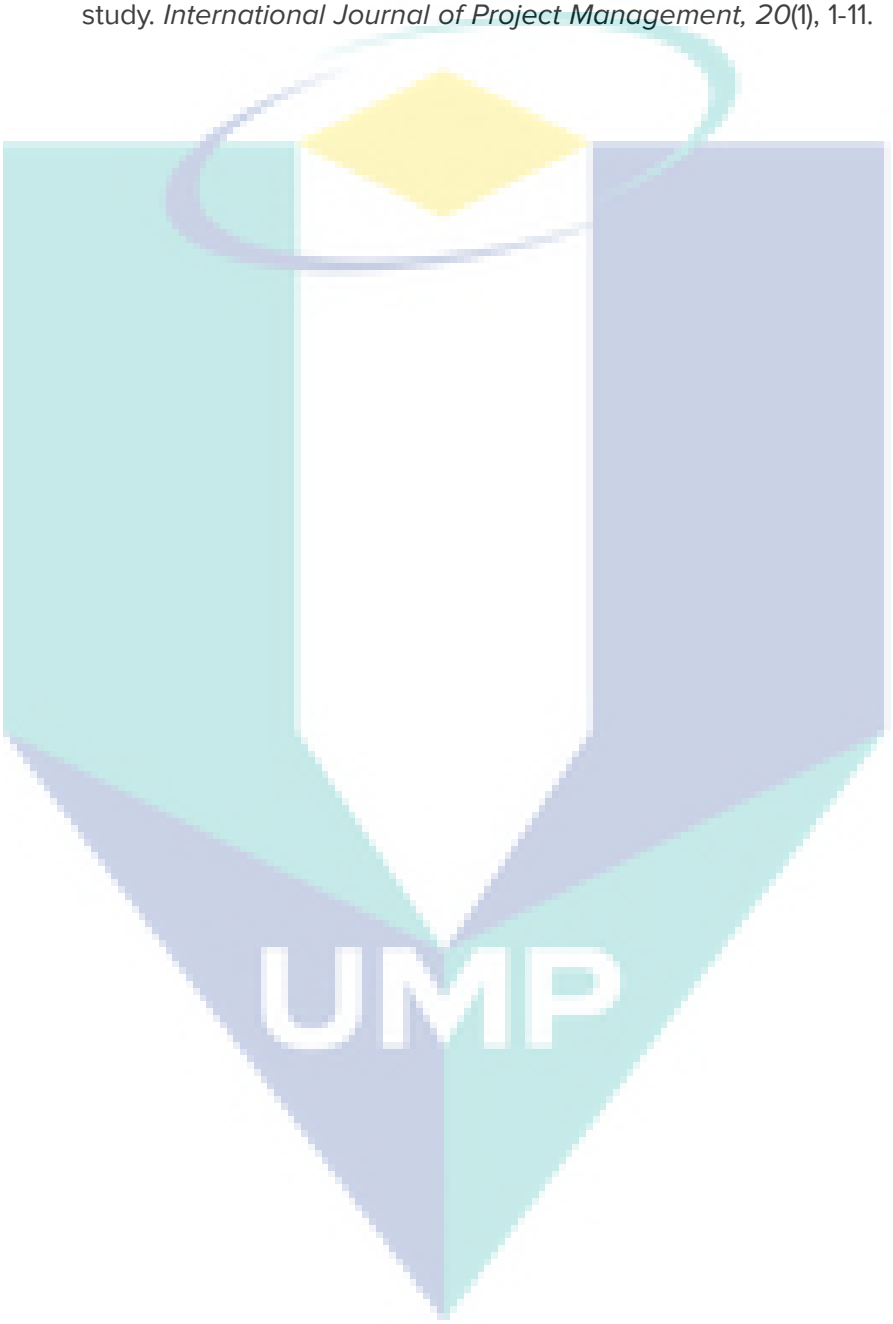
[53] Todd, P., & Benbasat, I. (1999). Evaluating the impact of DSS, cognitive effort, and incentives on strategy selection. *Information Systems Research, 10*(4), 356-374.

[54] Turner, J. R. (2008). *The Handbook of Project-Based Management*. New York: McGraw-Hill.

[55] Venkatesh, V., & Morris, M. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS Quarterly, 24*(1), 115–139.

[56] Ventakesh, V., & Bala, H. (2008). Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decision Sciences, 39*(2), 273-315.

[57] White, D., & Fortune, J. (2002). Current practice in project management-an empirical study. *International Journal of Project Management, 20*(1), 1-11.



PERBADANAN HARTA INTELEK MALAYSIA
Intellectual Property Corporation of Malaysia

Payment Slip

Application Number:	LY2019002344
Application For	CR-1: NOTIFICATION OF WORKS
Title of Work	GCPM MODULAR: GLOBAL CERTIFIED PROJECT MANAGEMENT MODULAR BASED ON RISK SIMULATOR
Type of Work	LITERARY
Filing Date:	30/04/2019
Applicant Name:	UNIVERSITI MALAYSIA PAHANG
Work Deposit Type:	Document
No of Pages	5
Copyright Work Fee (RM):	10
CR-1 Fee (RM):	15
Total (RM):	25

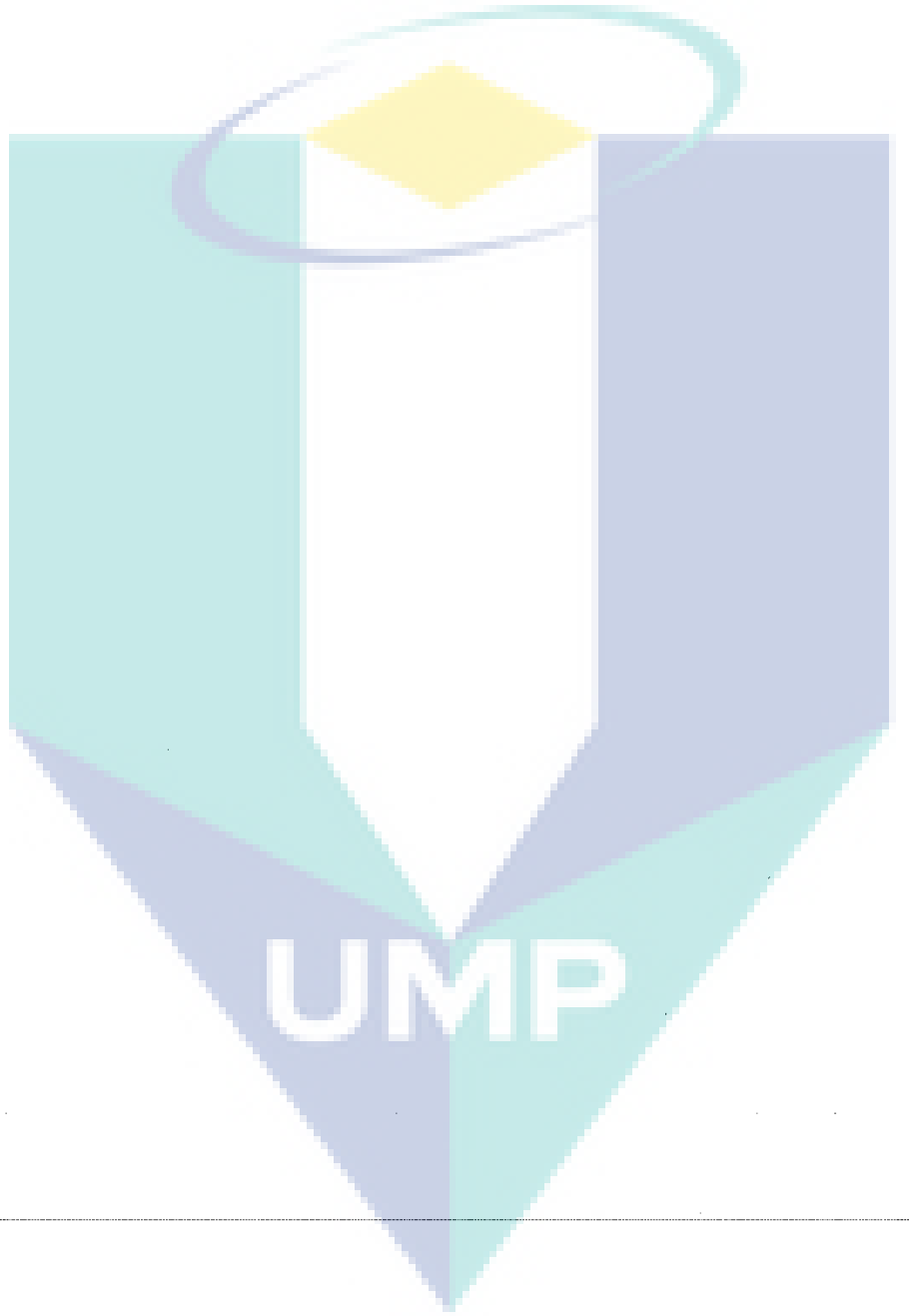
PERBADANAN HARTA INTELEK MALAYSIA * MyIPO * INTELLECTUAL PROPERTY CORPORATION OF MALAYSIA

PERBADANAN HARTA INTELEK MALAYSIA

Intellectual Property Corporation of Malaysia

Payment Slip

Application Number:	LY2018005803
Application For	CR-1: NOTIFICATION OF WORKS
Title of Work	SAFETY ASSESSMENT FOR ELECTRONIC MANUFACTURERS (SAEM)
Type of Work	LITERARY
Filing Date:	16/11/2018
Applicant Name:	UNIVERSITI MALAYSIA PAHANG
Work Deposit Type:	Document
No of Pages	11
Copyright Work Fee (RM):	10
CR-1 Fee (RM):	15
Total (RM):	25


UMP

An agency under the Ministry of Domestic Trade, Co-Operatives and Consumerism

COPYRIGHT ACT 1987
NOTIFICATION OF WORKS

[subregulation 5(2) and 5(3)]

CR - 1

Application No : LY2018005803

Applicant :

☒ Owner ☐ Author ☐ Licensee

Title of work *(Original language)* : SAFETY ASSESSMENT FOR ELECTRONIC MANUFACTURERS (SAEM)

Translation :

Transliteration :

Name of the Language *(*Language that been used in the work)* : English

If published in a periodical or serial *(Literary Work)* : (Volume / Number) (Issue Date) (On Pages)

Section A : Type of Works

☒ Literary ☐ Musical ☐ Artistic ☐ Film ☐ Sound Recording

Date of Fixation / First Published / Erected / Incorporated : 08 / 08 / 2018

Section B : Publication

The Work is : ☒ Published ☐ Unpublished

If published : 2018 (Year of Compilation) 08 / 08 / 2018 (Date of first publication) Malaysia (Country)

Section C : Author

(If author is "same as owner" go to Part D - if more than one author, please attach a list of names and addresses of all the author)

Name : LEE CHIA KUANG

National Identification No. / Passport No. : 850607-02-5281

Address 1 : FAKULTI PENGURUSAN INDUSTRI

Address 2 : UNIVERSITI MALAYSIA PAHANG

Address 3 : LEBUHRAYA TUN ABDUL RAZAK

Postcode : 26300 City : KUANTAN Nationality : MALAYSIA

State : PAHANG Country : MALAYSIA

Telephone No. : 09-5492548 E-mail : chia@ump.edu.my *Date of Death : / /

Fax No. :

☐ Please tick (✓) if Owner is same as Author

*Name :

*National Identification No. / Passport No. :

*Company Name : Universiti Malaysia Pahang

*Company Registration No. :

Address 1 : Jabatan Penyelidikan & Inovasi

Address 2 : Canseleri Tun Abdul Razak

Address 3 :

Postcode : 26600 City : Pekan Nationality :

State : Pahang Country : Malaysia

Telephone No. : 09-4245410 E-mail : Fax No. : 09-4245444

Section E : Licensee (Section D must be fill in)

*Name :

*National Identification No. / Passport No. :

*Company Name :

*Company Registration No. :

Address 1 :

Address 2 :

Address 3 :

Postcode : City : Nationality :

State : Country :

Telephone No. : E-mail : Fax No. :

Date of Agreement : ___/___/____

Period of Agreement : ___/___/____ until ___/___/____

Please provide copy of agreement(s)

Name	:	Nor Ilma binti Mustafa Kamal					
National Identification No. / Passport No.	:	821017-06-5192					
*Company Name	:	Universiti Malaysia Pahang					
*Company Registration No.	:						
Address 1	:	Jabatan Penyelidikan dan Inovasi					
Address 2	:	Canseleri Tun Abdul Razak					
Address 3	:						
Postcode	:	26600	City :	Pekan	Nationality :	Makaysia	
State	:	Pahang			Country :	Malaysia	
Telephone No.	:	09-4245406	E-mail :	norilma@ump.edu.my	Fax No. :	09-4245444	

Section G : Declaration

I hereby granted my works to be viewed by public for research and educational purpose : ☒ Yes ☐ No

☐ Author of the work

☒ Owner of the copyright in the work

☐ Licensee of copyright the work (Please provide adequate related document(s))

Signature,

(.....)

Name :

Date *(dd/mm/yy)*

NOR ILMA BINTI MUSTAFA KAMAL
Senior Assistant Registrar (Intellectual Property)
Technology Transfer Office
Department of Research & Innovation
Universiti Malaysia Pahang
26600 Pekan, Pahang Darul Makmur
Tel : 09-4245406 Faks : 09-4245444

Section H : Official Use

☑ Payment Received

Acknowledged by

(.....)

Officer's Name

Date *(dd/mm/yy)*

NUR SAIDATUL SHEILA BT TALIB
Pengarah
Cawangan Zon Timur (Kuantan)
Perbadanan Harta Intelek Malaysia (MyIPO)

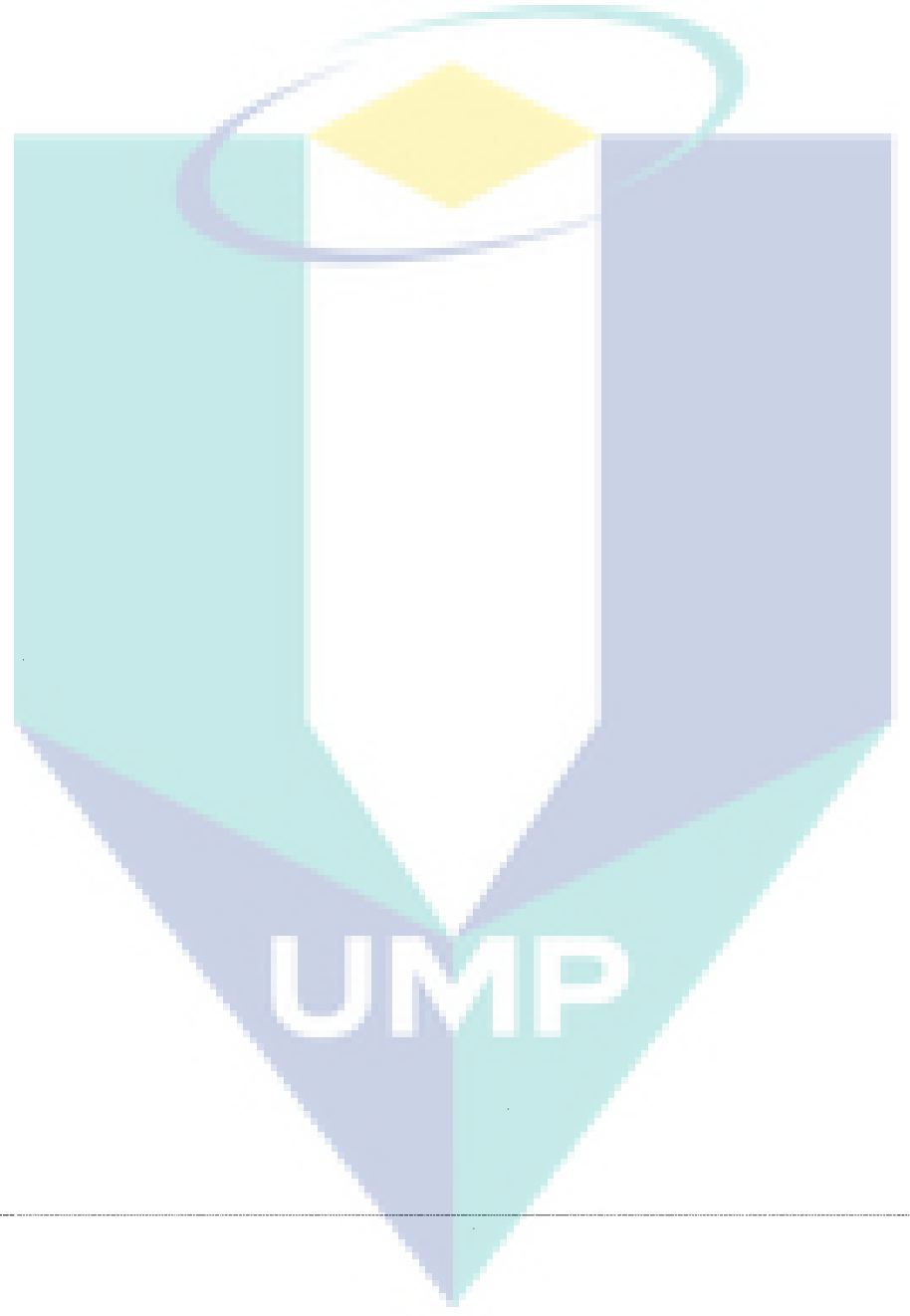
Diterima
16 NOV 2018
Cawangan Zon Timur
Perbadanan Harta
Intelek Malaysia

*Please state whichever applicable

All correspondence should be addressed to :

Copyright Division,
Intellectual Property Corporation of Malaysia (MyIPO)
Unit 1-7 & Mezzanine, Aras 12-19
Tower B, Menara UOA Bangsar,
No. 5 Jalan Bangsar Utama 1,
59000 Kuala Lumpur.

Telephone : +603 - 2299 8400
Fax : +603 - 2299 8989
Website : http://www.myipo.gov.my
E-Mail : infocopyright@myipo.gov.my


UMP

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION (CITREx)

Certificate of Award

SILVER MEDAL

This Certificate of Award is presented to

Dr. Lee Chia Kuang

For the invention entitled

Safety Assessment for Electronic Manufacturers (SAEM): Towards Zero Accidents with Riggs's OMAX.

CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION 2018
7th – 8th February 2018, Universiti Malaysia Pahang

.....

PROFESSOR DATO' DR. MASHITAH MOHD. YUSOFF
DEPUTY VICE CHANCELLOR (RESEARCH & INNOVATION)
UNIVERSITI MALAYSIA PAHANG

Certificate of Award

GOLD MEDAL

This Certificate of Award is presented to

DR. LEE CHIA KUANG

For the invention / innovation of

SAFETY ASSESSMENT FOR ELECTRONIC MANUFACTURERS (SAEM): TOWARDS ZERO ACCIDENTS WITH RIGGS'S OMAX

INTERNATIONAL FESTIVAL INNOVATION ON GREEN TECHNOLOGY (i-FINOG) 2018

20th – 22nd April 2018, Universiti Malaysia Pahang

PROFESSOR DATO' DR. YUSERRIE BIN ZAINUDDIN
Deputy Vice Chancellor (Student Affairs & Alumni)
Universiti Malaysia Pahang

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

CITREX | CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION (CITREx)

Certificate of Award

GOLD MEDAL

This Certificate of Award is presented to

Dr. Lee Chia Kuang

For the invention entitled

Certify Before Graduate:Towards CAPM and PMP with Risk Simulator

CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION 2019
12th – 13th February 2019, Universiti Malaysia Pahang

PROFESSOR TS DR. KAMAL ZUHAIRI ZAMLI
DEPUTY VICE CHANCELLOR (RESEARCH & INNOVATION)
UNIVERSITI MALAYSIA PAHANG

ITEX
INTERNATIONAL INVENTION, INNOVATION & TECHNOLOGY EXHIBITION, MALAYSIA

Certificate of Award

This is to certify that

DR. LEE CHIA KUANG

UNIVERSITI MALAYSIA PAHANG

MALAYSIA

has been awarded the

ITEX 2019 GOLD MEDAL

for the invention

GCPM MODULAR: GLOBAL CERTIFIED PROJECT MANAGEMENT MODULAR BASED ON RISK SIMULATOR

at the

30TH INTERNATIONAL INVENTION, INNOVATION & TECHNOLOGY EXHIBITION 2019

KUALA LUMPUR, MALAYSIA
2 – 4 MAY 2019

MALAYSIAN INVENTION AND DESIGN SOCIETY
MINDS

Academician Emeritus Professor
Tan Sri Datuk Dr Augustine Ong Soon Hock
President
Malaysian Invention and Design Society

SUPPORTED BY

MINISTRY OF ENERGY, SCIENCE, TECHNOLOGY, ENVIRONMENT & CLIMATE CHANGE MALAYSIA

MINISTRY OF EDUCATION MALAYSIA

IFIA INTERNATIONAL FEDERATION OF INVENTORS' ASSOCIATIONS

ENDORSED BY

MyIPO Perbadanan Harta Intelek Malaysia Intellectual Property Corporation of Malaysia

MATRADE Malaysia External Trade Development Corporation

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

ITREX 2020

Certificate of Award

GOLD

This Certificate of Award is presented to

DR. LEE CHIA KUANG

For the invention entitled

DEMAEX-SIM

CREATION, INNOVATION, TECHNOLOGY & RESEARCH EXPOSITION 2020 (STAFF CATEGORY)
12th – 13th February 2020, Universiti Malaysia Pahang

PROFESSOR Ts DR. KAMAL ZUHAIRI BIN ZAMLI
DEPUTY VICE-CHANCELLOR (RESEARCH AND INNOVATION)
UNIVERSITI MALAYSIA PAHANG