FRAMEWORK OF KNOWLEDGE MANAGEMENT EFFICIENCY IN MALAYSIAN ENGINEERING CONSULTING FIRMS

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A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy

Razak Faculty of Technology and Informatics
Universiti Teknologi Malaysia

NOVEMBER 2021

DEDICATION

To my beloved wife, Noblah Ahmad, thank you for your sacrifice, patience and support and for praying for my success. Thank you also to my children, Dr Athirah, Adilah, Mohammad Nazif and Nur Awatif for their understanding and support as well. Without them around, life itself would be bereft of joy and happiness. Thanks to my brothers and sisters, for their prayers and support and to my friends and colleagues, for their help and their sharing of thoughts and laughter. You will always be in my mind and may Allah reward you for your generosity and kindness.

ACKNOWLEDGEMENT

Alhamdulillah, praise be to Allah, the Most Beneficial and Merciful, for giving me the strength, courage and blessing until the end of challenging journey for my study. I could never have completed this thesis without the help of so many supportive people–starting with my supervisor Assoc. Prof. Ts. Ir. Dr. Syuhaida Ismail. It was a real pleasure working with her good-heartedness, great and unfailing support, encouragement, patience and for the continuous belief that this work would reach completion. Many thanks also go to my co-supervisor Dr. Khairulzan Yahya for his contribution towards this research. Last but not least thank you to all my research friends for sharing knowledge and supporting me along the journey.

ABSTRACT

The Malaysian construction industry is one of the backbones to accelerate economic growth. However, in today's competitive environment, the persistence of engineering and construction organisations depends on knowledge and innovation, which are mainly contributed by knowledge management (KM) practices. Although KM practices improve a company's performance and working efficiencies, the engineering consulting firms still lack systematic methods or reports on its implementation to create, capture, store, share, and reuse a professional's domain knowledge of products, people, and processes. Hence, the aim of the study is to develop a framework of KM practice in engineering consulting firms in the Malaysian construction industry, fulfilled through five research objectives, which are: (1) identifying the main processes of the current KM implementation; (2) determining the challenges of KM efficiency; (3) assessing the critical success factors (CSF) of KM efficiency; (4) examining the relationships of independent variables (namely processes, understanding, challenges, and CSF) and the dependent variable (namely KM efficiency) with the moderation of experience of engineers to understand KM implementation; and (5) developing a framework of KM for engineering consulting firms in the Malaysian construction industry. A literature review was performed to construct a 90-item questionnaire, which has passed the reliability of 0.700 through a pilot study involving 30 participants from the construction industry, hence 202 successful responses were collected from professional engineering consulting firms in the northern region of Peninsular Malaysia. The analysis using the Statistical Package of Social Sciences (IBM SPSS version 23) and Smart Partial Least Squares (Smart PLS version 3.2.9) software shows that: (1) the main processes of current KM are identification, capturing, dissemination, utilisation, sharing, storage, and planning; (2) the challenges of KM efficiency are technological, organisational and individual; (3) CSFs of KM efficiency are organisational, technology, and people; (4) there is a positive relationship between KM processes, understanding, challenges and CSF, and KM efficiency among professional staff working in engineering consulting firms; and (5) the framework of KM for engineering consulting firms in the Malaysian construction industry consists of independent variables of 4 constructs of KM processes, understanding, challenges, and CSF, towards the dependent variable of KM efficiency, which is moderated by experienced consulting engineers. The primary contribution of this study is the development of a framework to improve KM in engineering consulting firms, demonstrating the positive impacts of the four variables namely processes, understanding, challenges, and CSF on KM efficiencies. Moreover, it presented an evidence-based strategy to enhance the growth of consulting business, which will boost the country's economy. Likewise, key policymakers, including the Construction Industry Development Board could employ the proposed framework to equip the construction industry to realise Organisational Strategic Plan 2021-2025 by the Ministry of Works. This framework is closely aligned with the United Nations Sustainable Development Goals to meet partnership goals worldwide through a knowledge-sharing culture of expertise, technology, and financial resources, especially for developing countries like Malaysia.

ABSTRAK

Industri pembinaan Malaysia adalah salah satu tulang belakang dalam mempercepatkan pertumbuhan ekonomi. Namun, dalam persekitaran persaingan hari ini, kegigihan organisasi kejuruteraan dan pembinaan sangat bergantung kepada pengetahuan dan inovasi yang disumbangkan oleh amalan pengurusan pengetahuan (KM). Walaupun amalan KM meningkatkan prestasi syarikat dan kecekapan kerja, firma perunding kejuruteraan masih lagi kekurangan kaedah atau pelaporan sistematik mengenai pelaksanaannya untuk tujuan penciptaan, pengambilan, penyimpanan, perkongsian, dan penggunaan semula domain profesional dalam ilmu pengetahuan berkenaan produk, manusia dan proses. Justeru, kajian ini bermatlamat untuk membangunkan kerangka praktik KM dalam firma perunding kejuruteraan dalam industri pembinaan Malaysia yang dipenuhi melalui lima objektif penyelidikan, iaitu: (1) mengenal pasti proses utama pelaksanaan KM semasa; (2) menentukan cabaran kecekapan KM; (3) menilai faktor kejayaan kritikal (CSF) kecekapan KM; (4) memeriksa hubungan pemboleh ubah tak bersandar (iaitu proses, pemahaman, cabaran, dan CSF) dan pemboleh ubah bersandar (iaitu kecekapan KM) dengan moderasi pengalaman jurutera untuk memahami pelaksanaan KM; dan (5) membangunkan kerangka kerja KM untuk firma perunding kejuruteraan dalam industri pembinaan Malaysia. Tinjauan literatur dilakukan untuk membina 90 item soal selidik yang telah mencapai kebolehpercayaan 0.700 melalui kajian rintis yang melibatkan 30 responden dari industri pembinaan. Sebanyak 202 respon telah berjaya dikumpulkan dari firma perunding kejuruteraan profesional di wilayah utara Semenanjung Malaysia. Analisis menggunakan perisian *Statistical Package of Social Sciences* (IBM SPSS versi 23) dan *Smart Partial Least Squares* (Smart PLS versi 3.2.9) menunjukkan bahawa: (1) proses utama KM semasa adalah pengenalpastian, penangkapan, penyebaran, penggunaan, perkongsian, penyimpanan, dan perancangan; (2) cabaran kecekapan KM adalah teknologi, organisasi dan individu; (3) CSF kecekapan KM adalah organisasi, teknologi dan manusia; (4) adanya hubungan positif antara proses KM, pemahaman, cabaran, dan CSF, dan kecekapan KM di antara staf profesional yang bekerja di firma perunding kejuruteraan; dan (5) kerangka KM untuk firma perunding kejuruteraan dalam industri pembinaan Malaysia terdiri daripada pemboleh ubah tak bersandar dari 4 konstruk proses KM, pemahaman, cabaran, dan CSF, terhadap pemboleh ubah bersandar kecekapan KM, yang dimoderasi oleh jurutera perunding berpengalaman. Sumbangan utama kajian ini adalah pembangunan kerangka kerja untuk mempertingkatkan KM dalam firma perunding kejuruteraan yang menunjukkan impak positif ke atas empat pemboleh ubah iaitu proses, pemahaman, cabaran, dan CSF terhadap kecekapan KM. Di samping itu, ia juga membentangkan strategi berasaskan bukti untuk meningkatkan pertumbuhan perundingan perniagaan yang akan meningkatkan ekonomi negara. Pembuat dasar utama, termasuk Lembaga Pembangunan Industri Pembinaan juga boleh menggunakan kerangka kerja yang dicadangkan untuk digunakan oleh industri pembinaan ke arah pelaksanaan Pelan Strategik Organisasi 2021-2025 oleh Kementerian Kerja Raya. Kerangka ini juga sejajar dengan Matlamat Pembangunan Mampan Pertubuhan Bangsa-Bangsa Bersatu untuk memenuhi matlamat budaya perkongsian pengetahuan di seluruh dunia mengenai kepakaran, teknologi, dan sumber kewangan, terutama untuk negara-negara membangun seperti Malaysia.

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LIST OF ABBREVIATIONS

3P	-	People, profit and planet
CIDB	-	Construction Industry Development Board
CITP	-	Construction Industry Transformation Programme
CoP	-	Community of Practices
ECKM	-	Enterprise Content and KM
EKM	-	Environmental Knowledge Management
EFF	-	KM Efficiency
HTMT	-	Heterotrait-Monotrait
ISO	-	International Organisation for Standardisation
IKMN	-	International Knowledge Management Network
KT	-	Knowledge Transfer
KM	-	Knowledge Management
KPI	-	Key Performance Indicators
KIF	-	Knowledge-Intensive Firms
PMBOK	-	Project Management Body of Knowledge
PWD	-	Malaysian Public Work Department
MBO	-	Management by Objective
MoW	-	Ministry of Works
MyNDS	-	National Development Strategy of Malaysia
NEP	-	New Economic Policy
SDG	-	Sustainable Development Goals
OLS	-	Ordinary Least Squares
TBL	-	Triple Bottom Line theory
VIF	-	Variance inflation factor

LIST OF SYMBOLS

D^2	-	Mahalanobis distances
β	-	Outside brackets
χ^2	-	Critical chi-square value
d	-	Degree of freedom
f^2	-	Predictors’ effect sizes
ρc	-	Composite reliability
R^2	-	Model’s exploratory power
Q^2	-	Structural model predictive accuracy
XP	-	Working Experience

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CHAPTER 1

INTRODUCTION

1.1 Background of Research

Civil engineering consulting firms responsible for designing, executing, and monitoring construction projects are experience-driven and knowledge-intensive operations (Ding et al., 2011). Simply put, firms primarily rely on the experience and knowledge gained from past projects, which is acknowledged as a strategic and core asset for sustaining competitiveness. Additionally, Yusof et al. (2019) assert that the ability of engineering firms to exploit knowledge for innovation is a crucial problem that this industry deals with a large number of stakeholders with different levels and areas of knowledge. Moreover, Du Plessis (2007) conclusively proves that innovation is highly dependent on knowledge availability; hence, to mitigate the complexity created by straightforward reach and access of knowledge, knowledge must be appropriately recognised and managed to ensure practical innovation. Thus, innovation must incorporate the firm's unique knowledge, initiatives, and capabilities (Baro, 2008). As a result of the civil engineering firm's competitive environment and low-profit margins, knowledge management (KM) is a remarkably attractive approach for firms to continuously improve their performance (Masa'deh et al., 2015; Wu et al., 2012; Lin and Lee, 2012).

Based on the data that has been produced by the Malaysian Construction Industry Development Board (CIDB) from 2010-2017, the involvement of foreign contractor in construction has been increased in term of total value of projects which is RM223.78 billion (CIDB Malaysia, 2017). This is due to the complexity of the projects constructed and as well the need of experts in the construction industry. Furthermore, it can enhance and improve the level of efficiency and performance of KM through the implementation of KM framework.

This scenario also shows how important civil engineering firms (contractors and consultants) play the role in realising the Malaysian aspiration towards accomplishing the National Construction Policy 2030 in the construction industry. This has been proven through the statistic that the total number of projects constructed by local contractor (54,276 projects) and by foreign contractor (1143 projects) since 2010–2017.

According to Maqsoodet (2006), construction industry is a workplace that is dominated by heuristic construction companies and their staffs are more likely to carry out their project management task based on their past experiences, rather than following a textbook approach, or established logical approaches. Kim and Park (2006) asserted that management of people at construction site successfully has been a major challenge since industrialisation because construction site is a place where intensive knowledge tasks are performed with highly intellectual people. Similarly, Fong and Chu (2006) have noted that management of knowledge within the construction project setting is very essential as information and knowledge are scattered over different processes, trades, and people in different construction projects and in different organisations. This view has been convincingly presented by Fong (2021) that KM has a role in improving more collaborative behaviour among organisations and individuals that are involved in the construction processes.

KM framework thus provides the organisations with the central areas for consideration in KM efforts (Earl, 2001). The frameworks can help such organisations to approach KM methodically and consciously (Okunoye and Bertaux, 2008). Furthermore, they can help to identify a specific approach to KM, to define goals and strategies, to understand the various KM initiatives, and then to choose the best ones in the particular circumstances (Maier and Remus, 2001; Earl, 2001). Hence, in order for the organisation, especially for engineering consulting firm to achieve the KM efficiency, this study proposes factors of KM processes, KM understanding, KM challenges, and the critical success factors (CSF) of KM and its impact towards KM efficiency with the added moderator of the experience of engineers. Thus, by the implementation of KM framework, it can increase efficiency, efficiency, and adaptability of KM efforts so as to add more value to the overall performance of the organisation (Toften and Olsen, 2003). The efficiency of KM can ensure the sustainability and success of KM efforts over time (O'Dell and Grayson, 1998). In the context of civil engineering firms, the leading role of these firms, especially engineering consulting firms, is to create and apply knowledge, and their competencies are highly dependent on their capability to make specialist organisations available in order to create knowledge that matches the clients' demands (Powell and Ambrosini, 2012).

Therefore, KM is an efficient and open approach for managing and organising knowledge as a tool for the benefit of society or an individual. This knowledge could be created, stored, and transferred in order to assist individuals in making knowledgeable decisions. This KM data can be generated individually or collaboratively by a group of experts. In practice, when organisations gather their expertise, they may develop KM, from which other organisations can learn (Serrat, 2017). KM spans different disciplines because it optimises the outputs across multiple sectors by leveraging the knowledge generated among the industry or firm.

KM methods include developing, implementing, and assessing different activities that contribute to knowledge acquisition inside an organisation. KM supports innovation by promoting the adoption of attempted inventive methods; it is human-centred and uses available information to decrease complexity and ambiguity via knowledge connections and networks. Moreover, the implementation and usage of KM are to transform tacit knowledge to explicit knowledge and increase the efficiency and competencies of their resources (Saini et al., 2018; Wu et al., 2012; Lin and Lee, 2012). Tacit knowledge is concealed, difficult to explain, and is frequently assumed to be gained from experience. This category of knowledge includes contributions, responses, and more solutions from the forum. Meanwhile, explicit knowledge is clearly defined, formally and easily accessible through books, manuals, memos, or other sources. The term explicit knowledge also refers to documentation of final solutions reached in a forum as well as materials written by retired expertise (Yin et al., 2008).

Besides that, KM frameworks are critical tools in implementing KM, as they are intended to be used and reused to solve issues and problems (Lin and Lee, 2012). These KM frameworks have been used to design and create KM systems in organisations or firms in order to achieve business efficiencies. KM framework is sometimes referred to as KM strategy. Additionally, KM frameworks play a role to clinical development firms in comprehending the benefits and fundamental components of KM. The framework's components are based on established KM theories and practises (Salzano et al., 2016). However, the KM framework is not designed to be a one-size-fits-all solution. Rather than that, it is a universal, adaptable strategy that can be customised to a firm's size, business objectives, and unique knowledge requirements. Furthermore, KM efficiency is a measure that indicates how well an input is managed in relation to the criteria obtained, for example, the performance of the interaction between input and output variables of knowledge in engineering (Low, 2000). Likewise, KM efficiency is the capability to retrieve the required knowledge from the original sources. In particular, KM efficiency assesses the feasibility of achieving a higher level of performance using current knowledge and the potential to enhance the level of performance through the use of the KM framework (Serna et al., 2017).

However, a successful KM is only possible if the individuals participating in the process are effectively mentored, committed, and motivated throughout the process (Natalicchio et al., 2017; Bavik et al., 2018). The majority of research concluded that KM is a critical approach that substantially affects organisational benefits, including innovation, organisational performance, and competitive advantages (Deepak, Mahesh and Medi, 2019). Dzenopoljac et al. (2018) state that excellent KM encourages an organisation's human resources to talk about their experiences, which assists in the conversion of tacit knowledge into explicit knowledge needed for KM success. Nazim and Mukherjee (2016) demonstrate how tools such as information management systems, document management systems, search and indexing systems, communication and collaboration systems, expert systems, and educational asset management systems optimise the KM processes, which are knowledge creation, transferring, and implementation. In the context of civil engineering firms, the leading role of these firms especially engineering consulting firms is to create and apply knowledge, and their competencies are highly dependent on their capability to make specialist organisations available in order to create knowledge that matches the clients' demands (Powell and Ambrosini, 2012). Thus, consulting firms are considered a suitable context for investigating the impacts of KM on innovation, as knowledge and technical innovation have developed into critical success elements (Alenezi et al., 2015).

1.2 Problem Statement

In today's competitive environment, engineering consulting firms are highly dependent on knowledge and innovation to survive (Grill and Nielsen, 2019). According to Crane and Bontis (2014), one of the primary core competencies of engineering consulting firms is to offer their clients the most current and up-to-date advice and utilise information obtained from theoretical and practical sources. In another sense, engineering consulting firms need a variety of strategies in order to sustain organisational capabilities for potential project appointments. Despite that, the majority of knowledge assets are preserved mentally in the minds of experienced engineers or in massive amounts of documentation (Tseng, 2014). Typically, information has been gathered through the reading of papers or oral interactions between professionals. However, knowledge loss is caused by senior engineers' resignations might result in a loss of competitive edge (Lin and Lee, 2012; Ding et al., 2011). Furthermore, segmentation and decentralisation of project organisations, as well as the insufficient supporting environment, may hinder knowledge sharing even more (Ni et al., 2018). Hence, it becomes necessary to enhance engineer productivity and minimise the impact of employee attrition.

Therefore, knowledge management (KM) techniques may be regarded as enhancing the experience and competence of human resources, which are critical for productivity growth in engineering consultation firms (Abdul-Rahman et al., 2006). Although it has been practised for over a half-century, existing consulting firms still lack any systematic methods or reports on its implementation for the creation, acquisition, sharing, and reusing of a consultant's knowledge of products, people, and processes (Snyman and Smallwood, 2017; Abu Bakar et al., 2016). Currently, most research efforts worldwide focus on KM techniques (Carrillo et al., 2013; Abdul-Rahman et al., 2008; Tan et al., 2007), but little is known about the state of KM techniques, particularly in Malaysia.

Based on the data created by CIDB (2020), the purpose of KM can deliver high values to the local organisations. A comprehensive study of the Malaysian KM practices is necessary to assure the strategic strength of knowledge and its exploitation (Yu, 2003). In addition, Malaysia is still far behind in terms of KM usage. According to (Goh, 2002), the primary challenge faced by organisations in Malaysia is changing the employees' practice on KM since organisation in Malaysia tend to be highly bureaucratic and have a centralised decision-making structure with lower levels of KM applications (Baharuddin et al., 2016). While some firms claim to start applying knowledge sharing, their practices are mostly centred on conventional information communication methods, including face-to-face meetings, notice boards, and bulletin boards (Salleh and Ahmad, 2006). Public Works Department (PWD), the country's central authority for works, has prompted the adoption of KM in the organisation known as the Enterprise Content Knowledge Management (ECKM) programme promote the culture among employees to share their knowledge based on their experience handling projects (JKR, 2018). However, their effort is still facing particular implementation challenges, and some adaptations in engineering consulting firms are still needed (Ozturk and Yitmen, 2019). Numerous factors impact the adoption of KM approaches in Malaysia. The majority of challenges are recognised as internal human-centred, such as people issues, semantic barriers, and cultural differences (Yap and Lock, 2017). Additionally, Goh (2002) said that the primary issue confronting Malaysian firms is transforming staff behaviour and practices. Malaysian organisations are notoriously bureaucratic, with a centralised decision-making process and inadequate levels of KM tools and systems in place (Baharuddin et al., 2016). Comparatively, understanding KM in the Malaysian context is challenging due to the lack of published research on the topic. Therefore, it is a need to assess KM efficiency in order to develop effective techniques for leveraging the benefits of KM in optimising both project and firm performance. Coleman (1999) mentions that KM provides a number of independent variables, including knowledge creation, evaluation, transportation, distribution, and sharing. Nevertheless, far too little attention has been paid to the relationship between the main processes, the understanding, the major challenges and the critical success factors (CSF) of current KM efficiency. Therefore, this study intends to investigate the relationship between KM variables and develop a framework development in order to improve KM efficiency in the Malaysian engineering consulting firms.

1.3 Research Questions

Based on the problem statements highlighted, the main research questions of this study are:

i. What are the main processes of current knowledge management (KM) implementation by engineering consulting firms in the Malaysian construction industry?
ii. What are the main challenges of the KM implementation by the engineering consulting firms in the Malaysian construction industry?
iii. What are the critical success factors (CSF) of KM implementation by the engineering consulting firms in the Malaysian construction industry?
iv. How much is the understanding of KM implementation by engineering consulting firms in the Malaysian construction industry?
v. How to achieve the KM efficiency for engineering consulting firms in the Malaysian construction industry?

1.4 Aim and Objectives

This study aims to develop a framework of knowledge management (KM) efficiency for engineering consulting firms in the Malaysian construction industry. In achieving the aim, five research objectives of the current study in line with the aforementioned research questions are described as follows:

i. To identify the main processes of current KM efficiency by the engineering consulting firms in the Malaysian construction industry.
ii. To determine the challenges of KM efficiency by engineering consulting firms in the Malaysian construction industry as a potential variable.
iii. To assess the critical success factors (CSF) of KM efficiency by the engineering consulting firms in the Malaysian construction industry.
iv. To examine the relationships of independent variables (namely processes, understanding, challenges and critical success factors) and the dependent variable (namely KM efficiency) with the moderation of experience of engineers, in order to understand KM implementation by engineering consulting firms in the Malaysian construction industry.
v. To develop a framework of KM efficiency based on the assessment of engineers' experience towards KM process, KM understanding, KM challenges and KM CSF for engineering consulting firms in the Malaysian construction industry.

1.5 Scope of Research

Fundamentally, this study covers the scope of knowledge management (KM) from the perspective of civil engineering firms, specifically centred on project management in the construction field, as limited reports on its implementation in the civil engineering firms are observed. Furthermore, the scope examines the relationship between KM processes, KM understanding, KM challenges, and KM critical success factors (CSF) to enhance the KM efficiency.

This study variables include all the civil and structural (C&S) engineering consulting firms located in the northern region of Peninsula Malaysia. The study settings were chosen primarily due to the lack of expertise, inadequate resources, strategic planning and vision, standard and quality control, and poor productivity in their employees as reported by SME Corporation Malaysia (2013). The study in this area is still limited as compared to the central region. This study also looks at the organisation, namely C&S engineering consulting firms, where the workers, including engineers, designers, project managers, and other relevant technical staff with at least three years of experience but not necessarily to be professional engineers. These engineering consulting firms could be limited, public limited, partnership, or sole proprietary in nature.

1.6 Contribution of Research

In presenting the contribution of this study, the emphasis focuses on the development and analyses relating to the knowledge management (KM) efficiency in the engineering consulting firms, specifically in the Malaysian construction industry. Furthermore, the contribution is categorised into two substantial aspects: the contribution to the body of knowledge and the practical contribution to the management of engineering consulting firms.

In order to reach the theoretical contribution, this study is able to identify a set of challenges faced by the consulting firm in Malaysian construction industry. These challenges have been used as one of the variables that affect the KM efficiency. From the literature review, it is expected to produce such variables having a relationship towards the KM implementation in the Malaysian construction industry. The cause and effect of these variables will lead to achieving the effective performance and efficiency in the implementation of KM. By examination of the effects through relationships between all the variables, it is expected to give a positive direct and significant relationship towards KM efficiency and hence, the development of framework will be produced in the engineering consulting firm in Malaysian construction industry.

From the perspective of the body of knowledge, a theoretical framework has been developed related to the performance measures of KM efficiency in the engineering consultancies to increase the understanding of the construction-related literature. The framework includes four independent variables or factors: KM processes, KM understanding, KM challenges, and KM critical success factors (CSF), with KM efficiency serving as the dependent variable. The framework development has also contributed to the positive effects of each factor towards KM efficiency during its implementation.

From a managerial or practical viewpoint, the developed framework and its positive impacts or interactions could be employed to assist in effective decision-making critical for developing more efficient engineering consulting firms. Besides, the study findings have offered an evidence-based solution to promote the development of the civil and structural (C&S) engineering consulting industry, especially in the northern region of Malaysia, thereby supporting the national economy by serving as a reference guide for the construction consultant industry, as outlined in the Ministry of Works (MoW) Organisational Strategic Plan 2021-2025. The MoW's Organisational Strategic Plan 2021-2025 aims to strengthen the construction industry to level with other Malaysian economic sectors, with this study focused on matching the development of firms in the northern region on par with the firms in the central region of Malaysia. It is built on four pillars that serve as the foundation for the construction industry's efforts to revive the Malaysian economy in pursuit of the Shared Prosperity Vision 2030 (SPV203) (Ministry of Works, 2021). The Organisational Strategic Plan 2021-2025 will implement a wide range of programs, initiatives, and activities as part of a national collaborative effort to ensure the continued growth and success of the Malaysian construction industry so that the construction sector would expand substantially in response to increasing demands for construction and competitive marketplace.

As the study focused on human-related factors, the optimistic outcomes could be helpful for policymakers and stakeholders like the Construction Industry Development Board (CIDB) to provide relevant guidelines and best practices for improving knowledge, technologies, and design in both public and private sectors of the construction industry. The developed framework complements the overall goals of creating a strategic knowledge-based asset through systematic knowledge sharing and organizational leadership. This study would also contribute to the United Nations' Sustainable Development Goals (SDGs) for 2030 (Abugri, 2020) aimed at supporting partnerships by sharing experience and strategy resources among partnerships in both public and private sectors (Javed, 2017). In this sense, the partnership is referred to the shared knowledge, expertise, technology and financial resources among multi-stakeholders (Haywood et al., 2019). All these partnership efforts are expected to support the achievement of the SDGs in all countries.

1.7 Structure of Thesis

This thesis consists of five chapters. Chapter 1 presents the research background with objectives and research questions. The research background provides an overview of the knowledge management (KM) in engineering consulting firms in the Malaysian construction industry. Additionally, this chapter also presents the scope and contribution of the study.

Chapter 2 reviews the theoretical basis of KM. Initially, this chapter discussed the outlines of the nature of KM. It also highlights the implementation of KM by engineering consulting firms in the construction industry. Coherently, this chapter discussed the background information that relates to the subject matter based on the perspective of engineering consulting firms operating within the Malaysian construction industry. It then continued to address the KM implementation, which is the central part of this study. This chapter also investigated the critical success factors (CSF), which encouraged the successful KM implementation in the construction industry. Lastly, this chapter suggests the conceptual framework of KM for engineering consulting firms in the Malaysian construction industry that can be used as a fundamental to develop the practical framework as aimed in this study.

Chapter 3 described details of the research framework developed based on the existing literature reviews, notably the elements used in the KM. It presents the methodology processes and activities along with some relevant justifications towards achieving the proposed KM framework with respect to the management of engineering consulting firms in the Malaysian construction industry. The emphasis includes data collection, questionnaire measurement design, measurement scales, questionnaire administration, semi-structured interview questions for pilot and actual studies and data analysis techniques. The methods of quantitative analysis are also discussed.

Chapter 4 starts with the analysis of the data collected. Various statistical analyses were carried out on data obtained from the pilot study and surveys. This chapter has further elaborated on the discussions, which relates to several assessment models that need to be clarified before specific analysis can be done, fulfilling the requirements for the development of the proposed hypotheses. The interaction effects of independent variables to dependent variables were discussed comprehensively. Furthermore, the moderating effect analysis and the hypothesis testing results were also discussed, which finally established the KM factors and KM efficiency relationship. Lastly, the practical framework of KM efficiency has been developed and validated for the consulting engineering firms based on the results and findings obtained from the analysis.

Chapter 5 presents the conclusion of the study reported in this thesis. A summary of the findings and successful accomplishment of the research objectives are highlighted. Specific contributions of the research are also emphasised. Some limitations to the work and recommendations for future studies are presented in the final part of this chapter.

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Appendix A Appropriate Sample Size for Partial Least Squares-Structural Equation Modelling (PLS-SEM) Analysis

Exhibit 1.7 Sample Size Recommendation a in PLS-SEM for a Statistical Power of 80%

Maximum Number of Arrows Pointing at a Construct	*Significance Level*											
	1%				*5%*				*10%*			
	Minimum R^2				*Minimum* R^2				*Minimum* R^2			
	0.10	*0.25*	*0.50*	*0.75*	*0.10*	*0.25*	*0.50*	*0.75*	*0.10*	*0.25*	*0.50*	*0.75*
2	158	75	47	38	110	52	33	26	88	41	26	21
3	176	84	53	42	124	59	38	30	100	48	30	25
4	191	91	58	46	137	65	42	33	111	53	34	27
5	205	98	62	50	147	70	45	36	120	58	37	30
6	217	103	66	53	157	75	48	39	128	62	40	32
7	228	109	69	56	166	80	51	41	136	66	42	35
8	238	114	73	59	174	84	54	44	143	69	45	37
9	247	119	76	62	181	88	57	46	150	73	47	39
10	256	123	79	64	189	91	59	48	156	76	49	41

Source: Cohen, J. A power primer. *Psychological Bulletin*, 112, 155–519.

Appendix B Questionnaire Survey

QUESTIONNAIRE SURVEY:

FRAMEWORK OF KNOWLEDGE MANAGEMENT PRACTICE FOR MALAYSIAN ENGINEERING CONSULTANT FIRM IN CONSTRUCTION INDUSTRY

Dear Sir/Madam,

I am Azlan Bin Othman, a student from Universiti Teknologi Malaysia, Kuala Lumpur. Currently I am a second year of my postgraduate studies pursuing my PhD. As part of my PhD programme, I am conducting a study on "Framework of Knowledge Management Practice for Malaysian Engineering Consultant Firm in Construction Industry".

The overview and purpose of this survey is attached to provide an understanding of the research. Consequently, in making this survey a fruitful exercise, I wish to seek your cooperation and support by kindly inviting your esteemed organisation to take part in this study.

I would be very grateful if you could kindly complete the attached questionnaires and return to the address by 30 November 2016. Furthermore, if a softcopy version of the survey is required by your organisation, kindly please email to irazlan@gmail.com

All information received will be treated in the strictly confidential and anonymity of firms and respondents will be ensured. The information provided by the organisation will be used strictly for this research purpose only.

Finally, I would sincerely like to thank you for your cooperation and your support as well as your kind interest in this survey participation.

Yours faithfully,

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Knowledge management (KM) is a system of capturing, managing and disseminating information, database, best practices and lesson learns in a company or organisation. This study is conducted to comprehend how knowledge management is applied in a consultant firms engaged in construction industry in Malaysia, as well as to understand what are the associated challenges and critical success factors (CSF) in knowledge management implementation. To achieve these objectives, the questionnaires below are developed to obtain the response from respondents who are employed to/running these consultant firms.

QUESTIONNAIRES

These questionnaires are divided into **6 sections** as follows:

Section A: to obtain the respondents' particulars and the company/organisation background

Section B: to identify the effect of the processes of current knowledge management (KM) practices in the Malaysian engineering consulting firms in the construction industry

Section C: to investigate the effect of the understanding on knowledge management (KM) practices Malaysian engineering consulting firm in the construction industry.

Section D: to examine the effect of challenges related to knowledge management (KM) implementation in the engineering consulting firms Malaysian construction industry.

Section E: to assess the effect of critical success factors (CSF) on knowledge management (KM) implementation in the engineering consulting firms in Malaysian construction industry.

Section F: to examine the effect of the efficiency on knowledge management (KM) implementation in engineering consulting firms of the Malaysian construction industry

SECTION A: RESPONDENTS' PARTICULAR AND COMPANY/ ORGANISATION BACKGROUND

Please TICK [/] the most appropriate answer

A1. What is your current position in your company/organisation?

[ ] Managing Director/Director/Principal
[ ] Senior Engineer
[ ] Junior Engineer
[ ] Others (Please specify: ____)

A2. How many years of working experience do you have?

[ ] 20 years and above
[ ] 10-19 years
[ ] 5-9 years
[ ] Less than 5 years

A3. What is your highest level of academic qualification?

[ ] Phd
[ ] Master
[ ] Bachelor Degree
[ ] Others (Please specify: ____)

A4. Registration as Professional Engineer?

[ ] Yes (Please specify………………………………………..
[ ] No

A5. What is the ownership / shareholding of the company/organisation?

[ ] Public Listed
[ ] Limited Company
[ ] Partnership
[ ] Sole Proprietor
[ ] Others (Please specify: ____)

A6. What is the company size by number of staff?

[ ] Large Consultant Firm (>50 staff)
[ ] Medium Consultant Firm (10 - 50 staff)
[ ] Small Consultant Firm (< 10 staff)

SECTION B: PROCESSES OF KNOWLEDGE MANAGEMENT (KM) PRACTICES IN THE CONSULTANT FIRMS

Please rate the extend of KM processes implemented in your company/ organisation?

Please TICK [/] the most appropriate answer:
5 = Strongly Agree
4 = Agree
3 = Not Applicable/Not Sure
2 = Disagree
1 = Strongly Disagree

No	Knowledge Management Process Elements	1	2	3	4	5
1	**Identification**					
B.1	Knowledge assets (information, skills) is identifiable					
B.2	Identification of the different types of knowledge (tacit, explicit) available in the organisation					
B.3	Core values and competencies identified in the organisation					
B.4	Opportunities for innovation identified to create competitive advantage.					
2	**Capture**					
B.5	Knowledge and information is captured in minutes of meetings					
B.6	Knowledge and information is captured in seminars					
B.7	Knowledge and information is captured in presentation sessions					
3	**Dissemination**					
B.8	Knowledge dissemination is encouraged through workshop					
B.9	Knowledge dissemination is encouraged through meetings					
B.10	Documents are disseminated to authorised employees					
4	**Utilisation**					
B.11	Best practices from previous project have been utilised in the new projects					
B.12	Lesson learnt from previous project will be utilised in the future projects.					
B.13	New knowledge utilised by team members in the company/organisation.					
5	**Sharing**					
B.14	Knowledge sharing (best practices/lesson learnt) is encouraged through meetings					

B.15	Knowledge sharing (best practices/lesson learnt) is encouraged through presentations					
B.16	Knowledge sharing (best practices/lesson learnt) is encouraged through publications					
B.17	Knowledge is shared among peers					
6	**Storage**					
B.18	Documents and reports properly stored in a softcopy database system					
B.19	Documents and reports stored in hardcopy in the library					
B.20	Physical storage uses established records management or archival practices, with adequate shelving durable boxes, folders, labelling and etc.					
B.21	The repository for electronic resources has adequate capacity for long-term storage					
B.22	The repository for electronic resources is backed up routinely, based on established and enforced procedures and protocols.					
B.23	The location of stored resources, physical and electronic, is reasonably convenient and accessible.					
B.24	Documents securely stored and protected.					
7	**Strategising**					
B.25	KM process has been well strategised by the company/organisation					
B.26	Strategic knowledge well protected					
B.27	Training of workers required to meet the strategic objectives in the organisation					
B.28	Employees well understood and aware of KM strategies in the organisation					
B.29	Relevant knowledge assets created in the organisation					

SECTION C: UNDERSTANDING OF KNOWLEDGE MANAGEMENT (KM) AMONGST PRACTITIONERS IN THE MALAYSIAN CONSTRUCTION CONSULTANT FIRMS

How well do you understand the importance of knowledge management (KM)?

Please TICK [/] the most appropriate answer:

5 = Strongly Agree

4 = Agree

3 = Not Applicable/Not Sure

2 = Disagree

1 = Strongly Disagree

No	Measure of Understanding the Importance of Knowledge Management (KM)	1	2	3	4	5
1	**Attitude**					
C.1	Information and knowledge are confidential and therefore need to be kept safely in personal storage drive					
C.2	KM processes are very time consuming					
2	**Ignorance**					
C.3	Most companies perceive KM as non-beneficial					
C.4	Due to ignorance, organisation fail to appreciate the impact of KM					
C.5	KM exist in most business entities					
C.6	Business required KM-based KPI					
C.7	Shareholders and employees required KM-based KPI					
3	**Motivation**					
C.8	KM enhances performance of employees					
C.9	KM boosts motivation among workers					
C.10	KM facilitate proper decision making					
4	**Benefit**					
C.11	KM enables a competitive business environment					
C.12	KM increases revenue and overall productivity					
5	**Need**					
C.13	Training on KM is important					
C.14	Coaching on KM is necessary					

Please share your thought on how beneficial KM is and how it can be applied to your company/organisation:

____

____

____

____

SECTION D: CHALLENGES IN KNOWLEDGE MANAGEMENT (KM) IMPLEMENTATION

How do you rank the challenges in knowledge management (KM) implementation in your company/organisation.

Please TICK [/] the most appropriate answer:

5 = Strongly Agree

4 = Agree

3 = Not Applicable/Not Sure

2 = Disagree

1 = Strongly Disagree

No	**Challenges of Knowledge Management (KM)**	**1**	**2**	**3**	**4**	**5**
1	**Organisational Challenges**					
D.1	No sharing culture					
D.2	Difficult to implement					
D.3	Lack of social network					
D.4	Differences in culture					
D.5	Lack of interaction					
D.6	Fear of minimal recognition					
2	**Individual Challenges**					
D.7	Difficulty to capture knowledge during informal discussions					
D.8	KM is not well understood					
D.9	Lack of communication skills					
D.10	Lack of time					
D.11	Lack of trust					
D.12	Lack of motivation					
D.13	Lack of awareness of the benefit of knowledge sharing					
D.14	Fear of causing internal conflicts					
3	**Technological Challenges**					
D.15	Technological limitations					
D.16	Document contents are difficult to understand					
D.17	Fear of knowledge insecurity					
D.18	Keeping data accurate and relevant					
D.19	Difficult to determine where KM belongs to (HR/IT/etc)					

Please share your thought on the biggest challenge to apply KM to your company/organisation:

SECTION E: CRITICAL SUCCESS FACTORS (CSF) OF KNOWLEDGE MANAGEMENT (KM) IMPLEMENTATION

How important are these elements towards the success of knowledge management (KM) implementation?

Please TICK [/] the most appropriate answer:

5 = Strongly Agree

4 = Agree

3 = Not Applicable/Not Sure

2 = Disagree

1 = Strongly Disagree

No	**Critical Success Factors (CSF) in Knowledge Management (KM) Implementation**	**1**	**2**	**3**	**4**	**5**
1	**Organisational**					
E.1	Continuous organisation support					
E.2	Strategic plan					
E.3	Knowledge and sharing culture					
E.4	Human capital development					
E.5	Financial capability					
E.6	Strengthened business imperative					
E.7	Human capital management					
E.8	Marketing					
E.9	Market dynamics for instance, competition, markets, time, pressure, governmental and economic climates					
E.10	Benchmarking KM system nationwide					
2	**Technology**					
E.11	Technology					
E.12	Infrastructure					
E.13	Precision of KM processes					
E.14	Quality control and assurance					
E.15	KM measurement with respect to KPI					

3	**People**					
E.16	Detailed strategy on knowledge management process					
E.17	Leadership competence by the executive					
E.18	Continuous learning					
E.19	Training of staff should be made compulsory					
E.20	Elimination of constraints that defer knowledge management implementation					
E.21	Accurate knowledge management processes					

Please share your thought on critical factors for a successful KM implementation in your company/organisation:

____

____

____

____

SECTION F: KNOWLEDGE MANAGEMENT (KM) EFFICIENCY

How efficient are these elements towards the knowledge management (KM) implementation?

Please TICK [/] the most appropriate answer:

1 = Not Important

2 = Less Important

3 = Not Sure

4 = Important

5 = Very Important

No	KM Efficiency	1	2	3	4	5
1	**Planet**					
F.1	Pollution prevention - KM practices which aim to reduce waste and emission at a cost-efficient price					
F.2	Environment management - A systematic approach in an organisation to improve environmental awareness among employees through environmental decision making					
2	**People**					
F.3	Equal opportunity - Fair and tolerant KM practices in relation to following guidelines in managing diversity in an organisation and equivalent access towards learning resources and tools					
F.4	Career - Profession advancement opportunities for knowledgeable and skilled employees					
3	**Profit**					
F.5	Growth - Comprehensive and strategic approach in managing knowledge in an organisation towards performance projection					
F.6	Profit - Utilisation of knowledge and intellectual resources/tools in yielding innovation process in order to identify any entrepreneurial opportunities.					

F.7	Cost saving - A systematic approach of KM in managing in and out cash flow through its efficiency in reducing employee turnover and production of innovative product/service/ideas					

Please share your thought to improve KM efficiency implementation in your company/organisation:

____

____

____

____

- END OF QUESTION -

THANK YOU FOR TAKING YOUR PRECIOUS TIME TO FILL THE QUESTIONNAIRE AND YOUR CO-OPERATION IS REALLY APPRECIATED.

Appendix C Statistical Package of Social Sciences (SPSS) Output: Missing Values

PI1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	6	3.0	3.0	3.0
	3	69	34.2	34.3	37.3
	4	99	49.0	49.3	86.6
	5	27	13.4	13.4	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

PT2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	.5	.5	.5
	2	9	4.5	4.5	5.0
	3	50	24.8	24.9	29.9
	4	103	51.0	51.2	81.1
	5	38	18.8	18.9	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

PT5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	.5	.5	.5
	2	4	2.0	2.0	2.6
	3	48	23.8	24.5	27.0
	4	108	53.5	55.1	82.1
	5	35	17.3	17.9	100.0
	Total	196	97.0	100.0	
Missing	System	6	3.0		
Total		202	100.0		

PR5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	.5	.5	.5
	2	8	4.0	4.0	4.5
	3	39	19.3	19.4	23.9
	4	101	50.0	50.2	74.1
	5	52	25.7	25.9	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

UA1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	7	3.5	3.5	3.5
	3	41	20.3	20.4	23.9
	4	92	45.5	45.8	69.7
	5	61	30.2	30.3	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

UI3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	2.0	2.0	2.0
	2	16	7.9	8.0	10.0
	3	70	34.7	34.8	44.8
	4	61	30.2	30.3	75.1
	5	50	24.8	24.9	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

UM1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	10	5.0	5.0	5.0
	3	48	23.8	23.9	28.9
	4	102	50.5	50.7	79.6
	5	41	20.3	20.4	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

UM3

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	10	5.0	5.0	5.0
	3	42	20.8	20.9	25.9
	4	91	45.0	45.3	71.1
	5	58	28.7	28.9	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

UB2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	9	4.5	4.5	4.5
	2	35	17.3	17.4	21.9
	3	64	31.7	31.8	53.7
	4	55	27.2	27.4	81.1
	5	38	18.8	18.9	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

EE1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	.5	.5	.5
	2	9	4.5	4.5	5.0
	3	56	27.7	27.9	32.8
	4	116	57.4	57.7	90.5
	5	19	9.4	9.5	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

EP1

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	21	10.4	10.4	10.4
	2	20	9.9	10.0	20.4
	3	58	28.7	28.9	49.3
	4	79	39.1	39.3	88.6
	5	23	11.4	11.4	100.0
	Total	201	99.5	100.0	
Missing	System	1	.5		
Total		202	100.0		

Result Variables

	Result Variable	N of Replaced Missing Values	Case Number of Non-Missing Values		N of Valid Cases	Creating Function
			First	Last		
1	PI1	1	1	202	202	SMEAN(PI1)
2	PT2	1	1	202	202	SMEAN(PT2)
3	PT5	6	1	202	202	SMEAN(PT5)
4	PR5	1	1	202	202	SMEAN(PR5)
5	UA1	1	1	202	202	SMEAN(UA1)
6	UI3	1	1	202	202	SMEAN(UI3)
7	UM1	1	1	202	202	SMEAN(UM1)
8	UM3	1	1	202	202	SMEAN(UM3)
9	UB2	1	1	202	202	SMEAN(UB2)
10	EE1	1	1	202	202	SMEAN(EE1)
11	EP1	1	1	202	202	SMEAN(EP1)

Appendix D Chi-Square Table

Critical values of the Chi-square distribution with *d* degrees of freedom

Probability of exceeding the critical value

d	0.05	0.01	0.001	*d*	0.05	0.01	0.001
1	3.841	6.635	10.828	11	19.675	24.725	31.264
2	5.991	9.210	13.816	12	21.026	26.217	32.910
3	7.815	11.345	16.266	13	22.362	27.688	34.528
4	9.488	13.277	18.467	14	23.685	29.141	36.123
5	11.070	15.086	20.515	15	24.996	30.578	37.697
6	12.592	16.812	22.458	16	26.296	32.000	39.252
7	14.067	18.475	24.322	17	27.587	33.409	40.790
8	15.507	20.090	26.125	18	28.869	34.805	42.312
9	16.919	21.666	27.877	19	30.144	36.191	43.820
10	18.307	23.209	29.588	20	31.410	37.566	45.315

***INTRODUCTION TO POPULATION GENETICS*, Table D.1**

Appendix E Data Normality Test from WebPower

New Analysis Login Register

ENHANCED BY Google

WebPower

Statistical power analysis online

Navigation

- WebPower
- Ask Power
- My Analyses
- New Analysis
- Tools
- Manual
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- What's new
- Workshop
- FAQ

Output of skewness and kurtosis calculation

```
Sample size:  198
Number of variables:  27

Univariate skewness and kurtosis
        Skewness   SE_skew    Kurtosis   SE_kurt
EFF -0.246291897 0.1727781 -0.55832257 0.3438849
PRO  0.156490182 0.1727781  0.31194580 0.3438849
UDS  0.413316988 0.1727781 -0.63430383 0.3438849
CSF -0.661937247 0.1727781  0.83833649 0.3438849
CLG -0.615271688 0.1727781 -0.07991400 0.3438849
XP   0.021466399 0.1727781 -1.41507963 0.3438849
CI  -0.447403735 0.1727781  0.12613990 0.3438849
CO  -0.302837424 0.1727781 -0.51593918 0.3438849
CT  -0.539999647 0.1727781  0.26474544 0.3438849
EE  -0.486413357 0.1727781  0.61420763 0.3438849
EP  -0.329111604 0.1727781 -0.54929402 0.3438849
ES  -0.549489919 0.1727781 -0.35933781 0.3438849
FO  -0.468107694 0.1727781  0.51365407 0.3438849
FP  -0.394565190 0.1727781  0.28525785 0.3438849
FT  -0.113765995 0.1727781 -0.37142270 0.3438849
PC  -0.222843974 0.1727781 -0.45780317 0.3438849
PD   0.295791192 0.1727781 -0.28956630 0.3438849
PH   0.008277109 0.1727781 -0.51037763 0.3438849
PI   0.138776672 0.1727781 -0.04522762 0.3438849
PR  -0.405053638 0.1727781  0.16933876 0.3438849
PT   0.011941306 0.1727781  0.57908623 0.3438849
PU  -0.273560385 0.1727781  0.36077480 0.3438849
UA  -0.309873285 0.1727781 -0.57884256 0.3438849
UB  -0.121319607 0.1727781 -0.55014463 0.3438849
UI   0.180680590 0.1727781 -1.11363648 0.3438849
UM  -0.301530279 0.1727781  0.01515664 0.3438849
UN  -0.111064326 0.1727781 -0.71499080 0.3438849
Mardia's multivariate skewness and kurtosis
                b          z p-value
Skewness 206.3363 6809.09768       0
Kurtosis 887.2324   18.53145       0
```

Last modified: April 18 2019 13:22:04.

Appendix F Statistical Package of Social Sciences (SPSS) Output: Demographic of Respondents

Position

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Managing Director/Director/Principal	89	44.9	44.9	44.9
	SEnior Engineer	57	28.8	28.8	73.7
	Junior Engineer	46	23.2	23.2	97.0
	Others	6	3.0	3.0	100.0
	Total	198	100.0	100.0	

Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20 years and above	54	27.3	27.3	27.3
	10 to19 years	46	23.2	23.2	50.5
	5 to 9 years	48	24.2	24.2	74.7
	Less than 5 years	50	25.3	25.3	100.0
	Total	198	100.0	100.0	

Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	PhD	17	8.6	8.6	8.6
	Master	29	14.6	14.6	23.2
	Bachelor Degree	152	76.8	76.8	100.0
	Total	198	100.0	100.0	

Ownership

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Limited Company	68	34.3	34.3	34.3
	Partnership	82	41.4	41.4	75.8
	Sole Proprietor	38	19.2	19.2	94.9
	Others	10	5.1	5.1	100.0
	Total	198	100.0	100.0	

Company's Size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Large (> 50 staffs)	67	33.8	33.8	33.8
	Medium (10 - 50 staffs)	80	40.4	40.4	74.2
	Small (< 10 staffs)	51	25.8	25.8	100.0
	Total	198	100.0	100.0	

Appendix G Statistical Package of Social Sciences (SPSS) Output: Descriptive Statistics

Descriptive Statistics

	N	Mean	Std. Deviation
CSFactor	198	3.8893	.57457
Process	198	3.8403	.55780
Understanding	198	3.7586	.70845
Challenges	198	3.7169	.68366
Effectiveness	198	3.5291	.67780
Valid N (listwise)	198		

Appendix H Smart Partial Least Squares (SmartPLS) Output: PLS Algorithm

Construct reliability and validity (Stage 1)

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
CI	0.926	0.940	0.663
CLG	0.955	0.960	0.566
CO	0.907	0.929	0.687
CSF	0.955	0.959	0.531
CT	0.895	0.923	0.706
EE	0.615	0.833	0.715
EFF	0.852	0.890	0.545
EP	0.829	0.898	0.747
ES	0.791	0.905	0.827
FO	0.944	0.952	0.666
FP	0.907	0.928	0.683
FT	0.878	0.913	0.682
PC	0.809	0.888	0.726
PD	0.882	0.927	0.809
PH	0.866	0.909	0.715
PI	0.856	0.903	0.701
PR	0.925	0.944	0.770
PRO	0.966	0.969	0.518
PT	0.893	0.917	0.612
PU	0.816	0.891	0.732
UA	0.929	0.966	0.934
UB	0.964	0.982	0.965
UDS	0.950	0.956	0.611
UI	0.937	0.952	0.799
UM	0.910	0.944	0.848
UN	0.960	0.980	0.961

Construct reliability and validity (Stage 2)

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
CLG	0.892	0.933	0.822
CSF	0.878	0.925	0.806
EFF	0.785	0.871	0.693
PRO	0.937	0.950	0.731
UDS	0.879	0.912	0.675

HTMT Ratio (Stage 2)

	CLG	CSF	EFF	PRO	UDS
CLG					
CSF	0.362				
EFF	0.431	0.569			
PRO	0.311	0.175	0.402		
UDS	0.145	0.154	0.373	0.342	

HTMT Ratio (Stage 1)

	CI	CLG	CO	CSF	CT	EE	EFF	EP	ES	FO	FP	FT	PC	PD	PH	PI	PR	PRO	PT	PU	UA	UB	UDS	UI	UM	UN
CI																										
CLG	0.994																									
CO	0.896	0.998																								
CSF	0.307	0.326	0.228																							
CT	0.699	0.894	0.755	0.380																						
EE	0.463	0.507	0.437	0.590	0.518																					
EFF	0.433	0.405	0.303	0.498	0.367	0.977																				
EP	0.333	0.258	0.129	0.412	0.220	0.564	1.062																			
ES	0.394	0.384	0.334	0.361	0.320	0.681	1.061	0.866																		
FO	0.223	0.235	0.181	0.935	0.252	0.407	0.353	0.272	0.296																	
FP	0.347	0.374	0.264	0.966	0.443	0.653	0.556	0.482	0.376	0.668																
FT	0.305	0.318	0.184	0.943	0.410	0.645	0.517	0.443	0.328	0.619	0.898															
PC	0.259	0.369	0.393	0.171	0.408	0.306	0.285	0.195	0.293	0.086	0.249	0.179														
PD	0.095	0.136	0.143	0.155	0.153	0.554	0.339	0.169	0.283	0.075	0.213	0.183	0.760													
PH	0.281	0.347	0.376	0.115	0.321	0.370	0.227	0.120	0.181	0.073	0.167	0.090	0.841	0.789												
PI	0.148	0.157	0.132	0.153	0.156	0.530	0.424	0.275	0.397	0.074	0.186	0.210	0.784	0.874	0.729											
PR	0.233	0.254	0.274	0.119	0.191	0.256	0.239	0.189	0.209	0.073	0.159	0.113	0.636	0.537	0.539	0.537										
PRO	0.268	0.316	0.322	0.168	0.295	0.463	0.373	0.239	0.355	0.092	0.228	0.181	0.957	0.928	0.900	0.956	0.765									
PT	0.345	0.373	0.363	0.162	0.325	0.500	0.433	0.290	0.426	0.090	0.221	0.171	0.874	0.872	0.871	0.872	0.642	1.023								
PU	0.231	0.297	0.300	0.206	0.313	0.383	0.359	0.207	0.428	0.115	0.272	0.229	0.881	0.817	0.782	0.879	0.688	0.995	0.895							
UA	0.181	0.187	0.174	0.132	0.162	0.390	0.279	0.187	0.219	0.132	0.089	0.129	0.311	0.284	0.374	0.314	0.224	0.341	0.331	0.320						
UB	0.138	0.100	0.084	0.186	0.033	0.325	0.291	0.238	0.232	0.148	0.172	0.205	0.062	0.168	0.133	0.231	0.076	0.164	0.161	0.210	0.427					
UDS	0.154	0.169	0.160	0.156	0.155	0.448	0.323	0.245	0.213	0.122	0.141	0.178	0.235	0.318	0.296	0.310	0.200	0.318	0.331	0.304	0.742	0.807				
UI	0.134	0.174	0.170	0.140	0.190	0.365	0.228	0.146	0.149	0.108	0.129	0.163	0.192	0.216	0.225	0.183	0.151	0.231	0.249	0.227	0.528	0.670	0.953			
UM	0.104	0.122	0.136	0.106	0.102	0.469	0.277	0.180	0.156	0.068	0.120	0.121	0.236	0.424	0.320	0.339	0.204	0.347	0.349	0.327	0.651	0.634	0.937	0.731		
UN	0.094	0.093	0.064	0.087	0.099	0.308	0.332	0.360	0.186	0.064	0.066	0.123	0.179	0.248	0.195	0.303	0.194	0.269	0.313	0.202	0.551	0.632	0.867	0.683	0.765	

Inner VIF

	EFF
CLG	**1.189**
CSF	**1.140**
EFF	
PRO	**1.186**
UDS	**1.118**
XP	**1.013**

R square

	R Square	R Square Adjusted
EFF	0.721	0.693

f square

	EFF
CLG	0.040
CLG x XP	0.045
CSF	**0.218**
CSF x XP	**0.211**
EFF	
PRO	0.051
PRO x XP	0.054
UDS	0.061
UDS x XP	0.060
XP	**0.198**

Appendix I Smart Partial Least Squares (SmartPLS) Output: Blindfolding and PLSpredict

Q square

	SSO	SSE	Q² (=1-SSE/SSO)
CLG	594.000	594.000	
CLG x XP	594.000	594.000	
CSF	594.000	594.000	
CSF x XP	594.000	594.000	
EFF	990.000	468.177	0.527
PRO	1386.000	1386.000	
PRO x XP	1386.000	1386.000	
UDS	990.000	990.000	
UDS x XP	990.000	990.000	
XP	198.000	198.000	

PLSpredict: Latent Variable Q square predict

	RMSE	MAE	Q²_predict
EFF	0.834	0.640	0.329

PLSpredict: Manifest Variable Q square predict (PLS Model)

	RMSE	MAE	MAPE	Q²_predict
EE	0.807	0.622	94.582	0.357
EP	0.939	0.708	139.027	0.130
ES	0.936	0.677	99.441	0.137

PLSpredict: Manifest Variable Q square predict (LM Model)

	RMSE	MAE	MAPE	Q²_predict
EE	0.832	0.617	103.208	0.316
EP	0.962	0.716	179.666	0.087
ES	1.041	0.777	136.313	-0.069

Appendix J Smart Partial Least Squares (SmartPLS) Output: Bootstrapping

Path coefficients with t statistics

	Original Sample (O)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
CLG -> EFF	0.167	0.067	2.502	**0.006**
CLG x XP -> EFF	0.112	0.050	2.240	**0.008**
CSF -> EFF	0.380	0.067	5.654	**0.000**
CSF x XP -> EFF	0.281	0.058	4.880	**0.000**
PRO -> EFF	0.189	0.058	3.290	**0.001**
PRO x XP -> EFF	0.139	0.054	2.575	**0.005**
UDS -> EFF	0.198	0.062	3.199	**0.001**
UDS x XP -> EFF	0.108	0.055	1.973	**0.015**
XP -> EFF	0.311	0.059	5.195	**0.000**

Path coefficients with confidence interval

	Original Sample (O)	5.0%	95.0%
CLG -> EFF	0.167	0.064	0.280
CLG x XP -> EFF	0.112	0.061	0.242
CSF -> EFF	0.380	0.277	0.492
CSF x XP -> EFF	0.281	0.116	0.192
PRO -> EFF	0.189	0.096	0.287
PRO x XP -> EFF	0.139	0.122	0.132
UDS -> EFF	0.198	0.094	0.296
UDS x XP -> EFF	0.108	0.110	0.223
XP -> EFF	0.311	0.083	0.099

Appendix K List of Awards

1. Gold medal Awarded to Ir. Azlan Othman, Asssoc. Prof. Ts. Ir. Dr. Syuhaida Ismail, Nurfatin Syazwani Abu Bakar for invention entitled "Framework of Knowledge Management Practice in Construction Industry" during 2018 International Innovation and Invention Competition in Taiwan. Organised by Taiwan International Invention Award Winners Association.

Appendix L List of Copyrights

Copyright 1

Title: Framework of Knowledge Management Practice Amongst Malaysian Consulting Firms in Construction Industry

Date of copyright granted: 10 December 2018

Granted By: UTM

Reference No: LY2018006359

UTM Universiti Teknologi Malaysia | Innovation and Commercialisation Centre (ICC)

Innovation and Commercialisation Centre
Industry Centre, Technovation Park
Universiti Teknologi Malaysia
81310 Johor Bahru
Johor, Malaysia

Tel: +(6)07-5591500, 5591520 Fax: +(6)07-5565899 http://www.icc.utm.my Email:info@icc.utm.my

OUR REF.:
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Ruj. Kami : UTM.J.14.01/27.13/1JLD139 (21)
Tarikh : 21 Disember 2018

PROF. MADYA DR. SYUHAIDA BINTI ISMAIL
Kejuruteraan Teknologi,
Fakulti Teknologi & Informatik Razak
UTM, KUALA LUMPUR.

Assalamualaikum,

Saudara,

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Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA KERANA ALLAH"

Saya yang menjalankan amanah,

PROF. DR. MOHD. SHAHIR SHAMSIR BIN OMAR
Pengarah,
Pusat Inovasi & Pengkomersilan (ICC)
Universiti Teknologi Malaysia
☎ : 07-559 1501

s.k. : **TIMBALAN DEKAN**
(Penyelidikan, Inovasi, Pembangunan dan Alumni)

: **En. Azlan bin Othman**
Jabatan Kejuruteraan Awam,
Fakulti Teknologi & Informatik Razak
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Copyright 2

Title: Framework of Knowledge Management Practice Amongst Malaysian Consulting Firms in Construction Industry

Date of copyright granted: 10 December 2018

Granted By: MyIPO

Reference No: CRLY00016318

Copyright by MyIPO

AKTA HAK CIPTA 1987

PERATURAN-PERATURAN HAK CIPTA (PEMBERITAHUAN SUKARELA) 2012

SIJIL PEMBERITAHUAN HAK CIPTA
[Subperaturan 8(2)]

No. Pemberitahuan	:	**CRLY00016318**
Tajuk Karya	:	**FRAMEWORK OF KNOWLEDGE MANAGEMENT PRACTICE AMONGST MALAYSIAN CONSULTING FIRMS IN CONSTRUCTION INDUSTRY**
Jenis Karya	:	**SASTERA**
Tarikh Pemberitahuan	:	**10 DISEMBER 2018**

Saya dengan ini mengesahkan di bawah Akta Hak Cipta 1987 [Akta 332] dan Peraturan-Peraturan Hak Cipta (Pemberitahuan Sukarela) 2012 bahawa karya hak cipta dengan No. Pemberitahuan seperti di atas bagi pemohon **UNIVERSITI TEKNOLOGI MALAYSIA** sebagai **PEMUNYA** dan **SYUHAIDA BINTI ISMAIL (810624095082), AZLAN BIN OTHMAN** sebagai **PENCIPTA** telah didaftarkan ke dalam Daftar Hak Cipta menurut seksyen 26B Akta Hak Cipta 1987 [Akta 332].

....
DATO' MOHD ROSLAN MAHAYUDIN
PENGAWAL HAK CIPTA
MALAYSIA

LIST OF PUBLICATIONS

Journals

1. **Azlan Othman**, Syuhaida Ismail, Khairulzan Yahya, Mohd. Hafis Ahmad (2018). Critical success factors in implementing knowledge management in consultant firms for Malaysian construction industry. *Management Science Letters*, 8, 305–316 **(SCOPUS).**

2. **Azlan Othman**, Syuhaida Ismail, Khairulzan Yahya (2018). Knowledge Management: an Analysis of Knowledge Storage Amongst Consultant Firms in Malaysian Construction Industry. *Journal of Management, Economics, and Industrial Organization*, Vol.2 No.1, 2018, pp. 60-67.

Conference Proceedings

1. **Azlan Othman**, Syuhaida Ismail, Khairulzan Yahya (2017). An Overview of Knowledge Management (KM) Issues for Implementation in Consultant Firms in Malaysian Construction Industry. *IOP Conf. Series: Materials Science and Engineering*, 277, (2017) 012032 **(SCOPUS).**