ACCIDENT CAUSATION MODEL FOR BUILDING CONSTRUCTION SITES

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A thesis submitted in
fulfilment of the requirement for the award of
the Doctor of Philosophy

Faculty of Civil and Environmental Engineering
Universiti Tun Hussein Onn Malaysia (UTHM)

DECEMBER 2017
My dearest most lovely Ayahanda and Bonda,
Allahyarham Haji Asan Bin Engku Sharif Al-Rembauri and Hajjah Ramlah Binti Mohd Yusoff Al-Naningri

and

For my beloved wife,
Pn. Zulina Intan Haji Omar Gusti Napiah Al-Banjari

and

My sweet children’s,
Datinur Sajidah Binti Amran, Amir Syamim Bin Amran, Amir Akmal Bin Amran, Datinur Anati Binti Amran and Datinur Auni Binti Amran

May ALLAH S.W.T protect and bless us all of the times. In shaa ALLAH
ACKNOWLEDGEMENT

I am very grateful and indebted to my first supervisor Assoc. Prof. Dr Hj. Zainal Abidin bin Hj. Akasah for his treasured supervision, support, motivation and encouragement throughout the time of my PhD study. I would also like to thank him for his thoughtfulness and ingenuousness to introduce me to so many top-class academics. This was a prodigious and irreplaceable experience.

Furthermore, I would like to thank my second supervisor Dr Sasitharan a/l Nagapan for their constructive supervision, guide, inspiration and sustenance all the way through my study.

I would also like to thank all academics with which I had inspiring discussions and who have shared their thoughts with me along the way of my PhD.

Moreover, I am eternally grateful to my loved parents who have encouraged and supported me throughout my life. I would not have achieved this without them. Finally, my deepest thank and love goes to my wife and children’s, for the patience and constant encouragement that he has offered to me during the entire time of this journey.

Finally, appreciations also to everyone involved directly or indirectly in the completion of this thesis.

And above all, thank ALLAH S.W.T for giving the strength and courage to undertake and complete this research.

“May ALLAH S.W.T Bless Us All To Achieve Excellence in Life”
ABSTRACT

Construction safety at Malaysian building and construction project sites is of utmost importance due to the nature of the construction industry. Workplace safety is a care consideration for all types of organizations or stakeholders. However, statistics shows that safety at project sites is not adequately considered. Reports on site accidents represented nearly 50% of overall fatality cases across all industries. These statistics are indications of a continuing severity of building site accidents compared to others. Malaysian building site accidents are the results of various factors which are crucial to be identified. Therefore, a comprehensive understanding of the factors or the root causes that contribute to site accidents is essential. Thus, the aim of this study was to develop an accident causation model (ACM) at building construction projects sites, focusing on determining the significant factors that cause site accidents. These factors consisted of 93 items and they were divided into seven constructs. The study was undertaken in two stages. Firstly, relevant literatures were reviewed to identify the factors. The data were gathered to assess the suitability of the factors based on experts' judgement and survey. Data obtained were statistically analyzed using the statistical tools in the Statistical Package for Science Social (SPSS) 20.0 and the proposed model was recognized. Then, data collected from actual survey involving 420 respondents were analyzed to test the research model validity and the proposed hypothesis using the Partial Least Squares - Structural Equation Model (PLS-SEM) tool. From the results, it was revealed that the seven constructs have a direct positive effect on accident causation. The developed model is fit ($R^2$ value) and the identification of the seven constructs are significant (t-value). The model indicates that the highest impact on construction site accidents with a path coefficient $\beta$ (beta) value is unsafe equipment, followed by job site conditions, natural disaster, unique nature of the industry, unsafe methods, organization and management, and human elements. In conclusion, the findings through the ACM model of this study are reliable and very useful for construction organizations or stakeholders understand the significant root cause of the project site accidents. Hence, this can assist them to further implement an appropriate control measures to prevent accidents in Malaysian building construction site projects.
ABSTRAK

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LIST OF SYMBOLS AND ABBREVIATIONS

CIDB  Construction Industry Development Board
PLS-SEM  Partial Least Square-Structural Equation Modelling
SEM  Structural Equation Modelling
JKR  Public Works Department (Jabatan Kerja Raya)
UTHM  Universiti Tun Hussein Onn Malaysia
BPKU  Bahagian Pembangunan Kontraktor dan Usahawan
csv.  Comma Separated Value
AVE  Average Variance Extracted
CR  Composite Reliability
CA  Cronbach’s Alpha
GDP  Gross Domestic Product
Q²  Predictive Relevancy
CV Red  Cross Validated Redundancy
CV Com  Cross Validated Communality
SPSS  Statistical Package for Social Science
CIMP  Construction Industry Master Plan
DOSH  Department of Safety and Health
SOCSO  Social Security Organizations
EPU  Economic Planning Unit
OSHA  Occupational Safety and Health Act
FMA  Factories and Machinery Act
NIOSH  National Institute of Occupational Safety and Health
OSH  Occupational Safety and Health
SHASSIC  Safety and Health Assessment System in Construction
MBAM  Master Builders Associate Malaysia
JPM  Information Department of Malaysia (Jabatan Penerangan Malaysia)
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CHAPTER 1

INTRODUCTION

1.1 Research Background

Malaysian construction industry plays an important role in stimulating economic activities and plays an essential role in arbitrating between wealth creations and raising quality of life (Dato’ Seri Abdullah Ahmad, CIMP 2007). Compare to other countries, Malaysia moves fast to keep pace with the changes of time as the country aspires to achieve strong economic growth and to chart its course, as a developed nation by the year 2020 (Malaysia Information Department, 2016). Therefore, one of the common ways to drive economic growth is to increase investment in the construction sector. According to Malaysian Prime Minister, Datuk Seri Najib Razak, Malaysia’s construction sector will be transformed into a modern, highly productive and sustainable industry under Construction Industry Transformation Programme (New Straits Times, 2015).

Meanwhile, as Malaysian population is expected to reach 35 million in the year 2020 (Department of Statistic Malaysia, 2015), the nation’s building sector with interrelated of building project’s property development is presence as a key construction subsector, as it caters to the basic needs of the people (Malaysian Institute of Architect, 2015). It is estimated that a total of one million new residential units will be required to be built by 2020 (Construction Industry Development Board,
2013). In the meantime, data from the Economic Planning Unit (UPU) show that from 2011-2015, the overall development expenditure in the Malaysian building construction sector exceeded more than RM216.96 billion funded by both public and private sectors, in various building projects including residential, community infrastructure, hospitals and schools. Furthermore, according to Urban Wellbeing, Housing and Local Government Minister, a total number of 723,000 affordable homes are being built nationwide as part of the Federal Government’s initiatives to build by 2018 (The Sundaily, 2016). In fact, the construction sector registered positively on the economic and social front with a yearly employment growth of more than 1,000,000 employed person and accounted for 9.3% of total employment since 2010 (Department of Statistics Malaysia, 2015; Akasah et al., 2015; Ramli et al., 2015).

However, according to a news reported by the New Strait Times (NST), despite the nation’s economic growth and numbers of employees depending on them, there have been significant number of construction accidents taking place in the country over the years, leading to a high accident rate of injuries and fatalities (Deputy Human Resources Minister, 2015; Chong & Low, 2014; Tan & Nadeera, 2014; Majid et al., 2008). Indeed, working at construction sites is still considered as an extremely dangerous, dirty and difficult job and exposes workers to a lot of occupational hazards and risks (Zakaria et al., 2012; Chan et al., 2012; Adel et al., 2012; Abdullah et al., 2011). Construction accidents cause damages, losses of properties, plants, materials and lead to delays in project completion, increase cost and tarnish reputation of constructors’ (Targhabeh & Hosseinian, 2012; Manu et al., 2010; Wang et al., 2006). The accidents also cause problems to construction workers such as loss of ability to work, long-term absenteeism, risk of exclusion from the labour market and even death due to sickness and injury (Talib, 2012; Spangenberg, 2010).

The issues and burden of work at workplace which lead to injuries, illness and fatalities have been widely discussed in the media especially the ones related to the construction industry. Studies by various researchers demonstrated that statistical rate of major injuries and fatal accidents related to the construction industry is higher than other industries in many countries (Dumrak et al., 2013; Chi et al., 2012; Zakaria et al., 2012; Adel et al., 2012; Manu et al., 2010). The risks of major injuries
and fatal accidents in this industry is higher than any other industries and have been identified as one of the most hazardous industrial activities at the workplace in many parts of the world (Chong & Low, 2014; Nden et al., 2014; Himadri & Partha, 2013; Ching et al., 2012; Edwin et al., 1999).

Statistical data on fatalities available from local government agencies showed that from 2007 to 2014 total fatality rates in the Malaysian construction industry accounted for an average of 50% of total fatality cases involving Malaysian employed workforce (Department of Safety and Health, 2015; Department of Statistics Malaysia, 2015; Asan & Akasah, 2014). According to Deputy Human Resources Minister, a total of 518 foreign workers’ were reported death at construction sites from 2006 until September 2015 (New Straits Times, 2015). Furthermore, the Director General of the Department of Safety and Health (DOSH) revealed that construction industry sector has one of the worst safety and health records with 89 fatalities in 2014 and 140 in 2015 (The Sun, 2016). This figure strengthens the claim that Malaysian construction industry is the most dangerous industry, measured by workers’ safety, risks of accidents and workplace hazards.

The building sector is one of the major categories and a key sub-sector in the Malaysian construction industry. However, it is also the sector where major site accidents take place. Therefore, a critical intervention to improve safety and health at sites is needed (Construction Industry Development Board, 2016; Department of Safety and Health, 2016; The Sun, 2016; Malaysian Institute of Architect, 2015). According to the Director General of DOSH, despite many regulations, specifications, job safety programmes have been implemented at workplaces, accidents at construction sites which resulted in fatalities and injuries continue to occur in recent years and this sector remains a dangerous place where frequent workplace accidents take place (The Sun, 2016). In this regards, the president of the Institute Engineering Malaysia (IEM) strongly suggested that there is a need to upgrade and amend the related local acts, regulations, guidelines and codes of practice (The Malay Mail, 2016).

In facts, in recent years there has been a number of tragedy construction accidents occurred at building construction site projects in Malaysia. In 2017, an eight floor building which was under construction collapsed at Kuala Lumpur that claimed major injuries to workers (New Straits Times, 2017). In another incident,
some workers were killed when a 17 floor apartment that was under construction collapsed at Bukit Jalil (The Malay Mail, 2017). In another case, the plaster ceiling of a mall building that was under construction in Klang suddenly collapsed (The Malay Mail, 2017). These are some indicators of how serious accidents at building construction sites in the country. These also serve as stem reminders that more actions need to be done to protect the workers and provide them a safer workplace that will prevent such accidents from happening. Researchers also need to examine various strategies for enhancing safety at building construction sites.

In addition, with emerging technologies and increasing complexity of the Malaysian building construction projects, there is an urgent need for developing a new model of framework to determine the significant factors that cause accidents at building sites in order to prevent such problems from occurring. Due to this reason, the main purposes of this research were to identify and determine the significance factors of accident causation factors at building construction site projects. The research also attempted to create awareness and safety at workplace. A simple and practical model of framework for understanding the factors that contribute to accident causation of building projects would be proposed. Furthermore, the aim of such model of framework is to provide an objective indicator for significant factors of accident causations that which can be used as a reference for construction practitioners to provide safety and health awareness at building construction project sites in Malaysia.

1.2 Problem Statement

The construction industry is also known as an industry that involves the most hazardous activities. A common phenomenon at construction sites is the occurrence of accidents which is a key problem in the industry (Adel et al., 2012). Thousands of people have either been killed or become disabled in construction industrial accidents every year (Pejman et al., 2013). Construction industrial accidents also cause huge injuries and loss of human lives, leading to terrible environmental damages and deep financial losses (Berend, 2002). Studies carried out in many countries such as USA, Finland, Turkey, China and South Korea revealed that high rates of accidents in the
construction industry are largely caused by poor performance in safety and health provisions (Pejman et al., 2013; Phoya, 2012; Chi et al., 2012; Manu et al., 2010). In South Africa, many recent workplace accidents involving losses of limbs and lives occurred at construction sites (Monsingh & Haupt, 2007). These accidents were not only very devastating but could also lead to major adverse impact on construction companies’ production and reputation (Zakaria et al., 2012).

This situation is similar in Malaysia, where the construction industry has also been considered as one of the most hazardous industries (Kamal et al., 2013; Zakaria et al., 2012; Abdullah et al., 2011; Hamid et al., 2008). According to official statistics by the Ministry of Human Resources Malaysia, the number of fatality and disability cases involving construction workers in Malaysia is the highest compared to in other sectors (Department of Statistic Malaysia, 2013). In fact, the actual number could be much higher due to unreported accidents. Majid et al. (2008) suggested that this figure could go as high as 80 per cent of Malaysian construction workers, as the majority of construction workers in this country are foreign workers. Many of them working with expired or without any work permit and therefore were afraid to report such incidents to the authorities. In this regard, chairman of National Institute of Occupational Safety and Health (NIOSH), Tan Sri Lee Lam Thye, confirmed that only 20 per cent of accidents at construction sites nationwide were reported to DOSH between 2009 and 2014 (New Straits Times, 2017).

Statistical data retrieved for the year 2007 until 2015 show that accidents in the construction industry represented only 5% of total industrial accidents but accounted for nearly 50% of overall fatality cases across all industries. This was despite the industry only employed an approximately 10% of the total employed workforce (Department of Safety and Health, 2016; Department of Statistic Malaysia, 2016). Therefore, these statistics are indications of a continued severity of construction site accidents compared to others. The statistics on accidents and fatality cases in all industrial sectors kept by local government agencies are available from 2007 until 2015 (Department of Safety and Health, 2016; Department of Statistic Malaysia, 2016).

In order to design a fully effective and appropriate preventive action plan for construction site accidents, the root causes of accidents must be investigated and fully understood. Effective and appropriate preventive actions against accidents can
be taken only by understanding and identifying these root causes. (Chong and Low, 2014; Keng and Razak, 2014; Targhabeh and Hosseinian, 2012; Jantanee et al., 2013; Suraji et al., 2001). Nevertheless, most accidents are preventable (Akasah et al., 2015; Ramli et al., 2012; Majid et al., 2008; Monsingh and Haupt, 2007). By knowing the accident causation factors, a safer, healthier and more conducive working condition and environment at construction workplaces can be created.

Without any doubt, building construction site projects in Malaysia remain as dangerous places where frequent workplace accidents take place. The occurrence of Malaysian accidents at building construction sites in Malaysia arose recently resulting in worker injuries, fatalities and damages to properties. Reports from the local news on accidents at building under construction revealed that many of the accidents caused injuries and fatalities. Three workers were badly injured when a building which was under construction collapsed (New Straits Times, 2017). A worker was killed when the structure of an apartment under construction collapsed (The Malay Mail, 2017). Fifty seven workers escaped accidents at a construction site where the plaster ceiling collapsed (The Malay Mail, 2017). Several workers were killed when scaffolding at a building construction in Bangi collapsed (New Straits Times, 2017). Six workers were badly hurt after a temporary structure of a building construction collapsed (The Malay Mail, 2016). Three were killed and six were injured after a shopping mall under construction collapsed (Astroawani, 2015).

Safety at workplace is considered very crucial. Unfortunately there are still many accidents occurred at building projects in the country. This suggests, a critical and detailed analysis of factors that cause accidents at building construction site projects is of immense important.

Previous studies on Malaysian construction industry accidents have looked into the causes of accidents, types of injuries and their magnitudes and places of injuries. Based on the findings in the past studies, most of the research focused, concerned and approached the area of study on Malaysian construction industry (Chong & Low., 2014; Keng & Razak., 2014; Kamal et al., 2013; Zakaria et al., 2012; Salleh et al., 2012; Abdullah et al., 2011; Kuang et al., 2010; Hamid et al., 2008; Rahman & Hassan., 2008; Majid et al., 2008). Nevertheless, the significant factors affecting of causes of accidents at building construction sites sector remain understudied and unclear. For this reason, it is worth to investigate further in order to
identify the significant accident causation factors in the Malaysian building construction sector. This is to ensure Malaysian building site projects are sufficiently safe and healthy for workers and workplace environment respectively.

Therefore, understanding, identifying and determining the significant root causes of accident causation factors can effectively prevent errors, failures, mislead and accidents that could lead to injuries and fatalities (Nden et al., 2014; Ramli et al., 2013; Kamal et al., 2013; Zakaria et al., 2012; Adel et al., 2012; Majid et al., 2008). Additionally, preventive actions can reduce site accidents, injuries, fatalities and would be highly beneficial for the nation’s economy, society, rising quality of life and betterment of workplace environment. Indeed, the nation’s building construction sector can strive for a better improvement, redefine its image and minimize accidents in the near future by improving or enhancing safety at project sites. Therefore, this study sought to develop and generate a model based on the actual needs for a proper and complete identification of the significant root causes of accident causation factors in Malaysian building construction site projects (Construction Industry Development Board, 2015; Akasah et al., 2016; Asan & Akasah, 2014)

1.3 Research Questions

Upon identifying the issues and the study’s problem statement, a list of research questions were developed to guide and help the researcher formed an achievable objective. This research focused on the following research questions:

Research question 1: What are the factors causing accidents in the construction industry?

The literature suggested that the number of construction accidents remains high and need to be minimized. It also highlighted the need to improve sites’ safety awareness in organizations undertaking construction and developments projects. For these reasons, this study sought to investigate the factors causing of site construction accidents. In order to answer question 1, the factors were conceptualized based on the literature review and through expert judgement (quantitative approach). The
expert judgement approach refers to the process of seeking opinions from the construction professionals and construction practitioners to enhance and develop further knowledge on the factors causing accidents. Furthermore, the accident causation model of framework was then developed in order to provide a better understanding of the factors covered in this study.

Research question 2: What are the main factors causing accidents at building construction sites in Malaysia?

This question was premised on the hypothesis that the factors causing accidents in the construction industry are closely related to the attributes that would potentially cause accidents at building construction sites in Malaysia. Furthermore, this research question addressed the completion of accident causation factors model (ACM) by identifying relevant factors to be included in the model. Hence, the second hypothesis was developed to support this effort. In addition, it aimed to develop reliable and valid measurement scales in order to develop the ACM model for Malaysian building construction sites. Content reliability, construct validity, mean ranking relevancy analysis of factors were assessed in order to develop the significant measures in an initial ACM for Malaysia’s building construction project sites. Thus, the initial ACM model was highly important to be used for testing the validity of the ACM.

Research question 3: How to evaluate the relationship between accident causing factors and accident causation for building construction sites?

This question aimed to develop a reliable and valid measurement scale in order to develop significant measures in an accident causation model (ACM) for Malaysian building construction site projects.

Research question 4: Is the accident causation model (ACM) valid for measuring the significant accident causation factors for building construction sites in Malaysia?
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