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The Causes and Mitigation Measures of Fall from Height Accidents in Malaysia

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Abstract: Falls from height (FFH) is a significant threat to the construction environment and are the leading cause of serious and fatal injuries for construction workers. Working at a height increases the likelihood of being involved in a fall from a height accident. Since the construction industry is carried out in risky environments, it is experiencing accidents at different severity rates, some causing minor injuries, some causing severe injuries, and some resulting in fatalities. Most fall from height accidents will affect the individual, such as permanent disabilities, worker fatalities, and affect the psychology of workers. This research objective is to find the cause and effect of fall from height accidents and mitigation measures in Malaysia. The findings of this research indicate that individual attitude is the main contributing factor to falls from height accidents, with the top five highest Relative Important Index (RII) ranking. The main causes of fall from height accidents are individual attitudes, which is workers' negligence toward safety rules with RII=0.901. Then, the respondent strongly agrees that the humanitarian categories of injuries or permanent disabilities with RII=0.899 are the adverse effects of fall from height accidents. After that, the utmost possible mitigation measures with the highest RII ranking are in the health protection categories, which forbid working at height if alcohol or drugs have been detected on workers with RII=0.930. Lastly, the identified causes of FFH accidents were selected to be used in the Loughborough ConAC Model. The establishment of the model is important to clearly represent the FFH accident and ultimately to reduce the fall from height accidents in Malaysia.

Keywords: FFH accidents, Loughborough ConAC Model, Causes of FFH

1. Introduction

The construction industry is a dynamic and innovative industry that delivers buildings and infrastructure for all aspects of commercial and domestic activity. It is a global industry that facilitates the development and maintenance of buildings, transport links, and energy supplies. It is an industry that continues to deliver many incredible things, from ever taller skyscrapers to expansive bridges, impressive stadia, and structures that arise out of land reclaimed from the sea.

The construction industry has grown over the last decades and resulted in improvements in company profits, financial accessibility, and increased commodity demand in Malaysia and other countries. Despite its importance, Mohammadi et al. (2018) describe construction as one of the most dangerous industries due to its unique, dynamic, and temporary nature. This dynamic and innovative industry is faced with safety challenges on a project-by-project and day-by-day basis. Accidents are a major problem in various industries as well as in everyday life. Hu et al. (2011) mentioned that compared to other industries, the construction industry has lousy working environments, a complicated

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situation, a high labor turnover rate, a lack of safety management, low educational standards, and poorly trained workers.

Furthermore, working four feet or higher off the ground puts workers at a greater risk of falling, but anything capable of causing you to lose balance and fall is a hazard (Arunkumar & Gunasekaran, 2018). Therefore, falling from height can be classified as a significant problem in construction accidents in the Malaysian construction industry (Williams et al., 2019). To prevent accidents, firstly, the causes must be identified, then the effects and mitigation measures for FFH can be proposed.

2. Issues of Fall from Height (FFH)

The construction industry is unique among other industries as its activities often take place outdoors, in unconducive conditions for safety and health. Workers on construction sites are exposed to constant changes like the work, the location of the work, and the composition of the workers. Most people associate the construction industry with a dangerous working environment and high risk compared to other fields (Misnan & Mohammed, 2014).

Chinese Idiom: “The higher you climb, the harder you fall.” A fall from height can be defined as a descent from an upright, sitting, or horizontal position, with the descent height being less than or equal to 1metre (Murthy et al., 2012). Falls from heights are persistent public health problems that cause catastrophic injuries to construction workers all over the world. A fatality due to falling from height is increasing annually as many work activities involve working at height. These falls are often seen in accidents or for suicide purposes. The victims can be killed or permanently injured. Workers in the construction industry are usually intended to perform work at heights, on scaffolding and ladders, and in windows and roofs.

It is axiomatic that falls from height have the highest rates of death amongst construction accidents compared with other types of accidents (example: hits by moving or falling objects, vehicle collisions, contact with electricity, and being trapped between stationary and moving objects) when compared to other industrial accidents (Nadhim et al., 2016). To prevent falls from height in the construction industry, a more comprehensive understanding of the casual influences contributing to falls from height accidents is necessary (Hu et al., 2011)

According to the statistics on FFH accidents reported to SOCSO in Table 1, the number of accidents has increased significantly every year. In 2014, there were 8840 FFH accident cases, and the number of accidents increased by 36.5% to 12069 accidents in 2018. The statistics indicate that this is quite worrying, and proactive action should be taken to evaluate and re-examine the exact cause of this FFH accident has led to these statistics increasing drastically every year.

Table 1 - FFH accidents reported to SOCSO (SOCSO Annual Report, 2018)

Year	Total Accidents Reported to SOCSO
2018	8841
2017	7870
2016	6552
2015	7338

2.1 Causes of FFH

Falling from a height remains the most causative factor of severe injuries at work and deaths in the construction industry (Dong et al., 2017). According to OSHA, most falls occur from work platforms, frameworks, ladders, or scaffolding. OSHA essentially allows it to protect from falling at four feet in the general industry, five feet in the maritime industry, and six feet in construction (OSHA, 2015). In line with Ali et al., (2010), the International Labour Organization revealed that some workers were inconvenienced by some types of PPEs and their working performance would implicitly be reduced. As a result, the number of accidents will increase due to the mentality of individuals who are selfish and ignorant of safety.

Undoubtedly, an accident is an accident of failure that can be caused by lack of training, inadequate equipment, work platform, unsafe work behavior, unsatisfactory housekeeping, and negligence in using personal protective equipment (PPE) (Goh et al., 2016). Commonly, subcontractors are minimal safety awareness at the construction site. In this case, safety from their point of view is an expensive thing and will require high costs. Ineffective leadership, inefficient guidance, and misunderstanding between a group of workers also contribute to construction accidents (Chen and Wu, 2010). Hence, to address this critical issue, this paper will focus on the cause and effect of falls from height accidents and mitigation measures in Malaysia. An extensive literature review of the research was conducted. Therefore, five categories of causes related to construction accidents have been identified as potential causes of falls from height accidents at construction sites. The five categories are below: individual attitude, management commitment, workplace condition, communication barrier, and humanitarian.

Construction companies are experiencing difficulties related to various risks, challenges, and uncertainties due to continuous accidents in construction projects. In a construction project, construction accidents are the mother of all other challenges and complexities (Ahmed, 2019). Failure to implement and maintain construction safety towards accidents in the construction project will adversely affect the project. A construction project can achieve its objectives if the construction professionals are aware of the safety-related aspects. Workers in the construction industry are constantly exposed to unsafe working conditions and must deal with various types of hazards. These include exposure to noise, dust and toxic substances, ergonomics issues, stress, etc. (Shamsuddin et al., 2015).

The construction industry is fraught with risky and unhealthy operations that have resulted in numerous human tragedies, discouraged workers, disrupted construction, delayed progress, and hurt costs, productivity, and the firm's reputation. Nevertheless, the FFH accident hurts all parties involved in the accident, especially individuals. Previous researchers cited the main effects of construction accidents in terms of humanitarian categories which is the fatality of workers, Injuries or permanent disabilities, psychology of workers affected, suffering to individual and the accident will contribute to possible loss of earning ability

Importunately, FFH accidents also as a significant impact on the economic elements of construction projects. The previous researchers cited the main impact of construction accidents in terms of economic categories which are the cost of liquidated damages upon the breach of agreement (eg: project delay), cost of medical expenses, cost of recruiting a new worker, cost of training given to a new worker, compensation cost, repairs or substitute damaged equipment cost, getting penalties from authorities, and work productivity loss (Oladipupo, 2012) (Tang et al., 2019), (Kadiri et al., 2014),

Therefore, a plethora of research has been conducted by the previous researcher and two categories have been identified as a potential effect of falls from height accidents at construction sites which are humanitarian and economic categories.

2.2 Loughborough ConAC Model

A substantial number of unreported accidents and a relatively small number of construction companies are qualified to investigate and learn from accidents (Gibb et al., 2005). Frequently, construction accident researchers primarily concentrate on accident statistics and incidence patterns. The Loughborough Construction Accident Causation model was the first framework immediately introduced at Loughborough University to remedy the balance between what caused construction accidents between the indirect (distal) and direct (proximal) causes (Behm & Schneller, 2013). The model was developed in the United Kingdom by a team of researchers after compiling results in specific accident reports, indicating a hierarchy of causal conditions, factors, and influences in construction accidents (Haslam et al., 2005).

The model describes how accidents arise due to a failure in the interaction between the work team, their workplace, and the materials and equipment (including tools and PPE) that they use. Furthermore, the model further indicates how originating organizational, managerial, and design influences shape the circumstances on-site, which lead to accidents (Abas, 2020). Gibb et al. (2005) have explained briefly that these model immediate accident circumstances, which relate to the site of the accident or incident, are affected by shaping factors, whereby the actions, behavior, capabilities, and communication of the work team are affected by their attitudes, motivations, knowledge, skills supervision, health, and fatigue. The workplace is affected by site constraints, work schedules, and housekeeping.

Therefore, materials and equipment's suitability, usability, condition, and safety depend on their design, specification, and supply/availability. The shaping factors are subject to originating influences, including the permanent works design, project management, construction processes, safety culture, risk management, client requirements, economic climate, and education provision'.

Subsequently, this paper proposes the Loughborough Construction ConAC Model as shown in Figure 1 because it is a conceptual but practical model of accident causation for the construction industry, including management and safety aspects of accident causation. The questionnaire is developed by referring to the Loughborough ConAC Model consisting of originating influences, shaping factors, and immediate accident circumstances. Ultimately, recognizing the risk of a fall and controlling the risks will help prevent some accidents from occurring and improve the overall safety level on construction sites.

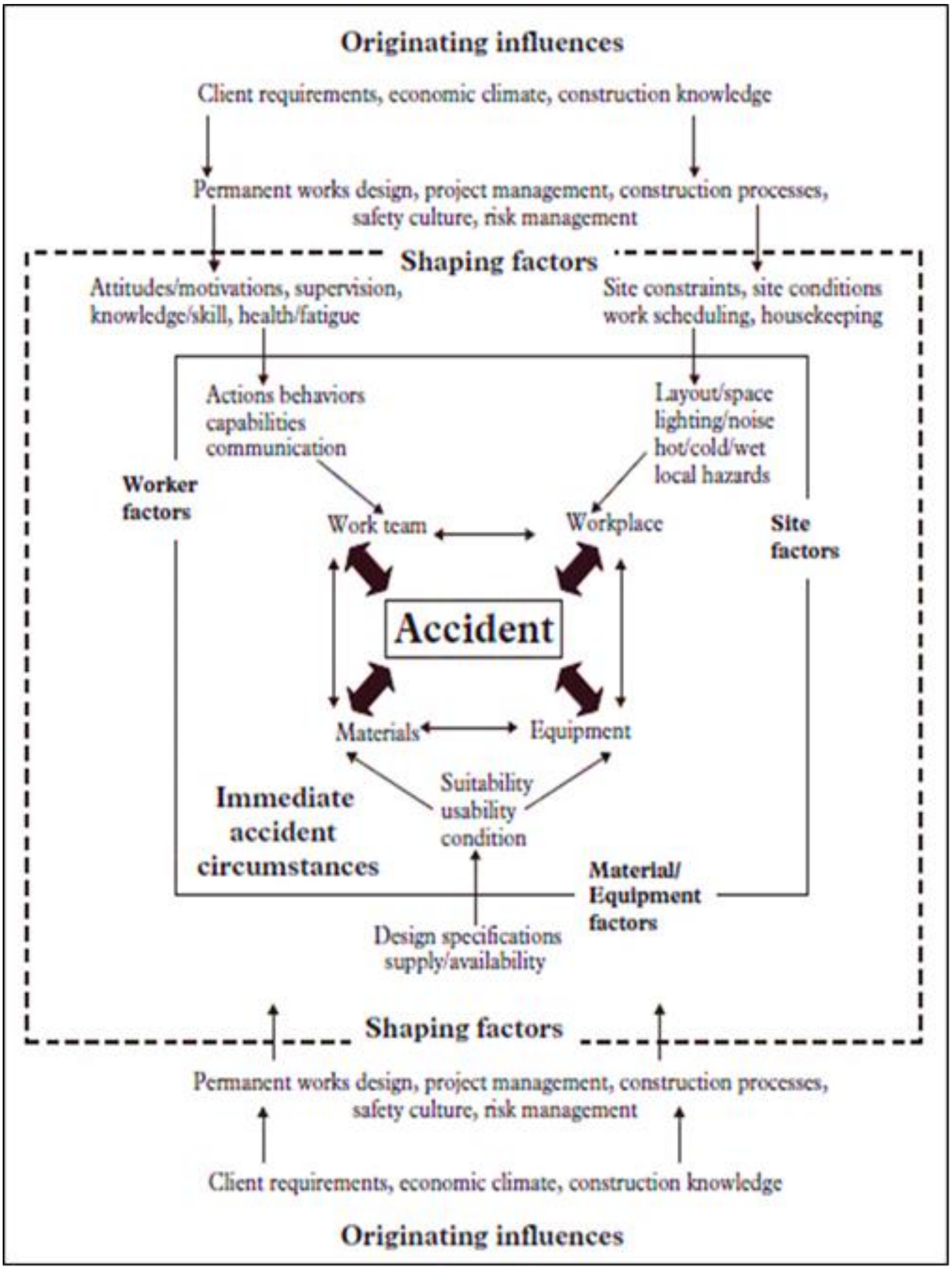

Fig. 1 - Loughborough ConAC Model (Haslam et al., 2005)

3. Methodology

In this research, the preferred research method is quantitative and qualitative. Therefore, the structured questionnaire is developed containing numeric data and the interview was set up with expertise in working at height involving the non-numerical data that are commonly used to understand people's experiences and express their perspectives. There were 365 sets of questionnaires sent out to construction workers around Peninsular Malaysia. But, only 115 set questionnaires were returned completely.

The questions were closed-ended using a Likert scale to represent the respondent's degree of agreement about the factors. The questionnaire consisted of two parts: Section A was about the respondent's background such as position, working experiences (in years), and questioned about their experienced or knew any accidents regarding falls from height; and Section B was the list of causes and effect of fall from height accident. In Section B, the respondents were required to rate the level of agreement of the causes and effects of falls from height accidents at construction sites, in the range of 1 (strongly disagree) to 5 (strongly agree); and Section C was the list of possible mitigation measure of fall from height accident. The mitigation measure is separated into five main categories. These categories are consisting of on-site precautionary measures, educating and training, workplace condition, job redesign, and health protections.

The questionnaire survey was validated by 7 panels of experts who had more than 10 years of experience in the construction industry and working at height safety. Several improvements have been made according to expert panels' suggestions before distributing the actual questionnaire to the respondents.

The questionnaires data is analyzed using the Statistical Package for the Social Sciences software (SPSS) and Relative Important Index (RII) using Microsoft Excel to achieve the objective. The data received from the questionnaire were analyzed using the Relative Importance Index (RII) method using MS excel. All the outputs were interpreted to get the results and further on to get a conclusion. The Likert scale from 1 = strongly disagree, 2 = disagree, 3 = uncertain, 4 = agree and 5 = strongly agree are analyzed according to the range of importance using RII. Furthermore, Loughborough ConAC Model is constructed by applying the data from a questionnaire distributed to the construction personnel. The models attempt to understand the factors and processes involved in accidents to develop strategies for accident prevention. The model indicates the main causes of falls from height accidents and illustrates how accidents are triggered at a construction site in terms of individual attitude, management commitment, workplace conditions, and communication barriers.

4. Result and Discussion

The demographic questions are designed in Section A to determine the respondent's background. Section A is the first part of the questionnaire consisting of site location, respondent profession, working experience, and experience in fall from height accidents. The data are analyzed using frequencies and percentages of respondents. As a result, the data are presented in the form of pie charts and bar graphs. The types of questions are open-ended questions and close-ended questions. Figure 2 presents the result of the respondent's background.

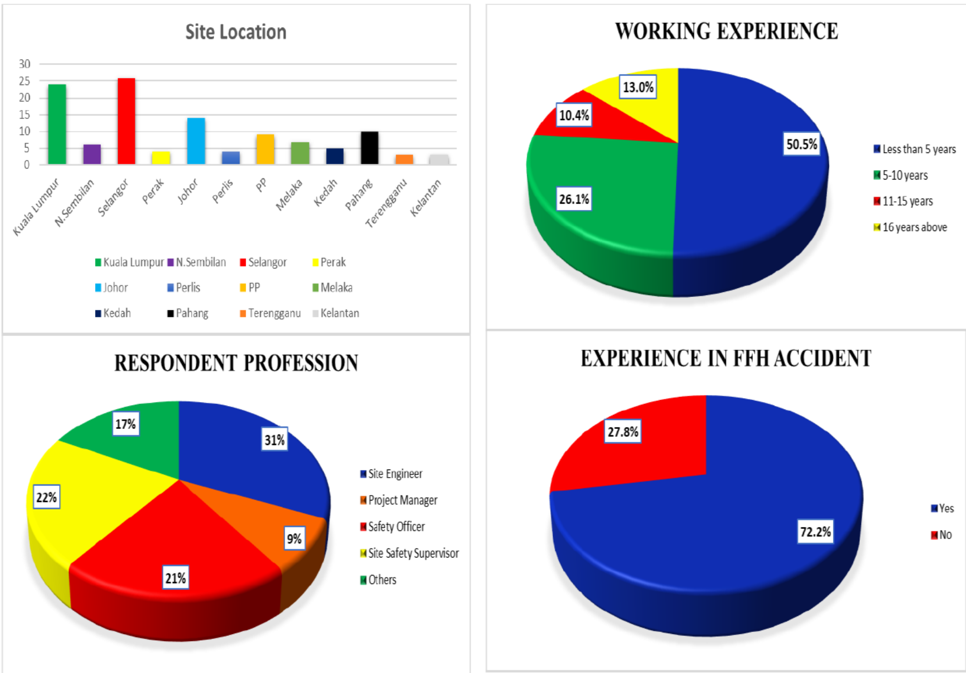

Fig. 2 - Background of the respondents

4.1 Causes of FFH Accidents

This section describes the multiple-choice question based on the views of 115 respondents due to a fall from a height accident. It contains the type of accident, the main faulty side when falls from height accident occur, and the frequency of accidents occurrence based on the respondent's experience. This section is configured to explain each of the causes agreed by respondents in the four main categories that have already been finalized using a Relative Important Index (RII). The result has shown in Table 2 the 17 identified causes by each category.

The analysis of the Relative Important Index (RII) illustrates that individual attitude is the main contributing factor to fall from height accidents, as evaluated by respondents with the top five highest in the relative rank. The first highest-ranking cause is negligence toward safety rules with RII= 0.901. The derivation of this ranking is based on Ahmed, (2019) mentioned that a higher ranking value indicates a higher degree of impact and pervasiveness of the causes and effects. Almost 108 out of 115 respondents strongly agree that negligence toward safety rules is the main cause of fall from height accidents at construction sites. The 2nd highest-ranking cause is failing to wear PPE (BIA1) with the RII=0.859. The 3rd, 4th, and 5th highest-ranking causes are an improper use of equipment (BIA2), use damage equipment (BIA3), and incorrect positioning and posture while working (BIA4) with the RII of 0.843, 0.781, and 0.776. It can be illustrated that individual attitudes are the main contributing factor to fall from height accidents evaluated by respondents.

Additionally, the middle-ranking causes of falls from height accidents are listed. The most noticeable 6th middle-ranking causes are poor site housekeeping (BWC1) from the group of workplace conditions with RII=0.763. It is followed by the 7th, 8th, 9th and 10th rank which is a failure to provide adequate PPE equipment and safety equipment (BMC1), abandonment the safety policies (BMC3), lack of safety monitoring (BMC4), and lack of exposure to safety training and orientation (BMC2) from the group of management commitment with RII=0.734, 0.729, 0.682, 0.678. The 11th highest-ranking causes are language barriers such as speaking, writing, and reading (BCB2) with RII=0.661 The crowded working space (BWC3) with RII= 0.659 also has the moderate level causes of fall from height accident at a construction site in 12th highest-ranking causes.

The lowest ranking causes in this research are poor communication among safety officers and employees (BCB4) with the RII=0.652 and unclear information provided (BCB1) with RII= 0.624 which are ranked in 13th and 14th positions in Table 2. The 15th, 16th, and 17th causes are bad weather such as rainy or windy (BWC2), poor understanding of signage (safety information and warning signs) (BCB3), and lastly, poor warning signage (BWC4) with the RII of 0.610, 0.605, and 0.600 respectively. In conclusion, individual attitude is one of the major causes of fall from height accident at construction sites and need to be a concerned from all parties involved in the construction industry.

Table 2 - Causes of fall from height accident at a construction site in Malaysia

Categories	ID	Causes of Accident	RII	Ranking
Individual Attitude	BIA1	Failed to wear PPE	0.859	2
	BIA2	Improper use of equipment	0.843	3
	BIA3	Use damage equipment	0.781	4
	BIA4	Incorrect positioning and posture while working	0.776	5
	BIA5	Negligence toward safety rules	0.901	1
Management Commitment	BMC1	Failure to provide adequate PPE equipment and safety equipment	0.734	7
	BMC2	Lack of exposure to safety training and orientation	0.678	10
	BMC3	Abandoned the safety policies	0.729	8
	BMC4	Lack of safety monitoring	0.682	9
Workplace Condition	BWC1	Poor site housekeeping	0.763	6
	BWC2	Bad weather (rainy/windy)	0.610	15
	BWC3	Crowded working space	0.659	12
	BWC4	Poor warning signage	0.600	17
Communication Barrier	BCB1	Unclear information provided	0.624	14
	BCB2	Language barrier (speaking, writing, and reading)	0.661	11
	BCB3	Poor understanding of signage (safety information and warning signs)	0.605	16
	BCB4	Poor communication among safety officers and employees	0.652	13

4.2 Effects of FFH Accidents

In this section, the main effect of falls from height accidents indicated by respondents in the two categories is identified using the Relative Important Index (RII). Referring to Table 3 demonstrate the 14 effects of fall from height accident at a construction site in Malaysia. This section is clarified the top five highest agreements by the respondent on the effect of falls form height accidents at construction sites.

The analysis of Relative Important Index (RII) reveals that humanitarian categories are the major adverse effect when fall from height accident occur at construction sites. The first highest ranking selected by respondents is injuries or permanent disabilities with the RII= 0.899. The second and third highest-ranking effects determined in this research are possible loss of earning ability (RII=0.890) and the fatality of workers (RII=0.883). Then, suffering to the individuals (RII=0.878) are in the 4th relative rank. Meanwhile, only one effect of fall from height accidents from economic categories is in top five rankings which is getting penalties from authorities with RII=0.840. Consequently, from the interpretation of this Relative Important Index (RII) it can estimate that falls from height accidents have deleterious effect on humanitarian categories.

Subsequently, the following are the moderate agreement by the respondent on the effect of FFH accidents at construction sites which is the reputation of the firm affected (RII=0.831), work productivity loss (RII=0.830), and cost of liquidated damages upon the breach of agreement (e.g.: project delay) (RII=0.824) are in 6th, 7th, and 8th relative rank. Next, the lowest ranking effects are the cost of medical expenses (9th) with RII=0.823, compensation cost and psychology of workers affected (10th) with RII=0.812, the cost of training given to a new worker, and repairs or substitute damaged equipment cost (11th) with RII= 0.786 and cost of recruiting a new worker (12th) with RII= 0.774.

Summarising, humanitarian and economic are the adverse effect in Malaysia when the accident falls from height occur. Hence, inevitable FFH accidents must be expected in the construction industry. The commitment of all parties involved, from the project manager to the laborer towards good practices would enhance the safety and health of construction sites.

Table 3 - Effects of fall from height accident at a construction site in Malaysia

Categories	Effect of Accident	RII	Ranking
Humanitarian	The reputation of the firm affected	0.831	6
	Psychology of workers affected	0.812	10
	Possible loss of earning ability	0.890	2
	Suffering to individual	0.878	4
	Injuries or permanent disabilities	0.899	1
Economic	Fatality of workers	0.883	3
	Getting penalties from authorities	0.840	5
	Cost of liquidated damages upon the breach of agreement (eg: project delay)	0.824	8
	Cost of medical expenses	0.823	9
	Cost of recruiting a new worker	0.774	12
	Cost of training given to a new worker	0.786	11
	Compensation cost	0.812	10

4.3 Mitigation Measures of FFH Accident

This section will describe the results found in the Relative Important Index (RII) analysis. To achieve the second objective of evaluating possible mitigation measures for accident prevention due to fall from height, the highest value of RII from the analysis are considered as superlative mitigation measures. Table 4 indicate the 20 elements of mitigation measure for fall from height accident under five main categories. These categories consist of on-site precautionary measures, educating and training, workplace condition, job redesign, and health protections.

Primarily, the 115 respondents are evaluated according to the best practice at a construction site. The highest-ranking for mitigation measures evaluated by respondents are those that forbid working at height if alcohol or drugs have been detected on workers (DHP2) with RII=0.930 under health protection categories. The second-highest ranking is identified as potential on-site risks related to falling from height accidents (DOP4) with RII=0.908. Therefore, the third rank is educating and stimulating employees to comply with safety regulations (DET5), proactive site actions (DOP2), and organizing a regular safety briefing before work at height commences (DJR3) with an RII value of 0.906. This mitigation measure from the categories of education training, on-site precautionary measures, and job redesign shows a similar value to RII. The respondents also strongly agree that the 4th rank mitigation measure is organizing courses on how to properly use climbing equipment (scaffold, ladder, harness) (DET2) with RII=0.904.

Moreover, the findings in Table 4 also show that the mitigation measure in 5th rank has a similar value of RII=0.901 to emphasize the importance of safety and health practices in carrying out activities at site (DOP1), all employers should have a specific Fall Protection Plan at the construction site by following the DOSH guidelines (DOP5), organize short safety training courses, seminars and talks for workers focusing on work at height risks (DET1) and avoid operation at height when workers suffer from physical disorders: excessive fatigue, sleepiness, depression (DHP1). The top 5 relative rankings indicates that each category has rational elements that can be utilized as main mitigation measures to reduce FFH accidents at construction sites.

Then, the third-highest ranking of mitigation measures stated by the respondent has three different categories with the same value of RII= 0.906, which are site proactive actions: provide guardrails, safety nets, safety helmets, personal protection equipment (PPE), and safety harnesses, etc., educating and stimulate employees to comply with safety regulations and organize a regular safety briefing before work at height commences.

Then, the fourth-highest ranking of FFH accidents mitigation measures is to properly organize courses on how to use climbing equipment (scaffold, ladder, harness). with the value of RII= 0.904 Lastly, in the fifth-highest relative rank, there are four elements of FFH accidents mitigation measures with the same value of RII=0.901. The four elements came from various categories of mitigation measures consisting of emphasizing the importance of safety and health practices in carrying out activities at the site, all employers should have a specific Fall Protection Plan at a construction site by following the DOSH guidelines, organize short safety training courses for the workers, seminars, and talks focusing on work at height risks, and lastly, avoid operation at height when workers suffer from physical disorders: excessive fatigue, sleepiness, depression. According to all mitigation measures selected by the respondent, all employers should have a specific Fall Protection Plan at the construction site by referring to the DOSH guidelines. DOSH Malaysia has reported and investigated the previous accidents, most falls from height were prevented and avoided by taking the most basic and necessary safety measures (DOSH, 2008).

Table 4 - Accident mitigation measures

Categories	ID	Accident Mitigation Measures	RII	Ranking
On-site Precautionary measures	DOP1	Emphasize the importance of safety and health practices in carrying out activities at the site	0.901	5
	DOP2	Site proactive actions: Provide guardrails, safety nets, safety helmets, personal protection equipment (PPE), and safety harnesses, etc.	0.906	3
	DOP3	Prohibits the work when there has a physical environmental hazard (e.g.: Storm)	0.892	8
	DOP4	Identify on-site potential risks related to fall from height accidents (HIRARC)	0.908	2
	DOP5	All employers should have a specific Fall Protection Plan at construction site by following the DOSH guidelines	0.901	5
Education and Training	DET1	Organise short safety training courses for the workers, seminars and talks focusing on work at height risks	0.901	5
	DET2	Organise courses on how to use climbing equipment (scaffold, ladder, harness) properly	0.904	4
	DET3	Organise a HIRAC training focusing on element of identifying and assessing hazards.	0.889	10
	DET4	Emphasize good communication skills in communicating safety and health matters	0.890	9
	DET5	Educating and stimulate employees to comply with safety regulations	0.906	3
Workplace Condition	DSR1	Strive to learn the laws, acts and regulations related to the health and safety management system	0.883	11
	DSR2	Frequent revision on safety regulations and regular inspections of sites.	0.892	8
	DSR3	Impose anti-drug policy to be part of disciplinary policy	0.889	10
	DSR4	Serious action taken if workers noncompliance to safety requirements/OSHA	0.897	7
Job Redesign	DJR1	Improve the ergonomics of the workplace (e.g., weather condition, enough illumination level, noise reduction) to reducing the possibility of falls from height accidents.	0.868	13
	DJR2	The climbing equipment (scaffold/ladder) are set up and dismantling by professional	0.899	6
	DJR3	Organise a regular safety briefing before work at height commences	0.906	3

Health Protections	DHP1	Avoid operation at height when workers suffer from physical disorders: excessive fatigue, sleepiness, depression	0.901	5
	DHP2	Forbidding working at height if alcohol or drug has been detected on workers	0.930	1
	DHP3	Shorten the periods of workers suffering from chronic disease: hypertension, heart disease, etc	0.877	12

4.4 The Accident Causation by Loughborough ConAC Model

This research demonstrated that the Loughborough Construction Accident Causation Model could be very useful in analyzing the causes of construction accidents to better understand how and why accidents occur in the construction industry.In this research, the model in Figure 3 adopts the Loughborough ConAC Model to suit the fall from height accidents.The model indicates the main causes of fall from height accident and illustrates how accidents are triggered at a construction site in terms of individual attitude, management commitment, workplace condition, and communication barrier. This model is constructed by applying the data from a questionnaire distributed to the construction personnel and divided into three parts which are originating influences, shaping factors, immediate accident circumstances.

Table 5 - Accident mitigation measures

Categories	Causes of Accident	RII	Ranking
Individual Attitude	Failed to wear PPE	0.859	2
	Improper use of equipment	0.843	3
	Use damage equipment	0.781	4
	Incorrect positioning and posture while working	0.776	5
	Negligence toward safety rules	0.901	1
Management Commitment	Failure to provide adequate PPE equipment and safety equipment	0.734	1
	Lack of exposure to safety training and orientation	0.678	4
	Abandoned the safety policies	0.729	2
	Lack of safety monitoring	0.682	3
Workplace Condition	Poor site housekeeping	0.763	1
	Bad weather (rainy/windy)	0.610	3
	Crowded working space	0.659	2
	Poor warning signage	0.600	4
Communication Barrier	Unclear information provided	0.624	3
	Language barrier (speaking, writing and reading)	0.661	1
	Poor understanding of signage (safety information and warning signs)	0.605	4
	Poor communication among safety officer and employees	0.652	2

The most prevalent immediate circumstance identified in Table 5 shows the 17 causes of fall from height accident under four main categories of causes at a construction site in Malaysia with relative rank. The table illustrates that individual attitude is the main contributing factor of fall from height accident that is evaluated by respondents with the top five highest in the Relative Importan Index (RII) ranking. Therefore, all five causes in individual attitude categories are selected to utilised in the Loughborough ConAC Model because these five causes recorded the highest agreement from respondent. Next, the top two highest ranking in the RII on management commitment, workplace condition and communication barrier categories are selected to be utilised in the Loughborough ConAC Model. Lastly, achieving a significant and sustainable reduction in accidents will require concerted efforts in mitigating the fall from height accidents as shown in Figure 3.

The originating influences in construction accidents are the significant level of determinate of the nature, extent, and existence of immediate causes of accidents. Besides, these influences have sometimes been referred to using terminology such as ‘root causes’. These key factors consist of client requirement, economic climate, and construction knowledge. Obviously, it seems this factor influences do affect safety on construction sites.

The performance of workers, site, equipment and materials that may ultimately lead to or prevent an accident relying on proximal effects; these factors are referred in this model as 'shaping factors'. Shaping factors depend on other effects away from the centre of model and are referred as 'originating influences'.

Immediate accident circumstances are the unsafe acts and conditions that resulted in or could have resulted in an accident. From this aspect, it can explain why the accident happens and the contributing factor of accidents. Some people's thought processes lead them to insist that something like "cut with a knife" is an immediate cause. This statement explains what happened. It does not explain why it happened. Examples of immediate causes for being cut with a knife would include using the wrong tool for the job (unsafe act), failure to wear cut-resistant gloves (unsafe act), or dull knife (an unsafe condition).

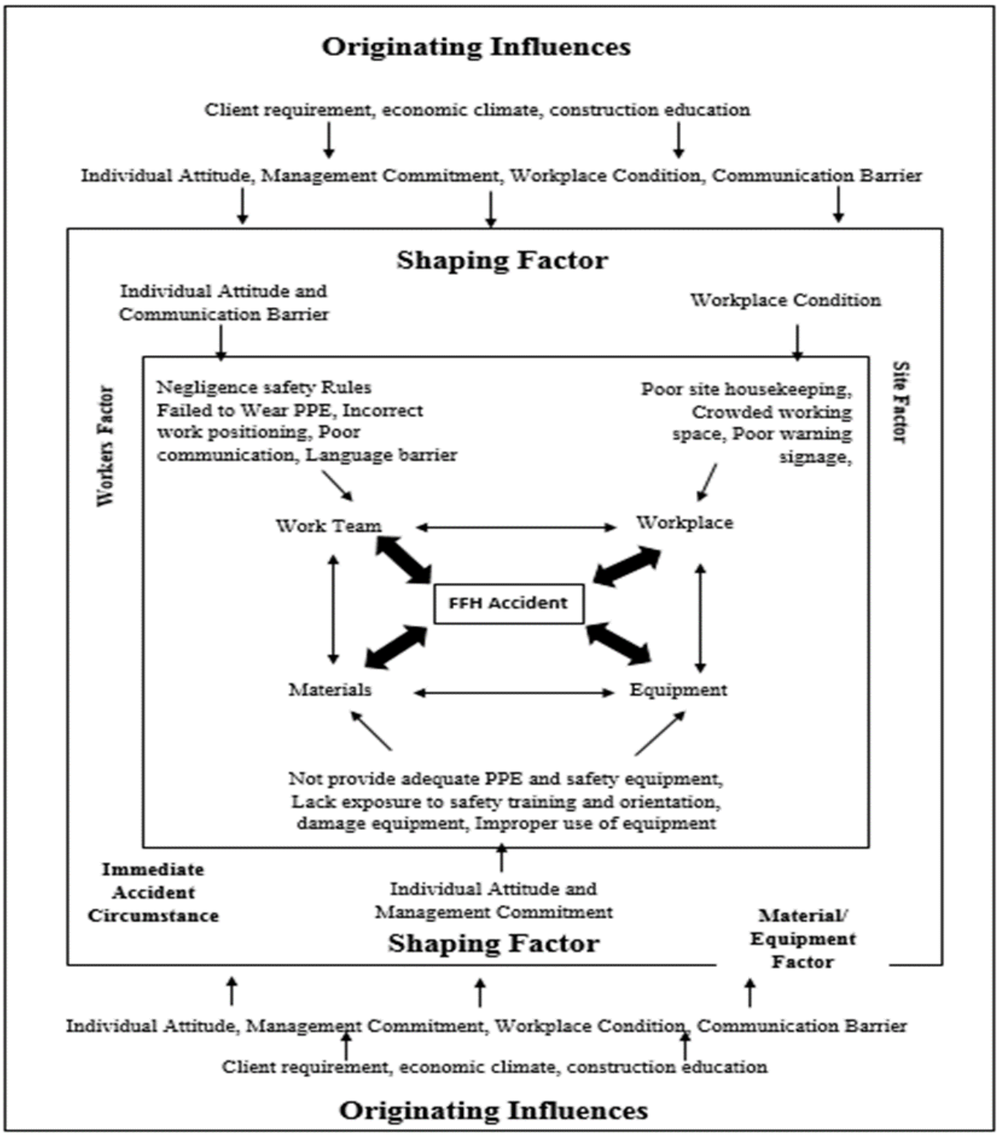

Fig. 3 - Loughborogh ConAC model for FFH accident in the Construction Industry of Malaysia

5. Conclusion

There are many factors that contributed to the FFH accidents at construction sites. This research presented the causes, effects, and mitigation measures of FFH accidents at construction sites, from the perceptions of the construction personnel who are working at construction sites in Peninsular Malaysia. The literature review identified seventeen (17) causes related to FFH accidents and categorized them into individual attitude, management commitment, workplace conditions, and communication barriers. The analysis of RII revealed that the top 5 causes of FFH accidents were negligence toward safety rules, failure to wear PPE, improper use of equipment, use of damaged equipment, and incorrect positioning and posture while working. Whilst the least significant causes were found to be bad weather (rainy/windy), followed by poor understanding of signage (safety information and warning signs), and poor warning signage.

Then, for the effect of the FFH accident at a construction site in Malaysia. There were twelve (12) effects of accidents related to FFH and were categorized into humanitarian and economic. Based on the data analysis, it can be summarized and concluded that the adverse effects of falls from height accidents are humanitarian and economic. The adverse effects were injuries or permanent disabilities, possible loss of earning ability, the fatality of workers, suffering to individuals, and getting penalties from authorities. However, the lease agreement from the respondent on the effect of the FFH accident is compensation cost, followed by the cost of training given to a new worker and the cost of recruiting a new worker.

Lastly, the FFH accident must be prevented to reduce the number of accidents at construction sites. There are many suggestions on accident mitigation measures upon FFH accidents from the previous researcher. Therefore, there were twenty (20) mitigation measures identified from the literature review and were categorized into on-site precautionary measures, followed by education and training, workplace condition, job redesign, and health protection. The five best-practice mitigation measures of FFH accidents consist of forbidding working at height if alcohol or drug has been detected on workers, identifying on-site potential risks related to fall from height accidents (HIRARC), site proactive actions, organizing courses on how to use climbing equipment (scaffold, ladder, harness) properly, organize short safety training courses for the workers, seminars, and talks focusing on work at height risks.

Then, for utilizing accident causation using the Loughborough ConAC model, significant indicators in this research were originating influences, shaping factors, and immediate accident circumstances. These four indicators gave the highest impact on fall from height accidents at a construction site in Malaysia. This utilize model is adopted from the actual Loughborough ConAC model to suit the fall from height accidents. The model indicates the main causes of falls from height accidents at a construction site in terms of individual attitude, management commitment, workplace conditions, and communication barriers.

The outcome of this research provides knowledge, and awareness and indicates that all parties involved in the construction industry need to take a big concern and must pay serious attention to reducing the number of accidents due to falls from height.

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