Occupational Accidents and Prevention through Design in The Malaysian Construction Industry

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Abstract

The construction industry plays a vital role in the social and economic development of all countries. However, it considered as one of the most vulnerable field to work-related injuries and fatalities. Thus, construction workers' safety and health should be considered as top priority. In this respect, this study focus on investigating the occupational accidents fatality and highlight the variables linked to the fatality as well to focus on prevention of the occupational accidents during the designing phase. The population size of this study is n=210 accident cases, the data collected from The Department of Occupational Safety and Health (DOSH). The study identified the relationship between fatality and 210 accidents occurred in Malaysian construction industry in the year 2018. Frequency analysis, cross tabulation and logistic regression implemented to analyze the dependent variable (fatality)'s relationship with seven independent variables using statistical tools, which include gender, nationality, cause of accident, type of accident, body part, agent of accident and month of accident. The outcomes of the statistical analysis show 6 independent variables except gender have significant link to fatality, and especially cause of accidents, type of accident and body part. They have strong relationship based on Phi or Cramer's V test. Also, preventive strategy for occupational fatal falls accident highlighted based on the falls are the leading cause of accidents. Designers can obtain great benefits from these results because some variables, can provide them with practical approach to hazard identification and design solution integration.

Keywords
Fatal occupational accidents, prevention through design, falls accidents during design, construction safety.

1. Introduction
The construction industry plays a vital role in the social and economic development of all countries. The importance and role of the construction industry in the economy of any country has been confirmed by several studies. However, when compared with other (labour intensive) industries, the construction industry has historically experienced a disproportionately high rate of disabling injuries and fatalities for its size (Khan 2008). The rules on occupational safety and health in Malaysia are comprehensive and reinforced with strict safety inspection and audit by DOSH during the proceedings of the 6th International Conference of the Asian Academy of Applied Business (AAAB) on a regular basis in 2013, accidents at construction sites are still alarming. There is a need to assess whether the number of injuries and fatalities is still at an unsustainable amount. It is very important to identify any loopholes in the enforcement of safety legislation requirements or any weaknesses in the inspection and auditing of construction sites. The aim of this study is to investigate the fatal accidents in the construction industry in Malaysia that associated with

demographic factors. This is with a view to developing an awareness that will aid decision making in the construction industry regarding health and safety (Kanchana et al. 2015).

1.1 Objectives
This study will be achieved through the following objectives:(a) to develop fatal accident construction industry profiles, (b) to study the relationship between dependent variables (fatal or not fatal) and the independent variables and (c) to purpose prevention through design for fatal falls accident.

2. Literature Review
Unplanned, unwanted, unexpected, and uncontrolled events may be defined as an accident. There is no necessity for an accident to cause injury. It can be of greatest concern in terms of damages to equipment and materials, particularly damage caused by wounds (Hamid et al. 2008). The construction industry has now been described as one of the most dangerous sectors in many parts of the world, based on labor injuries, workers ' compensation, injury and fatality rates, this is due to significant changes in industrial safety during the past decade (Chong and Low 2014).
Toole (2002) did a study in the USA and suggested that the causes of accidents were due to lack of proper training; deficient enforcement of safety; safety equipment not provided; unsafe methods or sequencing; unsafe site conditions; not using provided safety equipment; poor attitude toward safety; and isolated and sudden deviation from prescribed behavior.
A study has been undertaken to gain a new and expanded insight into the probable causes of construction accidents in Spain in order to determine the appropriate mitigation measures. A total of 1.163.178 incidents are were studied. The results showed that the severity of the accidents related to variables such as age, CNAE (National Classification of Economic Activities) code, and size of business, service life, accident location, weekday, and days of absence, deviation, injury and climate conditions. The data studied suggest that a large organization is not necessarily better in the face of tragic incidents than a small organization (López Arquillos et al. 2012).
In order to understand country specific similarities and differences in fatality risks of construction industry, a study conducted to compare the profile of fatal occupational injuries (FOI) in construction industry in three countries. Occupational fatal injury data of U.S., South Korea, and China from 2011 to 2015 were obtained from various public resources and analyzed with statistical analyses. Results showed that the construction industry in all three countries had consistently high FOI and the top common accident types were “fall from a higher level” and “struck by” (Choi et al. 2019). The irresponsible attitude of the workers during working or handling machines and discipline issues. Many accidents happen because of the irresponsible attitudes of the workers apart from their negligence and carelessness (Nawi et al. 2016).

2.1 Hierarchy of Controls
Controlling exposures to occupational hazards is the fundamental method of protecting workers. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective control solutions. As defined by NIOSH, it flows as follows: (a) elimination, (b) substitution, (c) engineering controls, (d) Administrative controls and (e) personal protective equipment. The idea behind this hierarchy is that the control methods at the top of graphic are potentially more effective and protective than those at the bottom. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness or injury has been substantially reduced. NIOSH leads a national initiative called Prevention through Design (PtD) to prevent or reduce occupational injuries, illnesses, and fatalities through the inclusion of prevention considerations in all designs that impact workers. Hierarchy of controls is a PtD strategy (CDC 2015).

2.2 Prevention through Design
Prevention through design is the technique of designing a facility in such a way that it is safe and healthy for construction workers to build goes by many names including designing for safety, safety constructability and prevention through design. The strategy typically involves identifying and mitigating hazards during the design phase by changing the design of the permanent structure so it is safer to build. According to experts, eliminating the hazard is far more effective than simply reducing the hazard or providing personal protective equipment to workers.
The most direct benefits of PtD are reduced construction injuries and increased construction worker health. Construction is one of the most hazardous industries in the U.S., typically accounting for approximately 1,000 fatalities and 200,000 serious injuries each year. All design and construction professionals recognize that the design affects the

cost, quality and duration of a construction project, so it makes sense that the design also affects the inherent risk to the workers constructing the project.
eliminating the hazard is far more effective than simply reducing the hazard or providing personal protective equipment to workers designers were recently asked to rate the importance of six aspects of their design work, it was found that construction worker safety ranked the lowest behind quality, end user safety, cost, schedule and aesthetics (Gambatese et al., 2005)
The use of the technique will also increase during the design of high performance sustainable buildings as new knowledge of the hazards and viable design interventions improves (Dewlaney and Hallowell 2012).The most direct benefits of PtD are reduce construction injuries and increase construction worker health (Toole and Carpenter 2012). A promising technique is construction hazard prevention through design (CHPtD). Logically, CHPtD is only effective to the extent that construction hazards have emerged and are recognizable during the design phase (Hallowell and Hansen 2016).Workplace safety typically receives the lowest level of priority during facility design compared with other design criteria. The apparent lack of safety training and knowledge observed among the study sample may be a key reason behind the lack of priority given to workplace safety (Ali et al. 2018).

2.3 Construction Design and Management
The Construction (Design and Management) Regulations 1994 came into effect on the 31st March 1995 and implements EC Council Directive 92/57/EEC which relates to the provision of minimum health and safety requirements at temporary or mobile construction sites. The regulations are considered to be more demanding than the minimum requirements of the directive.
The fundamental principles on which the CDM Regulations are based are (a) safety is to be considered systematically, stage by stage, from the outset of the project, (b) all members who contribute to the health and safety on a project are to be included, (c) Proper planning and coordination must be undertaken from the outset of the project, (d) provision of health and safety is to be within the control of competent persons, (e) communication and the sharing of information between all parties must be included, (f) a formal record of safety information for future use must be made.
The CDM Regulations bring health and safety management, on an obligatory basis, into the planning and design of construction work. Thus the contractor is no longer left with the sole responsibility of health and safety during construction.
Designers may include architects, consulting engineers, surveyors, specifiers, principal contractors and specialist subcontractors. The term `design' has a wide definition under the regulations; it includes drawings, details and specifications. The main requirement of designers is to deal with health and safety issues by designing them out ``so far as is reasonably practicable'', that is, by balancing the risk against the cost of averting it (Baxendale and Jones 2000).

2.4 Occupational Safety and Health Construction Industry management (OSHCIM)
The concept of OSHCIM is to design out the risk at the early stage, which apply the principle of "who create the risk should manage the risk". Hence, in order to practice this concept risk management approach and general prevention principle were carried out at the design stage. The current OSHCIM practice in Malaysia construction industry was found to be "Practice" among the construction stakeholders in their construction projects. The OSHCIM management element items such as written policy, OSH information sharing, the responsibility of the project team, OSH communication system, monitoring arrangement, training programs, duties competency and self OSH awareness were among the management practices that have been analysed and currently being implemented in the construction industry by the stakeholders (Mohd et al. 2020).

3. Methods
This study is separated in two-phase. In phase one, the first step the literature review is conducted. Relevant previous studies related to occupational falls and prevention through design is conducted. From the analysis, the existing results the gap of the study were identified. Also, the problems statement is defined. Objective and scope of the study are derived. Malaysian construction industry is selected, because of the high accident rate and limited mitigation strategies.
In phase two, data from DOSH database are collected in this research, which are primary data and secondary data. Primary data is obtained from DOSH for the year 2018 and secondary data obtain from published materials such as books, journal, and internet resources. The collected data has been analyzed using the Statistical Package for the social science (SPSS) software and Excel to identify the frequencies of accidents based on demographic characteristics. Also a review and comparison for published materials such as books, journal, and internet resources in order to propose the

best prevention strategy to eliminate or minimize the accidents. The validation is a comparison of the analyzed results with historical data or recent studies. The result is a frequencies, percentages and graphs from SPSS and excel software. A discussion on the comparison result of the data analyzed has been summarized in tabular format.

Seven categorical variables which can be used to analyze those independent variables' relationship with fatality, based on the initial categories and the possibility of extraction from the original data. The independent variables include (1) gender, (2) nationality, (3) cause of accident, (4) type of injury, (5) body part, (6) agent of accidents, and (7) month of accident.

The variables for each category have values as many as possible at the Initial stage because those values can provide designers with a great indication regarding hazard identification and design optimization the final variables and values of the research database.

4. Data Collection

The data source used in this study was collected from the database of Department of Occupational Safety and Health in Malaysia (DOSH). DOSH have been investigated incidents when fatal accidents occur at construction sites and record to the database under the Occupational Safety and Health Acts and data obtained in Excel file. 5031 accidents have been reported in all industries, 210 accidents reported in the construction industry occurred in the year 2018. The data initially included the following categories: the industry sector, gender, date of death, nationality, time of accidents, type of incident, cause of accidents, body part.

5. Results and Discussion

In order to detect the distributions of the values of each variable, frequency analyses were performed and then cross tabulation analysis applied to identify each of the dependent variable and the independent variable, to define the effect on the fatality of each individual variable.

In each combination of two cross-table values, the number of cells in a cross-table shows how many observed data are involved and the frequency of the combination-value are observed. The analysis of the cross-table was conducted using Pearson Chi Square and Phi or Cramer's value with the use of the SPSS software.

This test is usually adopted to identify the significance of the relationship between two variables where p-value indicates whether or not the observed data are consistent with the hypothesis that was previously formulated. If the p-value is less than 0.05 (confidence level of 95%), the null hypothesis, which is the two variables are independent, is then rejected. This mean the relationship of the two tested variables are statistically significant. In addition, Phi or Cramer's value was introduced to check the relative strength of the relationship between the two variables: if the value indicates 0-0.1, it means weak relationship; 0.1-0.3 means moderate relationship; 0.3-1.0 means strong relationship. In this study, dependent variable (fatality)'s relationship with each of 7 independent variables was examined.

Frequency analysis was first performed to identify the distribution of values in each coded area. The dependent variable frequency which indicates the relationship between fatality and independent variables were designed and displayed as a Table 1 in which each variable and its value frequency can be easily compared to other.

5.1 Frequency Analysis

Table 1 shows the number of accidents happened to the whole construction industry and the number of accidents involving men and women on construction sites in Malaysia for the year 2018, the number of accidents that were reported was 210 cases. In the case of accidents causing permanent disability, as many as 8 cases were recorded. Accidents that cause deaths are 96 and temporary disability are 106.

The frequency analysis of independent variables is shown in the Table 1, and each variable has its own characteristic of distribution. With respect to gender, males are the leading where 93 cases were killed, accounting for 96.9%, then females are followed (3.1%), most reported cases involved male workers because of the relatively low number of female workers on construction sites. the number of construction workers in 2000–2009. Only 9% of the total number of construction workers were female workers; according to the classification of the Department of Statistics Malaysia of female (95 000 in 2010 and 103 300 in 2011) and male workers (987 700 in 2010 and 1 030 300 in 2011) in the construction industry (Chong and Low 2014). Bangladesh is the majority of nationalities where 36 fatal accidents occurred, which accounts 37.5%, followed by Malaysia and Indonesia which accounted 28.1% and 24% respectively because there is still heavy dependence on foreign workforce especially from Indonesia and the Association of Southeast Asian Nations (ASEAN) region (Marhani et al. 2012).

The causes of the accidents accounted 45 cases of fatal accidents caused by falls with a percentage of 46.9% of the total fatal accidents, falling from height or from the same level has recorded the highest number of reported fatal accidents on construction sites (OSHA 2020) in Malaysia which is similar with the findings of (Hamid 2019) and According to recent statistics, falls from heights are the leading cause for at least a third of all construction accidents, based on the accident reports from Malaysia, United States of America (USA) and Great Britain (Zermane 2020) , although struck by falling objects score 23 cases with a percentage of 24% to be consider the second highest cause of fatal accidents. The third highest accident factor that contributed to the death at the construction site is from caught between objects.

In terms of type of accident, the result shows that the highest number of cases resulting to death recorded was due to contusions and crushing with 14 cases and accounted 14.6%. The head recorded as the leading body part injured and cause death among all the accidents with a frequency of 22 cases and a percentage of 22.9%, followed by general injuries, poisoning and diseases recording 15 cases and 15.6% of the total accidents.

Tools and working environment scored the highest in terms of agent of accident 41 and 26 cases which accounted 42.7% and 27.1% respectively due to the lack of experience in the field and the ignorance of the management for the safety of the working environment.

The month of accidents shows an approximate same number of cases through the whole year except in October and April where the accidents increased slightly with a score of 16 and 14 cases respectively accounted 16.7% and 13.5% of the total fatal accidents.

5.2 Cross Tabulation Associated With Chi Square Test

Cross tabulation methodology was adopted to analyze the relationship between dependent variable (Linkage to fatality) and 7 independent variables, and this analysis was associated with Chi-Square test and Phi or Cramer's Value which indicate the significance and strength of the two variable's correlation as shown in Table 2.

In reference to the Table 2, it indicates that all the independent variables except the variable of gender have significant relationships with fatality because the p values for Chi Square test for nationality, cause of accident, type of accident, body part, agent of accident and month of accident are less than 0.05 rejecting the null hypothesis that the two variables are independent. Phi or Cramer's values indicate that cause of accidents, body part and type of accident have strong relationship with fatality, and the linkage between the variables of nationality, agent of accident and month of accident and fatality has moderate strength.

Table 2 shows that nationality has moderate strength relationship with the fatality base on the Phi or Cramer's value (0.390) and on p value of chi square is less than 0.05, and Table 1 shows the workers from Bangladesh has the highest number of cases 36 fatal cases (37.5%) due to high dependency on foreigner workers with low salary and less education which has low level of awareness followed with the Malaysian and Indonesian. The Malaysian construction sector employs approximately 9% (or 900,000) of the total workforce in Malaysia. However, there is still heavy dependence on foreign workforce especially from Indonesia and the Association of Southeast Asian Nations (ASEAN) region. The use of foreign workforce has caused several problems on productivity of the Malaysian construction companies. The first of these is the low initiative to adopt more productive and modern methods of construction. Next is the availability of cheap foreign workers which are cheaper compared to employ the local workers (Marhani et al. 2012).

Based on the Table 1, falls are the leading of cause of accidents linked to the fatality, 45 fatal falls cases occurred with percentage of 46.9 % of the total fatal accidents that could have been prevented by design suggestions and guidelines, accounting This is probably because most projects where fatal fall accidents happened were new buildings or the extension of the previous ones. Another thing that should be considered is that maintenance or repair projects have relatively strong relationship with design. This is because some design guidelines or suggestions focus on the safety of maintenance or repair work, for instance designing safe access to roof for the future work, and placing electrical control boxes at lower level to reduce working on ladders for repair. The Phi or Cramer's value (0.569) indicates that the two variables have strong relationship with p value of chi square of (0.00) which is indicate that the fatality have significant relationship with cause of accident.

As mentioned in the Table 1 contusions and crushing dominate the type of fatal accidents. Where 14 fatal cases could have been prevented by design , accounting for 14.6%. This is probably because construction sites are filled with large machines, including pistons, cranes, and heavy equipment. If the machine moves over a worker with enough force, it can lead to a crush injury. Any employee operating these types of heavy equipment must be cautious and alert at all times, also falling objects, such as materials, collapsing structures, and even tools can lead to crushing injuries. Hardhats may protect the workers' heads, but they do not protect other vulnerable areas of their body, including appendages or being run over by large equipment, such as a bobcat or forklift, is another cause of crushing injuries on the job site. These pieces of equipment weigh thousands of pounds and can cause fatal injuries. As well construction work relies heavily on digging trenches for utility lines, footings, and foundations. When the site does

not shore and secure these trenches properly, the sides of the trench can collapse and crush anyone caught inside of them. The Phi or Cramer's value (0.512) it shows how strong the relationship between the variables.
The body part and agent of accident are significant variables scoring p value of Chi square test of 0.000 and 0.002 respectively with strong relationship for the body part with Phi or Cramer's value (0.541) and moderate relationship for the agent of accident scoring (0.337).
P value for chi square test for the last variable (month of accident) it shows a significant value of (0.042) which indicate that the due to the shortage of data this value can be not significant in the future studies also if the confidence level is (99%) this variable won be significant. Phi or Cramer's value (0.311) shows the relationship is moderate.

5.3 Logistic Regression Analysis

Because the dependent variable (fatality) has a binary nature, which means the variable has two values of fatal and non-fatal, logistic regression methodology was adopted in this study. This logistic regression model aims at the evaluation on which factors in the 210 accidents are highly connected to fatality. For this analysis, six independent variables were chosen based on the results of the previous cross tabulation analysis indicating their significant relationships with the fatality . The selected variables include gender, nationality, cause of accident, type of accident, body part, agent of accident and month of accident.
The Hosmer and Lemeshow test score 0.012 that indicates that this model is a poor fit because the significance p-value is less than 0.05 as shown in Table 4 however if p value less than 0.01 it should be good fit. Cox and snell R square and Nagelkerke R Square score 29.8% and 39.9% respectively indicating the model is moderately fits the data as in Table 5. The results of logistic regression analysis using SPSS program show that each accident case related to fatality could be predicted in 75.7 %, by comparing the observed and predicted results from the model. Given in the Table 3, the significance p-value for 3 variables (nationality, cause of accident and type of accident) are less than 0.05, which means those variables are significantly related to dependent variable (fatality); especially the significance p-values of the variable, cause of accident, indicate 0.000.

5.4 Numerical Results

Table 1: Demographic results

Independent Variables	Values	Fatal		Non-fatal	
		Freq	%	Freq	%
Gender	- Male	93	96.9	109	95.6
	- Female	3	3.1	5	4.4
Nationality	- Bangladesh	36	37.5	15	13.2
	- China	3	3.1	1	0.9
	- Indonesia	23	24	21	18.4
	- Malaysia	27	28.1	69	60.5
	- Myanmar	3	3.1	1	0.9
	- Nepal	2	1	1	0.9
	- Pakistan	3	3.1	2	1.8
	- Other nationality	0	0	2	1.8
	- India	0	0	1	0.9
	- Philippines	0	0	1	0.9
Cause of accident	- Falls of persons	45	46.9	25	21.9
	- Struck by falling objects	23	24	4	3.5
	- Stepping on, striking against or struck by objects including falling objects	7	7.3	9	7.9
	- Caught in or between objects	15	15.6	23	20.2
	- Overexertion or strenuous movements	0	0	3	2.6
	- Exposure to or contact with extreme temperatures	1	1	5	4.4
	- Exposure to or contact with electric current	3	3.1	0	0
	- Other types of accident, not elsewhere classified, including accidents not classified for lack of sufficient data.	2	2.1	45	39.5
Type of accident	- Fractures.	4	4.2	6	5.3
	- Sprains and strains.	0	0	2	1.8

	- Concussions and other internal injuries.	9	9.4	6	5.3
	- Amputations and enucleations.	1	1	2	1.8
	- Other wounds.	4	4.2	17	14.9
	- Superficial injuries.	0	0	1	0.9
	- Contusions and crushings.	14	14.6	1	0.9
	- Burns.	2	2.1	14	12.3
	- Asphyxia.	3	3.1	0	0
	- Effects of electric currents.	2	2.1	0	0
	- Multiple injuries of different nature.	18	18.8	2	1.8
	- Other and unspecified injuries.	39	40.6	63	55.3
Body part	- Head	22	22.9	7	6.1
	- Trunk	2	2.1	6	5.3
	- Upper limb	0	0	23	20.2
	- Lower limb	2	2.1	9	7.9
	- Multiple locations	29	30.2	4	3.5
	- General injuries/poisonings/diseases	15	15.6	18	15.8
	- Other	26	27.1	47	41.2
Agent of accident	- Machines	6	6.3	7	6.1
	- Means of transport and lifting equipment	10	10.4	15	13.2
	- Other equipment	0	0	1	0.9
	- Refrigerating installation, including electric motors	0	0	1	0.9
	- Tools, implements and appliances, except electric hand tools	41	42.7	58	50.9
	- Materials, substances and radiations	2	2.1	14	12.3
	- Working environment	26	27.1	9	7.9
	- Other agencies, not elsewhere classified	9	9.4	9	7.9
	- Agencies not classified for lack of sufficient data	2	2.1	0	0
Month of accident	- January	7	7.3	12	10.5
	- February	7	7.3	11	9.6
	- March	5	5.2	7	6.1
	- April	13	13.5	7	6.1
	- May	7	7.3	5	4.4
	- June	8	8.3	8	7
	- July	9	9.4	8	7
	- August	6	6.3	7	6.1
	- September	6	6.3	10	8.8
	- October	16	16.7	11	9.6
	- November	7	7.3	3	2.6
	- December	5	5.2	25	21.9

Table 2: Chi Square values and Phi or Cramer's V

Independent variables	**Chi Square Value**	**DF**	**Significance (p)**	**Phi or Cramer's V**	**Sig if p ≤0.05**
Gender	0.226	1	0.634	0.033	Not sig
Nationality	35.005	9	0.000	0.390	sig
Cause of accident	67.983	7	0.000	0.569	sig

Type of accident	54.956	11	0.000	0.512	sig
Body part	61.374	6	0.000	0.541	sig
Agent of accident	23.886	8	0.002	0.337	sig
Month of accident	20.272	11	0,042	0.311	sig

Table 3: Logistic regression analysis

Variable	**B**	**S.E.**	**Wald**	**df**	**P**	**Exp(B)**	**95% C.I.for EXP (B)**	
							Lower	**Upper**
Gender	-0.206	0.814	0.064	1	0.800	0.814	0.165	4.011
Nationality	0.237	0.092	6.618	1	0.010	1.267	1.058	1.517
Cause of accident	0.530	0.084	39.787	1	0.000	1.699	1.441	2.004
Type of accident	-0.099	0.047	4.341	1	0.037	0.906	0.825	0.994
Body part	-0.098	0.086	1.298	1	0.255	0.906	0.766	1.073
Agent of accident	-0.005	0.086	0.003	1	0.958	0.995	0.841	1.179
Month of accident	-0.069	0.047	2.147	1	0.143	0.933	0.850	1.024
Constant	-0.785	1.269	0.383	1	0.536	0.456		

Table 4: The Hosmer and Lemeshow test

Step	**Chi-square**	**df**	**Sig.**
1	19.641	8	.012

Table 5: Model summary

Step	**-2 Log likelihood**	**Cox & Snell R Square**	**Nagelkerke R Square**
1	215.221a	.298	.399

5.5 Prevention through Design for Occupational Falls Accidents

A designer has a strong influence, particularly during the very early planning and design stages of a project. Their decisions can affect the health and safety of not only those contractors and workers carrying out the construction

work, but those who use, maintain, repair, clean, refurbish and eventually demolish a building. Decisions such as selecting materials or components of a building can avoid, reduce or control risks involved in constructing a building and maintaining and using it after it is built (HSE 2020).
Based on the previous analysis it shows the occupational falls is the leading cause of accident in construction industry. The key finding of research by (Kyunghwan 2015) is that end-use construction, type of project, cost of the project, fall height, fall position and the Standard Industrial Classification (SIC) code are significant linked to design in terms of prevention of fall; in particular the linkage between design solutions and two the variables, which are the location of the falls and the SIC code, therefore some of the preventives techniques suggested based on the previous studies:

- Parapet wall on roof edge (during design).
- Fall prevention through skylights (during design).
- Roof anchors (during design).
- Fixed ladder (during design).
- Prefabrication and assembly at ground level (during construction).
- Fall protection (during design).
- Guide for roofing (during design).
- Guide for steel work (during design).
- Suspended access equipment (during design).
- Temporary structures (during construction).
- Towel rail in steel structure (during design).

6. Conclusion

During the past decades, the construction industry has been considered as one of the most vulnerable field to work-related injuries and fatalities, where construction workers' safety and health are not usually considered as top priorities because the contractors, who are normally small sized construction firms or self-employed, do not have safety budget to deal with construction workers' safety.
The main objective of this study to highlight the construction fatal accidents and investigate the variables connected to fatality, although to provide the designers with some prevention through design strategies to reduce or eliminate the fatal fall accidents.
The relationship between fatality (dependent variables) and 7 independent variables such as gender, cause of accident, body part and month of accident was investigated.210 accidents occurred in the industry in the year 2018, the data analysed using SPSS software to highlight the frequencies and the relation to the fatality.
The outcomes of the statistical analysis show 6 independent variables except gender have significant link to fatality, and especially cause of accidents and ,type of accident and body part have strong relationship based on Phi or Cramer's V test. Also, preventive strategy for fatal falls accident highlighted based on the falls are the leading cause of accidents. Based on the outcome of the analysis highlighting falls accident as the main cause of accidents some designing guidelines suggested based on the previous studies such as parapet wall on roof edge, fall prevention through skylights, roof anchors, fixed ladder and prefabrication and assembly at ground level.
The lack of experience and expertise in implementing safe design processes is a major barrier; researches suggest that designers have difficulty recognizing hazards and incorporating design solutions when applying safety concept design to their design process. The basis of the study was that the previous studies discussed the concept of construction safety design is the most effective approach to the prevention of occupational accidents within the construction industry but many professionals working for construction don't agree of this concept.
The findings of this study are essentials in terms of reducing cost, saving time for designers and contractors and also saving lives in the site.
As a recommendation for further studies it's required to do deeper investigation about the cause of accidents and highlight the factors involved to cause the accidents, although further studies required in terms of prevention through design concept and a trial of the concept on sites and analyse the progress and efficiency of the suggested concept.

References

Khan, Raza Ali. 2008. "Role of Construction Sector in Economic Growth : Empirical Evidence from Pakistan Economy." in First International Conference on Construction in Developing Countries (ICCIDC).
Kanchana, S., P. Sivaprakash, and Sebastian Joseph. 2015. "Studies on Labour Safety in Construction Sites." Scientific World Journal.
Hamid, Abdul Rahim Abdul, Muhd Zaimi Abd Majid, and Bachan Singh. 2008. "Causes of Accidents At Construction

Sites." Malaysian Journal of Civil Engineering.
Chong, Heap Yih, and Thuan Siang Low. 2014. "Accidents in Malaysian Construction Industry: Statistical Data and Court Cases." International Journal of Occupational Safety and Ergonomics.
O'Toole, Michael. 2002. "The Relationship between Employees' Perceptions of Safety and Organizational Culture." Journal of Safety Research.
López Arquillos, Antonio, Juan Carlos Rubio Romero, and Alistair Gibb. 2012. "Analysis of Construction Accidents in Spain, 2003-2008." Journal of Safety Research.
Choi, Sang D., Liangjie Guo, Jaehoon Kim, and Shuping Xiong. 2019. "Comparison of Fatal Occupational Injuries in Construction Industry in the United States, South Korea, and China." International Journal of Industrial Ergonomics.
Nawi, Mohd Nasrun Mohd, Siti Halipah Ibrahim, Rohaida Affandi, Nor Azalina Rosli, and Fazlin Mohamad Basri. 2016. "Factor Affecting Safety Performance Construction Industry." International Review of Management and Marketing.
Center of Disease Control and Prevention. Hierarchy of Controls
Available: https://www.cdc.gov/niosh/topics/hierarchy/default.html, January 13, 2015
Gambatese, John A., Michael Behm, and Jimmie W. Hinze. 2005. "Viability of Designing for Construction Worker Safety." Journal of Construction Engineering and Management.
Dewlaney, Katie Shawn, and Matthew Hallowell. 2012. "Prevention through Design and Construction Safety Management Strategies for High Performance Sustainable Building Construction." Construction Management and Economics.
Toole, T. Michael, and Gabrielle Carpenter. 2012. "Prevention through Design: An Important Aspect of Social Sustainability." in ICSDC 2011: Integrating Sustainability Practices in the Construction Industry – Proceedings of the International Conference on Sustainable Design and Construction 2011.
Hallowell, Matthew R., and Daniel Hansen. 2016. "Measuring and Improving Designer Hazard Recognition Skill: Critical Competency to Enable Prevention through Design." Safety Science.
Baxendale, Tony, and Owain Jones. 2000. "Construction Design and Management Safety Regulations in Practice Progress on Implementation." International Journal of Project Management.
Mohd, Norhazren Izatie, Hamizah Liyana Tajul Ariffin, Muhammad Hamka Abdul Hamid, Kamarizan Kidam, Mohammad Ismail, Kherun Nita Binti Ali, Nur Emma Mustaffa, Jafri Mohd Rohani, Noor Nabilah Sabrini, Samsiah Abdullah, Nazruddin Bin Mat Ali, and Muhammad Syaiful Ahdat M. Fetri. 2020. "Occupational Safety and Health Construction Industry Management (OSHCIM): Current Practice in Malaysia." in IOP Conference Series: Materials Science and Engineering.
Abderrahim Zermane, Mohd Zahirasri Mohd Tohir, Mohd Rafee Baharudin2 and Hamdan Mohamed Yusoff1. 2020. "Analysis of the Contributing Factors for Fatal Accidents due to Falls from Heights in Malaysia and the USA."Safety Engineering Interest Group, Department of Chemical and Environmental Engineering.
Occupational Safety and Health Administration 2020, United States, accessed 22 September 2020, <https://www.osha.gov/ >
Health and Safety Excutive 2020, United Kingdom, accessed 22 September 2020, < https://www.hse.gov.uk/ >
Marhani, Mohd Arif, Aini Jaapar, and Nor Azmi Ahmad Bari. 2012. "Lean Construction: Towards Enhancing Sustainable Construction in Malaysia." Procedia - Social and Behavioral Sciences.
Kyunghwan Kim. 2015 "Statistical Approach To design For Fall Prevention In Construction" ProQuest LLC.

Biography

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