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Causes of fatal construction accidents in Malaysia

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Abstract. Malaysia has moved fast to keep pace with the changes of times as the country aspires to achieve strong economic growth and to chart its course as a developed nation by the year 2020. The construction industry is one of the important sectors for nations to develop our country's economy and thus able to improve our competitiveness. However, in line with the positive growth of the economy, the construction sector also contributes to the high accident fatality rate. Construction workers are often exposed to various inherent risks associated with working conditions on construction sites. Although various approaches have been implemented in order to prevent accidents, the statistic indicates further improvement need to be taken fast. The objective of the study is to analyse the statistics and causes of fatal accidents at construction sites in Malaysia. The study focuses on 129 fatal construction accident cases based on database and document kept by the Malaysian authority, such as Department of Occupational Safety and Health (DOSH) and Social Security Organisation (SOCSO). The collected data were analyzed using frequency analysis and content analysis. The analysis shows that the number of fatal accidents is increasing every year. In the last five years, statistic from SOCSO and DOSH has shown an increasing number of fatal accident cases for about 231.9% and 125.8% respectively. The top three causes of fatal construction accidents are unsafe methods, the unique nature of industry and job site conditions. Whereas, the leading sub-causes are work at high elevation, incorrect or no work procedure and failure of structure.

1. Introduction

Malaysia has moved fast to keep pace with the changes of times as the country aspires to achieve strong economic growth and to chart its course, as a developed nation by the year 2020 [1]. The construction industry is one of the important sectors for nations to develop. Through this, it can give a major contribution to our country's economy and thus able to improve our competitiveness [2-4].

However, in line with the positive growth of the economy, the construction sector also contributes to the high accident rate. Accidents contribute to the cost of construction, directly through increased



compensation and insurance, and indirectly through decreased productivity, quality non-conformance and schedule overruns. The characteristics of the industry and the challenges they create for safety and health are well documented. Construction is often classified as a high-risk industry because it has historically been plagued with much higher and unacceptable injury rates when compared to other industries. The fatality rate from construction accidents are among the highest compared to the overall industry. Construction area is always exposed to the hazard because of its unpredicted behaviour. Over the years, there have been several deaths caused by fall from heights.

The construction industry remains one of important sectors in Malaysia, creating employment to around 1.33 million people represents 9.1% of total employment in 2017. Statistics from the Social Security Organisation (SOC SO) indicate that 7,338 accidents were reported in the construction industry in 2016, compared with 4,330 cases in 2011, an increase of 69.47%. Based on the Department of Occupational Safety and Health (DOSH) records, 106 deaths were reported in the construction industry in 2016 compared with 88 in 2015. These statistics, especially those involving fatalities, are worrying as they only covered cases investigated by DOSH. If we consider unreported cases, the figure would be higher. According to Anton [5], accidents are unplanned and unintentional events that result in harm or loss to personnel, property, production or nearly anything that has some inherent value such as targets. In many parts of the world, the construction industry has been identified as one of the most hazardous industries and falls from height are a leading cause of fatalities in construction operations [6]. Among the most common cases are falls from ladders and through fragile surfaces or unstable structures such as badly erected scaffolds and soft concrete mixture.

Records tend to show that the construction industry is among the leaders in the frequency of injuries and fatalities. The number of construction accidents has increased by 55.7 per cent from 4,207 cases in 1993 to 6,552 cases in 2014. In addition, the fatality rate has increased by 74 per cent from 51 cases in 1993 to 89 cases in 2014. Between 2004 and 2013, 460,022 workers suffered from an injury caused by their job and 810 workers died at construction sites. These rates were on a par with the number of cases in the manufacturing industry, although the manufacturing sector produced a larger volume of works and a higher number of occupational accidents. The current number of incidents, injuries and fatalities recorded are still high and unacceptable as compared to other developed countries. This is due to the current practices of the construction industry, which often take place outdoors under conditions which are not favourable to health and safety. The main cause of accidents in construction is falling from elevation, like a fall from a roof, scaffolding collapses, and structures collapsing, followed by being struck, which includes, being struck by falling objects, run over by heavy equipment, or struck by a crane, boom or load.

Although, there have been various efforts to curb the accidents, the number of fatal accidents happened at the construction site in Malaysia has continually increased in number. Through the studies that have been conducted by Hamid et al. [7], the statistics for accidents that occurred in the construction industry show that the accident rate in the construction industry for the country is still high. These numbers give a clear picture that the construction industry in this country is one of the critical sectors and need a big improvement in terms of safety practices at the construction site. Therefore, there is a need to conduct research on this topic as to exemplify current status with regards to fatal construction accidents which eventually could trigger greater awareness among stakeholders to come out with a better long-term solution.

2. Construction accident

According to Ling et al. [8], the indicators compiled for workplace safety usually include fatality rate, injury rate, accident frequency rate and accident severity rate. Compared to other employment sectors, the construction sector has the highest number of accidents that resulted in injury or even death. The incidence of accidents on construction sites has led to thousands of injuries at work and contribute nearly 20 percent mortality rate in the private sector in the USA [9]. According to Anton [5], an accident can be defined as an event that is unplanned and unintentionally, where it can lead to an accident or loss to person, property, production or anything that has inherent value that exists. These

accidents can result in significant losses to an organization in terms of high production costs, less efficiency, and long-term effects such as decreased employee morale and discredit an organization in the public eye [9]. Normally, accident which can lead into fatality is classified according to type as shown in Table 1 [10].

The construction industry is known as one of the riskiest sectors in terms of accidents at work and also from an economic standpoint. Accidents happen to almost every project in the construction industry. Usually, when an accident happened, it will not only give an impact on the economic and time, but also involve human lives. From all Asian's countries, Hong Kong had the highest death rate per year, with an average score of 60.53 per 100,000 workers from 1999 to 2008. According to [11], these statistics include the number of workers employed outside Hong Kong but under the control of companies located in Hong Kong. For Europe, the Turkish had the highest mortality rate with the average of 37.32 from 100,000 workers within the ten years, followed by Romania with the fatality rate of 25 per 100,000 workers. According to the DOSH [12], in year 2018, a total of 1,809 accidents for all sectors up to June 2018 were recorded. Of this, a total of 95 accidents are from the construction sector. Out of the number, 52 cases of fatalities were recorded, making the construction industry the highest number of fatal accidents of the all industries. Based on these statistics, the construction industry is a sector with high risk for the occurrence of fatal accidents.

Table 1. Types of major accidents and definition of the types of accidents.

Types of Accidents	Definition
Fall	<ul style="list-style-type: none"> • Fall hazard incidents are injuries produced by impact between the injured person and the source of injury when the motion producing contact was generated by gravity • Examples are such as falls from ground level to lower levels or from elevation, fall through opening floor or area, fall on the same level and jumps from structures and equipment
Struck-by	<ul style="list-style-type: none"> • Struck-by injuries are produced by forcible contact or impact between the injured person and an object or piece of equipment • Struck-by hazards can be categorized into four that is struck-by falling object, struck-by flying objects, struck-by swinging object, and lastly, struck-by rolling object
Caught-in or in-between	<ul style="list-style-type: none"> • This type of injuries is resulting from a person being squeezed, caught, crushed, pinched, or compressed between two or more objects, or between parts of an object. • This includes individuals who get caught or crushed in operating equipment, between a moving and stationary object, between other mashing objects, or between two or more moving objects.
Electrocution	<ul style="list-style-type: none"> • Electrocution results when a person is exposed to a lethal amount of electrical energy. • For electrical hazard, it can be defined as exposing workers to a serious workplace hazard such as burns, electrocution, shock, arc flash/arc blast, fire, and explosions.

An accident will not happen by itself, but there are triggers for it to happen. According to Ridley [13], 99 percent of the accidents that occur are caused by unsafe behavior or unsafe conditions or both.

Unsafe behavior can be defined as a violation of security procedures that have been set up can result in a loss. While unsafe conditions are physically dangerous situations or situations where it can cause accidents events. While Abdel Hamed and Everett [14] defines unsafe conditions as a condition in which the layout of the workplace or the physical location of the work, the state apparatus, equipment and/or materials that have been in violation of safety standards. There were many theories related to the causes that lead to accidents that can be used to find out the causes of an accident. There are parties that focus on a physical hazard (unsafe condition), human behavior (unsafe acts), and there is a view from a management system failure [15]. An approach that combines all of these areas is the most productive since accidents are usually complex events that involve all of these areas. When conducting investigations, all factors and physical hazards and the environment, which may have contributed to the accident should be considered [16].

The main cause of accidents involving fatalities on construction sites is due to lack of understanding or ignoring the security measures that have been established [17]. The impact of past history, the economy, psychology, technical, procedural, organizational and environmental issues are considered as factors associated with the level of safety of a construction site [18]. In general, the incidence of accidents on construction sites are often caused by either lack of knowledge or training, lack of monitoring from the top, or from the negligence of the individuals themselves. According unsafe behavior is the main factor of the accident at the construction site and that this proves that there is less cultural security practice [19-21]. The common causes of construction accidents could be attributed to multiple factors as shown in Figure 1.

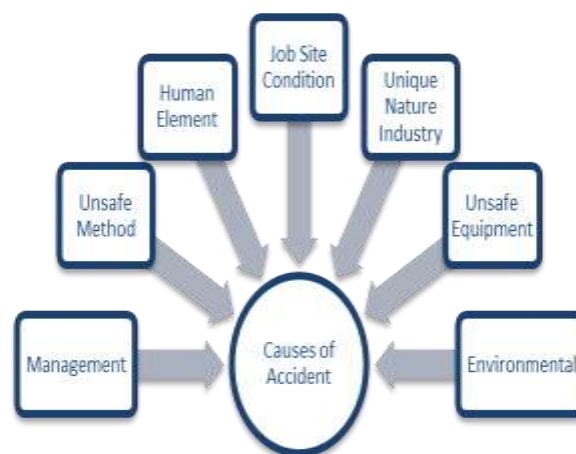


Figure 1. Causes of fatality accidents at construction sites.

3. Methodology

In this study, database and document search method from the primarily Malaysian Department of Occupational Safety and Health (DOSH), Malaysian Social Security Organisation (SOCSO), National Institute of Occupational Safety and Health (NIOSH), International Labour Organization (ILO), published reports, journal paper, etc. The database and document search from DOSH was collected from the previous seven years involving 129 fatal construction accident cases in Malaysia from 2009 until 2015. While, the search from SOCSO database and annual reports was from the period of 2009 until 2014. The data was analyzed using frequency distribution analysis and content analysis method. The data were categorized on several features such as by type of fatal accidents, statistic of fatal construction accidents, causes of fatal accidents and many more. The results were discussed and presented in tables and figures to simplify the understanding on the subject matter.

4. Results and discussion

The database and document search from DOSH was collected for the previous seven years involving fatal construction accident cases in Malaysia from 2009 until 2015. While, search from SOCSO database was from the period of 2009 until 2014. The statistic and causes of fatal construction accidents are as shown in the following sections.

4.1. Construction accident statistic from SOCSO records

Figure 2 shows the number of accidents happened to the whole industries in Malaysia namely manufacturing; mining and quarrying; construction; agriculture, forestry and fishery; utilities (electricity, gas, water and sanitary services); transport, storage and communication; wholesale and retail trades; hotels and restaurants; finance, insurance, real estate and business services; public services and statutory authorities; and others. The data were available from the year of 2009 until 2014. The rate of accidents is increasing every year except for the last year of 2014, which is decreasing slightly. Figure 3 shows the number of accidents involving men and women on construction sites in Malaysia for the year 2009 to 2014. According to the report from SOCSO, the overall number of accidents for that particular year was 31,347 cases (8.7 per cent of industrial accidents). In 2009, the number of construction accidents reported was 4,108. However, this figure is growing from year to year. Until the end of 2014, the number of accidents that were reported was 6,552 cases. This rate of accidents is consistently increasing by 59.5 percent from 2009 to 2014. Of the total accidents at construction sites, 651 fatality cases have been recorded. In the case of accidents causing permanent disability, as many as 6,783 cases were recorded. Accidents that cause deaths and permanent disability can be seen in Figure 4.

For fatality accident cases, this amount comprises 2.1 percent of the total number of accidents at the construction site for the full year of 2009 to 2014. Overall, the number of deaths is increasing every year. Starting from the year 2009, a total of 47 deaths have been reported. The following year, this number increased to 88 cases and subsequently reduced by one case in 2011, making a total of 87 cases during the year. However, in 2012 this figure is rising sharply. The numbers of accidents that cause these deaths continue to increase in the next year until in 2014 with respectively a total of 129,144, and 156 cases in 2012, 2013, and 2014. If this amount is compared between 2009 and 2014, the number of fatal accidents has increased by 231.9 per cent [22-30].

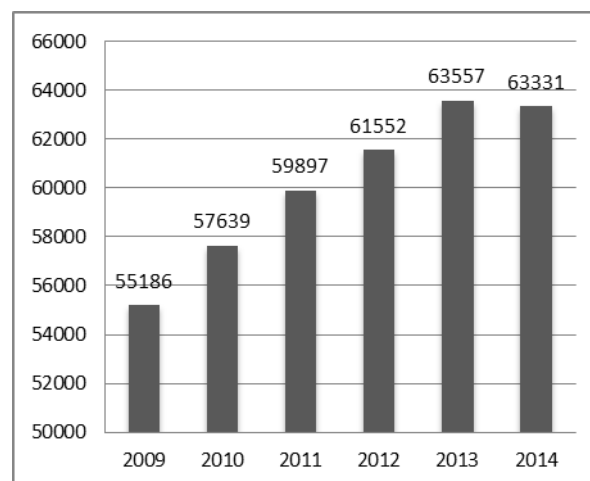


Figure 2. Number of accidents for whole Industries (SOCSO).

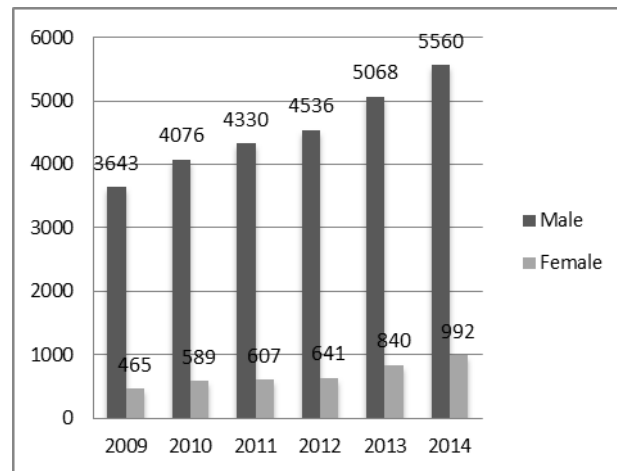


Figure 3. Number of Accidents at Construction Sites (SOC SO).

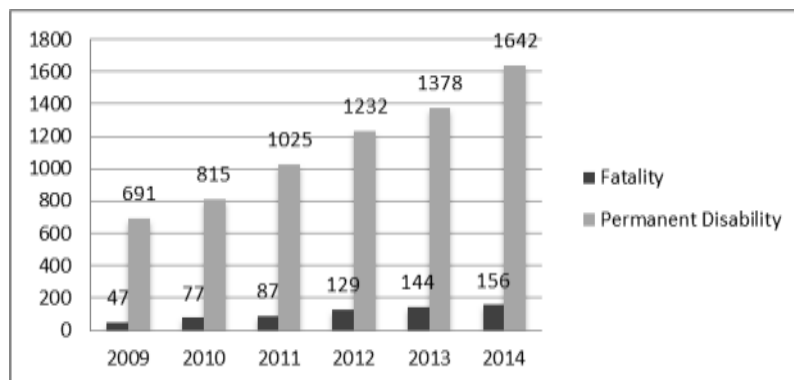


Figure 4. Number of fatality and permanent disability due to construction accidents (SOC SO).

4.2. Fatal construction accident statistics from DOSH report

Figure 5 shows the number of fatal accidents reported by DOSH from year 2009 to 2015. Based on the figure, we can conclude that the number of fatal accidents is increasing start from year 2012 until 2015. The results of this study were obtained through analysis of the data from the DOSH website starting from 2010 until 2015. A total of 129 fatal accident cases on construction sites have been reported for the year 2010 to 2015 on the DOSH website. The fatal accidents that have been obtained from the DOSH web site has been analyzed and sorted by common types of accidents as shown in Figure 6. There are eight categories of accidents resulting in death that have been analyzed and each category are divided into sub-categories as shown in Figure 7.

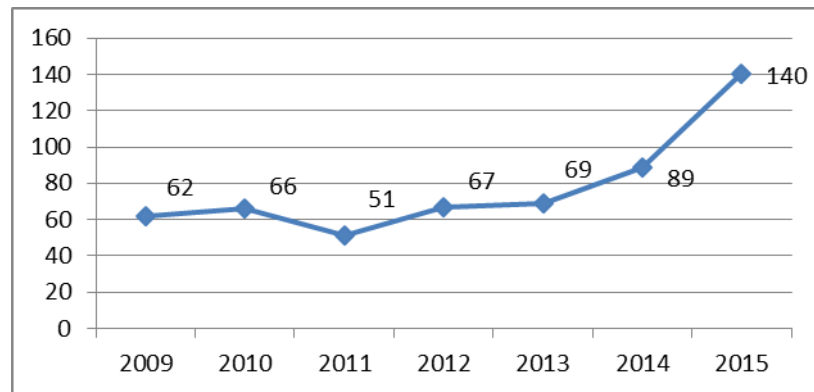


Figure 5. Number of fatal accidents in construction (DOSH).

Falling from height or from the same level has recorded the highest number of reported fatality accidents on construction sites in Malaysia. More than half of the factors that contribute to fatalities are from this factor. A total of 56 deaths was reported between 2010 and 2015 due to the fall from a high level or falling on the same level accidents. The second accident, which recorded the highest number of deaths, is caused by fallen objects. This type of accident has caused 19 deaths at the construction site. The third highest accident factor that contributed to the death at the construction site is from caught between objects, followed by a fourth factor that is struck by objects with a total of 17 cases and 14 cases for each factor. Other factors that contributed to fatal accidents in construction sites are buried, electrocution, and drowning with each recorded a total of eight, seven and six cases. For the last factor, namely from other categories, this factor consists of two types of cases that is caused by fire and from exposure to harmful chemicals [31].

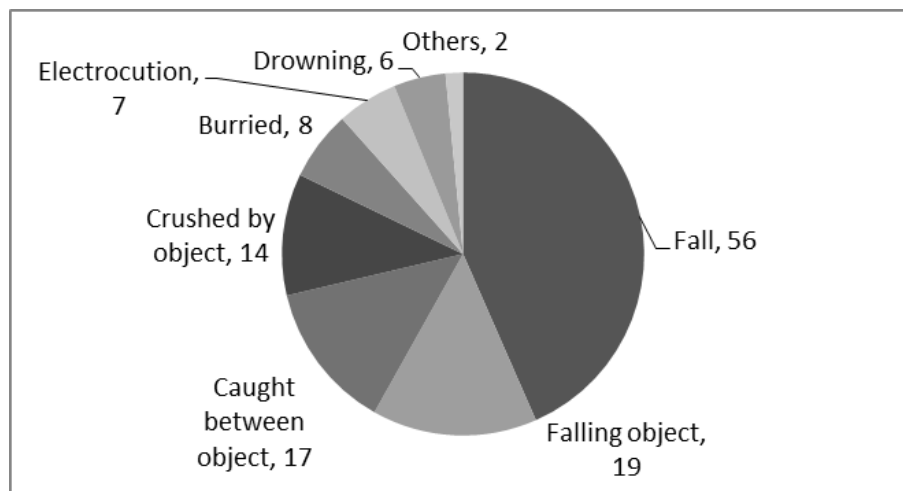


Figure 6. Number of fatalities based on the types of accidents in construction (year 2010-2015 DOSH).

EXCAVATION (8.6%) <ul style="list-style-type: none"> •Buried •Sinked into soft earth 	ELECTROCUTION (7.5%) <ul style="list-style-type: none"> •Electrocuted during maintenance of electrical equipment •Electric shock from exposed wire •Struck by lightning 	DROWNING (6.5%) <ul style="list-style-type: none"> •Falling into river •Falling into tank •Sudden increasing of water during maintenance work in water tank 	OTHERS (2.2%) <ul style="list-style-type: none"> •Fire •Exposed to hazardous chemical
FALL (56.4%) <ul style="list-style-type: none"> •Fall from height •Fall on the same level 	FALLING OBJECT (19.2%) <ul style="list-style-type: none"> •Struck by falling object 	CAUGHT BETWEEN OBJECT (17.1%) <ul style="list-style-type: none"> •Overturning vehicles •Struck by concrete •Formwork collapse •Caught between machineries and wall •Pinned by steamroller 	STRUCK BY OBJECT (14.1%) <ul style="list-style-type: none"> •Hit by vehicles •Crushed by iron pipes

Figure 7. Types of accidents that causes fatalities in construction (DOSH).

4.3. Causes of fatal construction accidents from DOSH reports

Figure 8 shows the possible causes of fatal accidents on construction sites. Based on the analysis that has been made, there are eight major causes that may lead to a fatal accident at the construction site. In each of the main causes are the causes of sub causes of fatal accidents occur on construction sites. For each of the cases that have been analyzed, can occur occurs more than one source of possible causes of fatal accidents occur on construction sites. The analysis shows that the main probable cause of most likely lead to fatal accidents on construction sites is unsafe methods of recording the number of 69 cases (29.4%). Then, followed by unique nature industry with 59 cases (25.1%), job site condition with 37 cases (15.7%), human factor with 30 cases (12.8%), management factor with 19 cases (8.1%), unsafe equipment with 16 cases (6.8%), and lastly is the environmental factor with a total of 5 cases (2.1%). For the sub-causes, work at high elevation (54 cases), incorrect or no work procedure (43 cases), failure of structure (20 cases), unsafe work practice or conditions (15 cases), not wearing personal protective equipment (13 cases), equipment failure or defective tools (13 cases) and no or lack of supervision (12 cases) are the most common factors that contribute to fatal accidents.

Working at height remains one of the biggest causes of fatalities and major injuries in the construction industry in Malaysia. Most of the fall from height incidents could be prevented by taking the proactive safety measures such as using appropriate and standardised personal protective equipment (PPE) and comprehensive risk assessment for working at height. Employers are responsible to provide training and personal protective equipment and enforced all employees to wear PPE. Under OSHA 1994, it is the responsibility of both employers and their workers to ensure safety and health at the workplace. Employers and contractors who fail to provide a safe and healthy working environment for their employees can be charged under Section 15 of OSHA 1994, which carries a maximum sentence of a RM50,000 fine, or two years' jail, or both [32].

Employers also have to adhere to the Factories and Machinery (Safety, Health and Welfare) Regulations 1970 [33] and follow the Guidelines for the Prevention of Falls at Workplaces [34] that was issued by the Department of Occupational Safety and Health in 2007. Under Regulation 12 (Working at a height) of the Factories and Machinery (Safety, Health and Welfare) Regulations 1970, practicable means that could ensure the safety of a person working more than 10 feet high must be provided, including the use of a safety belt or rope. Any person who commits an offence against the regulation could be fined a sum not exceeding RM1,000.

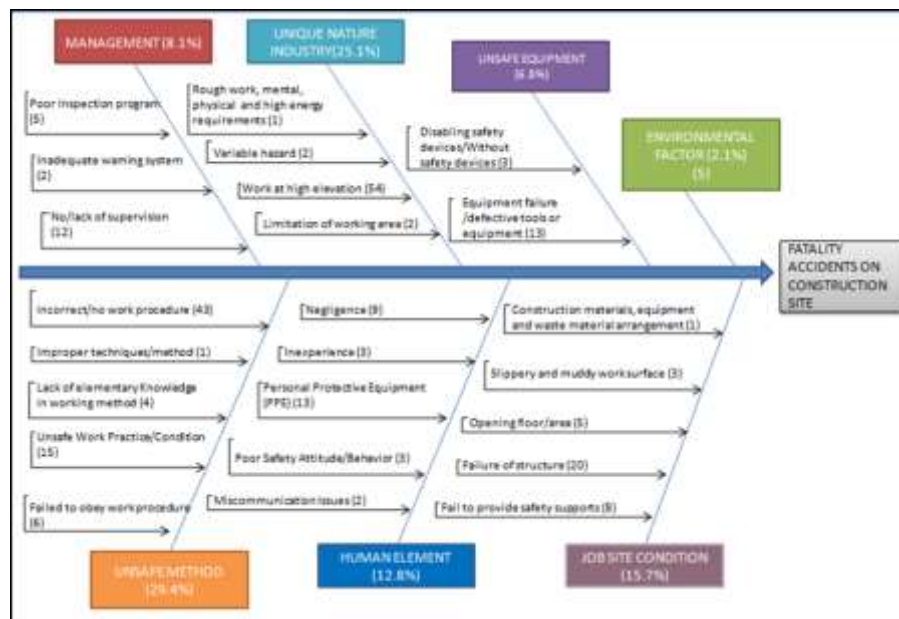


Figure 8. Causes of fatal accidents in construction based on 129 cases reported to DOSH.

5. Conclusion

Although DOSH covers all types of fatal accidents, including those who are from local or foreign worker, but still, the records of fatal accidents from DOSH are still lower compared to the records of fatal accidents from NIOSH who only cover for local workers only. This is because all statistics from DOSH is only from those who make a report of fatal accidents or cases that they are investigated. The number of fatal accidents in a construction site is increasing drastically in the last five years from year 2009 to 2014 by 231.9% as reported by SOCSO. While, DOSH reported the number of fatal accidents in a construction site is increasing by 125.8% from year 2009 to 2015. The results from 129 DOSH fatal construction accident reports show that the main causes of fatal accidents in construction are mainly due unsafe method followed by the unique nature of industry, job site conditions, human elements, management, unsafe equipment and environmental factors. For the sub-causes, work at high elevation, incorrect or no work procedure, failure of structure, unsafe work practice or conditions, not wearing personal protective equipment, equipment failure or defective tools and lack of supervision are the most common factors that contribute to fatal accidents.

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