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# Causes of crane accidents at construction sites in Malaysia

**Abdul Rahim Abdul Hamid<sup>1,4</sup>, Ridzuan Azhari<sup>1</sup>, Rozana Zakaria<sup>1</sup>, Eeydzah Aminudin<sup>1</sup>, Ramadhansyah Putra Jaya<sup>2</sup>, Logeswaran Nagarajan<sup>1</sup>, Khairulzan Yahya<sup>1</sup>, Zaiton Haron<sup>1</sup> and Riduan Yunus<sup>3</sup>**

<sup>1</sup>Department of Structures and Materials, Faculty of Civil Engineering, University Teknologi Malaysia, 81310 Johor Bahru, Johor Malaysia

<sup>2</sup>Faculty of Civil Engineering and Earth Resources, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang.

<sup>3</sup>Jamilus Research Centre, Faculty of Civil and Environmental, Department of Building and Construction Engineering, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, Malaysia.

<sup>4</sup>Corresponding author: [rahimhamid@utm.my](mailto:rahimhamid@utm.my)

**Abstract.** The usage of crane in the construction industry is widespread and very important regardless of the project size. In tall building construction, the efficiency of the tower crane is the backbone of the project success. The crane operator is responsible to control the crane efficiently and follows the provided safety guidelines. Loss of life, injury, and property damages are the consequences that will happen if the requirements and procedures for crane handling are not properly done. The increasing number of crane accidents in Malaysia has driven the awareness to conduct this study as to avert this problem from occurring. Thus, this study was conducted to analyse crane's accident statistic at construction sites in Malaysia. This study utilises official crane accident report database and document search from the Department of Occupational Safety and Health (DOSH). All collected data were analysed using two methods, namely frequency analysis and content analysis. The results of the study show that, mobile crane recorded 23 numbers of crane accident cases and the highest in term of the type of cranes. Structural failure leads as a higher factor that contribute to crane accident in Malaysia with 28 counts of causes. In order to minimize crane accidents, crane's safety measure and procedure as well as proper training to crane operator are among potential ways.

## 1. Introduction

The used of cranes in the construction industry worldwide are very common. The diversity of the use of cranes at construction sites includes the construction of small, medium and large-scale project. Uses of crane in all types of construction has increased the productivity rate of construction projects worldwide. Tower cranes are widely used in Europe than in the United States during the reconstruction phase of the building after the Second World War. In the US, the use of a mobile crane lifting is the popular choice at construction sites. A few years later, the tower crane made a new alternative and its utilization rate increased [1]. Rapid construction is influenced by the selection of appropriate cranes and on-going construction projects. The types of cranes needed depending on the situation. For example, concrete works such as beams, columns and walls on the second floor of an office building only required a crane to move, however, to work on a multi-storey building of reinforced concrete, it is necessary to implement a tower crane. Basic types of cranes are divided into



several categories such as tower, mobile, hydraulic, overhead and gantry crane. Based on these categories, the actual name of each crane can be identified [2].

Crane component consists of a hook, block, frame jib and cable. In addition, the crane also equipped with a coil of wire and chain. The main functions of the crane are to lift load, move and transport construction materials and to place heavy components in any area of the construction project. Crane with the various operating mechanisms have a heavy counterweight to stabilize the position and the crane can be divided into two categories: static cranes and mobile cranes [3]. Large objects can be moved efficiently and manual handling operations can be reduced significantly by implementing proper lifting operation. Annually, incorrect lifting procedures cause injuries, loss of work time and property. Generally, the accidents normally happen because of the attitudes of crane worker who ignore safety precautions when operating the crane [4]. The percentage of accidents at construction sites is very high. The number of crane accident is increasing by 58.3% from 60 cases recorded in 1995 to 95 cases in 2003 [5]. Various security measures have been set by government agencies such as the National Institute of Occupational Safety and Health Malaysia (NIOSH), Department of Safety and Health (DOSH), Construction Industry development Board (CIDB) and many others in order to increase crane safety practices [6-7].

Cranes play a major role in the construction industry in Malaysia. Construction projects that require a crane as a heavy machinery need to be handled efficiently and carefully. Since the year 2000, 1125 cases and 780 fatality loss due to the crane accident in the world. Besides that, the year 2010 recorded 154 crane accident cases and 113 losses of life. Thus, the improper handling of cranes can result a very big impact on a construction project. Accidents involving cranes can be categorized as technical accidents such as in terms of mechanical failure, loss of balance and crane overturned that would increase more liability losses. The impact of the crane accident that happened will cause an increment in term of external costs for maintenance, re-improvement and rebuilding. Accidents involving cranes in Malaysia recorded a few serious incidents and also claimed the life of workers at the construction site. The accident occurred involving a crane not only occur at the construction site, but also recorded the accident which occurred outside the construction sites such as roads, public housing, and many others.

Among the contributing factors to the frequent occurrence of accidents at construction sites is incompetent crane handler. Crane handlers should not work more than four hours without a rest and should not be allowed to handle the crane if they are not well. The cranes should also be regularly maintained, inspected and tested by competent persons before they are to be used at construction sites [8]. Accredited crane handlers with sufficient training and capability to operate suitable types of machine and weather in Malaysia should be made mandatory. Reduce the risk of crane accidents not just only the responsibility of the crane operator, those who are working near to the safety radius area need to be alert to the incoming danger. In addition, crane operator needs to operate the crane efficiently and accurately while determining the ideal weight of the load lifted by the crane.

While officers on duty at construction sites to check and ensure the cranes are safe for use. Some crane accidents in Malaysia for instance, on April 29<sup>th</sup> 2015 a massive construction crane running at top speed, reportedly lost control on the downslope of a flyover near Taman Bukit Kepayang, eventually crashing into no less than 13 vehicles [9]. On Aug 25<sup>th</sup> 2016, a woman was killed when a crane hook at a construction site fell on her car as she was driving along Jalan Raja Chulan, Bukit Bintang [8]. On the 10<sup>th</sup> November 2017 the luffing boom of the tower crane collapsed at a construction site in Kampung Baru and crashed on a vehicle outside the construction site. The incident caused minor injury on a worker and two members of the public [10]. A foreign construction site worker was killed while three others seriously injured after they were struck by a falling crane component in Seksyen 7 Shah Alam on 2<sup>nd</sup> January 2018 morning [11]. Based on these events, it can be concluded that the solution to reduce crane accidents still has not reached a satisfactory level, crane accidents keep happening and thus increasing the number of accidents and death rate. Generally, the responsible employers still do not implement secure approach when handling crane.

So far, there is very little published data and analysis of the causes of crane accident in the Malaysian construction industry. Therefore, this research examines the statistic and causes of crane accidents at construction sites in Malaysia from the official documented crane accident reports.

## 2. Crane accident

The crane is defined as a mechanical utility come up with a cable hoist, chains, sheaves and moving work, lifting heavy objects from one place to another. Cranes have a variety of functions and consists of a rotating structure for lifting and lowering horizontally on rubber tires or crawler treads. Cranes use one or more movement that is simply to generate mechanical ability, so a crane can move a heavier burden that exceeds the human capacity to lift it. There are three things to consider when determining the design process cranes. One is able to bear heavy load crane. Second, the crane cannot be reversed, and the last, the crane is damaged or failed. Generally, a crane consists of various types and shapes, and each type and shape depending on the particular application. For example, the size of a small jib crane suitable for a workshop and tower crane is suitable for the construction of a high building. However, the use of a crane is not limited only on land, the crane is now used heavily on the sea. Floating crane is a new revolution, used for transport sunk ships and to build an oil rig usually built away from the coast. Cranes can be categorized based on their specifications and application. Generally, the crane was divided into 3 main categories which is, tower crane, mobile crane and crawler crane.

Accidents is a common situation that occurred on construction sites and happen with many reasons and causes. Accidents can cause injury, damage to equipment or most of it is fatal. Major causes of crane accidents are overturns, contact with power lines, mechanical failures and falls. Crane accidents normally occur due to instability i.e. unsecured load, load capacity exceeded, or ground not level or too soft; lack of communication i.e. the point of operation is a distance from the crane operator or not in full view of the operator; lack of training and inadequate maintenance or inspection. Operators and persons at crane site are at risk from various crane hazards such as working too close to power lines, improper exhaust system, shattered windows, no steps/guardrails walkways, no boom angle indicator, not using outriggers, improper load rating, excessive speeds, no hand signals, inadequate inspection and maintenance, unguarded parts and unguarded swing radius [12].

Employees must be vigilant and alert to prevent any accidents, while managers need to understand and identify the causes and measures to deal with accidents from happening [13]. All operating systems need to comply with lifting whether it was the work of an individual or business operation are repeated. Crane is rated by the maximum weight it will lift at a minimum radius and minimum boom length – the further from its centerpoint, the less it will lift A system of work that has to be prepared and approved by the employer, based on the advice of an expert, security officials and those who are competence in it. The competent person must inspect all machinery and equipment prior to each use, and during use, to make sure it is in safe operating condition. The same principle should be prescribed and used either lifting operation on a construction site or a crane placed permanently or for example in factories and ports [14]. Investigations revealed that there are several causes of crane accidents at the construction site. The causes were split into 5 factors, which are structure failure, environment, human, safety management and on-site condition [15-24]. Operators or others working in the area can be victims to “struck by” and “caught in” injuries.

## 3. Methodology

In this study, database and document search method from the primarily Malaysian Department of Occupational Safety and Health (DOSH) and craneaccident.com website was utilised. The data were analyzed using frequency distribution analysis and content analysis method. The data were categorized on several features such as by the types of cranes, numbers of states involved, numbers of fatal and injured, list of probable causes 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 website was collected for the past eight years involving crane’s accident cases in Malaysia from 2009 until 2016. Exactly 44 cases of crane accidents were extracted from the website. Then, all the cases were analysed using frequency distribution and content analysis method.

##### 4.1 Crane’s accidents statistic in construction

Crane accidents result in injuries and damage to equipment and property. These causes missed work days, rising insurance rates, DOSH fines, litigation costs, lost business opportunities, and more. Although the DOSH keeps statistics on fatal incidents, the number of non-fatal crane accidents is underreported. Actually, hundreds of non-fatal but often serious crane incidents occur annually, with most going unreported/unrecorded with any governmental agency. Nevertheless, the pain and suffering the injured individuals encounter is real. The accident investigation or legal proceedings that follow can tie up the contractor, the crane company, and the building owner sometimes for years.

Based on Figure 1, the highest non-permanent disability and fatality due to the accidents in the construction sector was recorded in 2015 with 138 people and 88 people respectively. This statistic is an example of the high rate of fatality commonly associated with the construction industry. Figure 2 indicates the increment number of crane accident in the year 2014 with 11 cases. Besides that, the record clearly shows the stagnant pattern in year 2011 to 2013, which is 6 crane accidents occurred. Numbers of crane accidents happened also can be determined by the source of accidents itself. Figure 3 shows a mobile crane was the main type of crane that mostly involved in crane accidents with the 24 cases of crane accidents. The number of fatalities and injured from Figure 4 also mentioned mobile crane had a high-ranking for both which is 17 and 7 victims respectively. Furthermore, mobile crane continuously leading as the highest number of categories of crane that is involved in an accident which is about 15 numbers of mobile crane based on Figure 5. Involvement of crane in crane accidents reflects the types of accidents too. Figure 6 represent the types of crane accident and among all the types, there are two tops in a percentage which is toppled and overturned and struck by an object. The both types of crane accident had a percentage value of 39% and 23% respectively. From Figure 7, Pulau Pinang and Kuala Lumpur pointed as highest rank for the fatal and injured in crane accidents with 6 numbers of injured and 12 numbers of fatality. Figure 8 agreed that the increasing number of fatal and injured caused by crane accidents increased in 2014 with 10 fatalities and 1 injuries victim recorded.

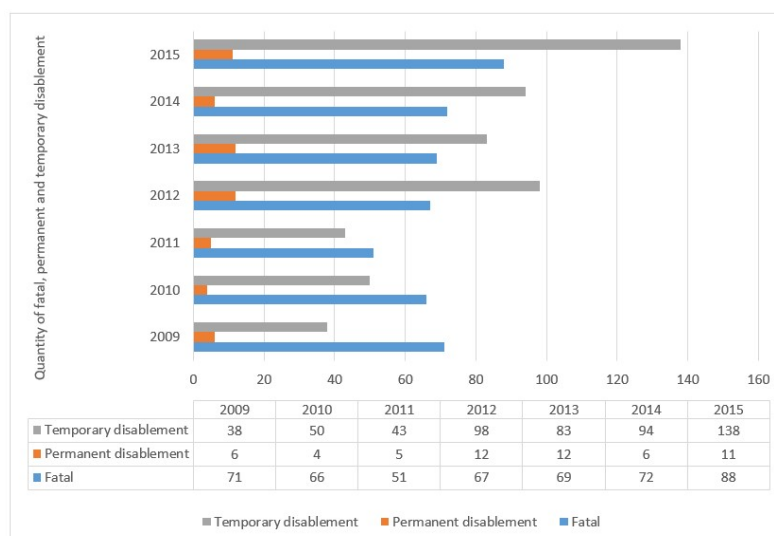


Figure 1. Statistic of fatal, permanent and temporary disablement in construction sector.

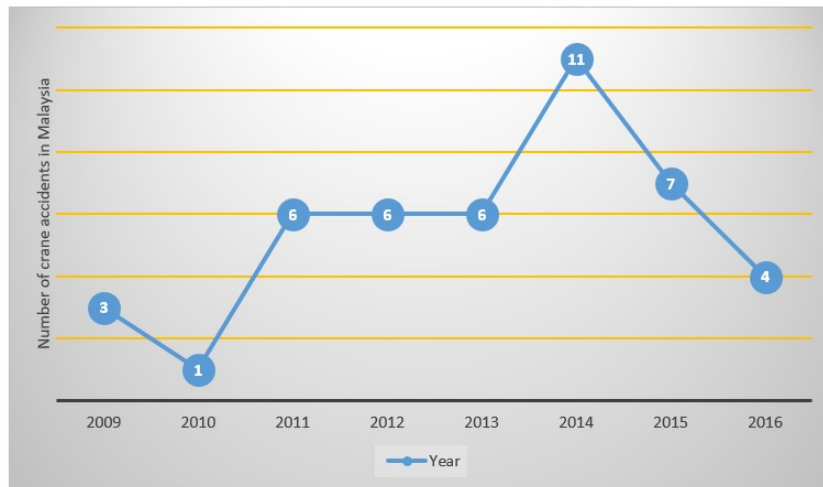


Figure 2. The number of crane accidents in Malaysia.

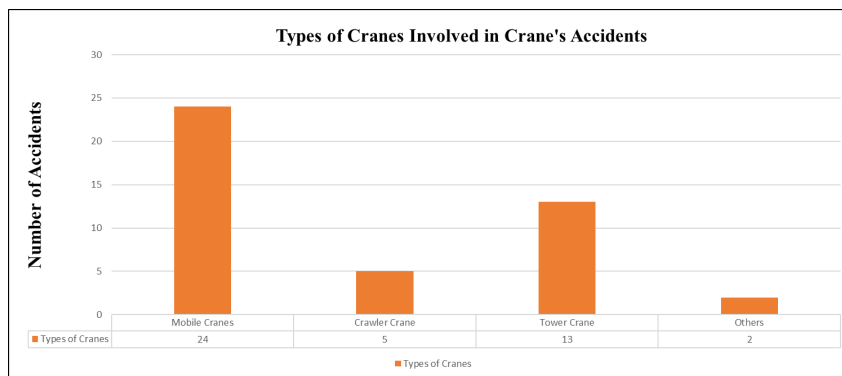


Figure 3. Types of cranes involved in crane's accident.

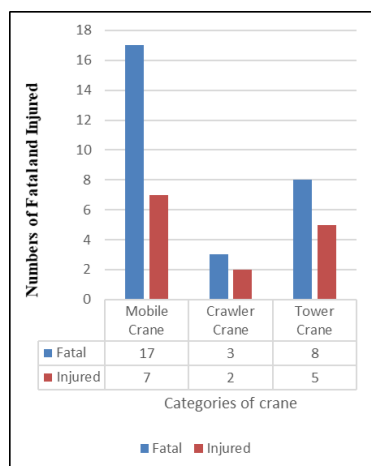


Figure 4. Category of cranes involved in accident.

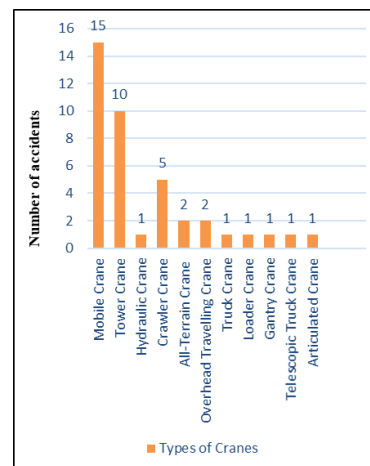


Figure 5. Types of cranes involved in accident.

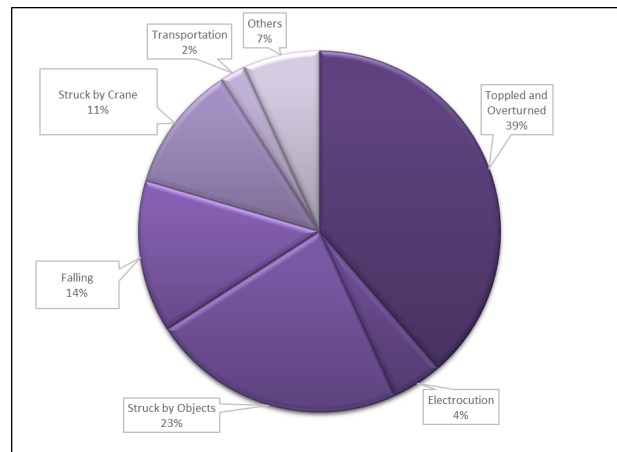


Figure 6. Crane's accident percentages by type of accident.

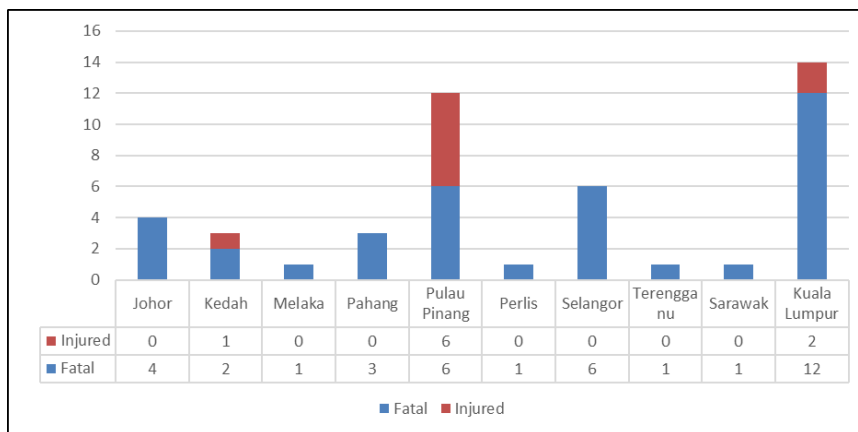


Figure 7. The number of cranes accidents fatal and injuries based on states in Malaysia.

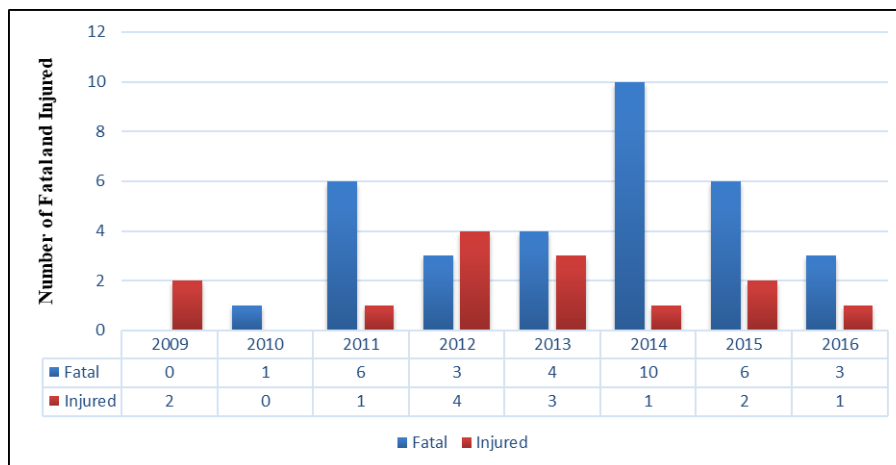


Figure 8. The number of cranes accidents fatal and injuries by year in Malaysia.

4.2 Causes of accidents involving cranes in construction

From Figure 9, 28 of probable causes was pointed to structure failure factor. The least value is from environment factors that contribute only 2 probable causes. From the overall factors with their own numbers of probable causes, it can be divided into 5 groups of factors corresponding with the year of crane accident happened. Thus, the number of probable causes can be estimated. By referring Figure 10, clearly show the gradually increment of the probable causes from the year 2010 until 2014 and the highest peak of that period is in year 2014 with 6 numbers of probable causes in the human factor. Besides that, equal numbers of probable causes were recorded for both years, which is 2011 and 2013 with 1 probable causes for environment factor in Figure 11. Figure 12 illustrated uniform pattern of probable causes from the year 2014 to 2015 which is 6 probable causes and 2 probable causes in the year 2016 become the lowest values in structure failure factors. The year 2014 become the dominant in term of numbers of probable cause in safety management factors with 8 probable causes by referring Figure 13. In Figure 14 indicate 3 probable causes in the year 2012 from Condition On-Site Factor become the highest values compare to the others. Table 4.2 shows the comparison, probable causes between crane accidents happened in Malaysia and worldwide. The highest percentage of probable causes in Malaysia is 35% that involved in structure failure factor. Besides that, worldwide category showed structure failure become the high rank of probable causes with 57% of percentages value.

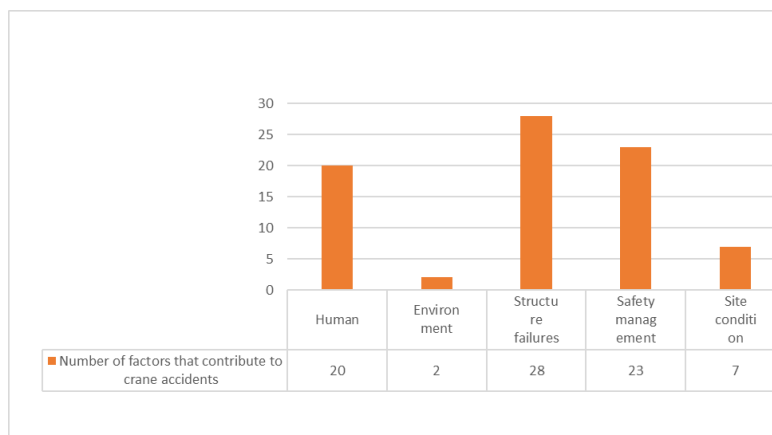
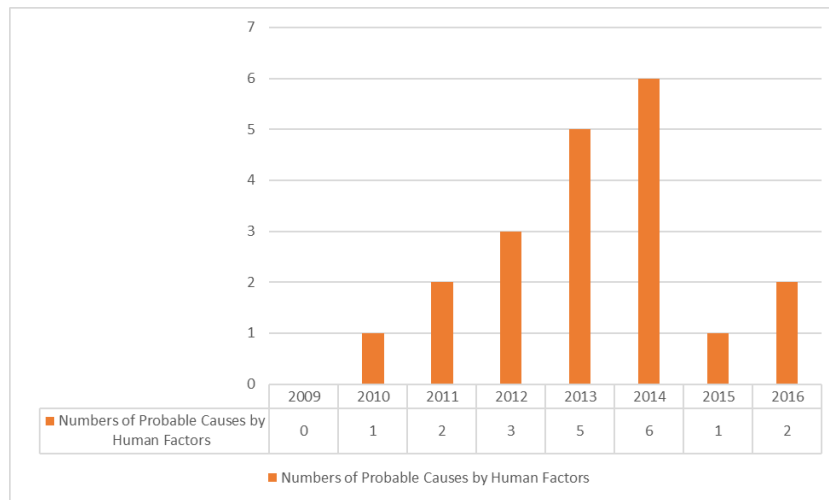
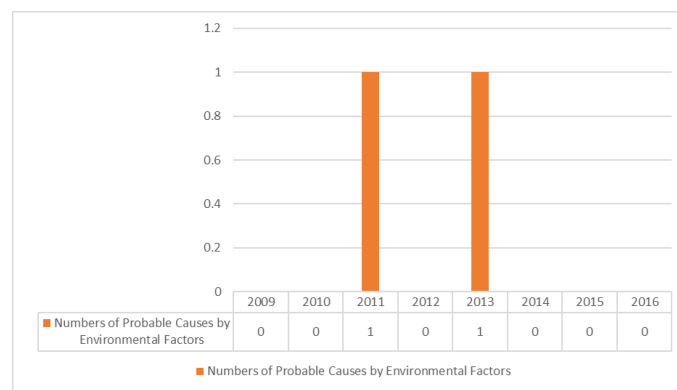


Figure 9. The number of Factors that Contributes to Crane's accident.





**Figure 10.** The number of probable causes by human factors from year 2009 to 2016.



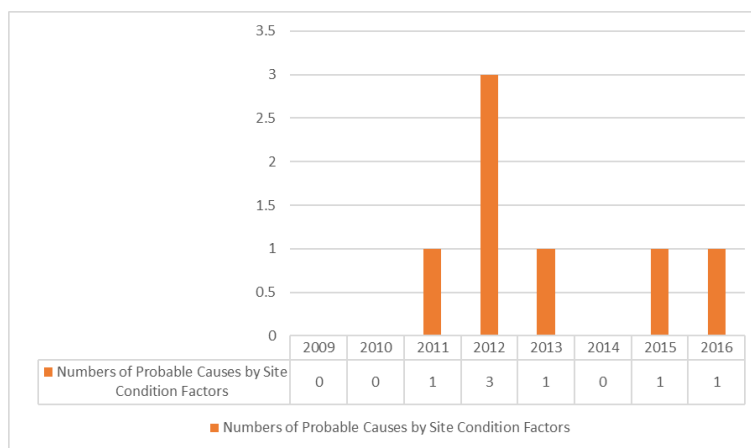
**Figure 11.** The number of probable causes by environmental factors from year 2009 to 2016.



**Figure 12.** The number of probable causes by structural failure factors from year 2009 to 2016.



**Figure 13.** The number of probable causes by safety management factors from year 2009 to 2016.



**Figure 14.** The number of probable causes by site condition factors from year 2009 to 2016.

**Table 1.** Comparison between crane’s accident cases in Malaysia and worldwide.

Crane’s Accident Factors	Numbers of Probable Causes			
	Malaysia		Worldwide	
	Cases	Percentage (%)	Cases	Percentage (%)
Human	20	25	35	10
Environment	2	3	43	12
Structure Failure	28	35	209	57
Safety Management	23	29	22	6
Condition On-Site	7	8	57	15
Total	80	100	366	100

## 5. Conclusion

Based on data analysis, clearly shown there are 3 possible aspects that exaggerate the numbers of crane accidents in Malaysia which is types of crane, states that involved in crane accidents and types of crane accidents in Malaysia. Mobile cranes become the dominant types of crane involved in crane accident in Malaysia with 23 of accidents. The increasing numbers of fatalities and injuries can be associated to where the cranes were working. Pulau Pinang, Selangor and Kuala Lumpur recorded the highest increase of fatality from crane accident. Pulau Pinang and Selangor recorded 6 fatality, while 12 fatal cases were in Kuala Lumpur. Crane toppled and overturned represent highest percentages of types of crane accident for the past 6 years with 39%. Based on the data analysis, among all factors, structure failure was a major contribution of crane accidents in Malaysia with 28 of the causes. Increment pattern shows human factor with the highest peak in the year 2014 with 6 numbers of probable causes. Structure failure factor pointed an equal number of probable causes in years 2014 and 2015 with 6 numbers of causes.

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