

# Crane Accidents: Identifying the Impact on Construction Cost among Contractors

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## Abstract

Cranes are frequently utilized in the construction industry due to their physicality and functionality, which are essential for constructing engineering and architecture and other big project works as investigated in this paper. However, if the safety measures are not followed properly and skillfully by the workers employed on the job sites, this machinery can contribute to fatal accidents. As a result, crane accidents will have an impact on all aspects of the construction project, particularly the high costs involved. These costs include project delays, medical expenses, safety training, and new hires. The purpose of the study is to determine the significant cost impacts of crane accidents in Malaysia among contractors. This is a quantitative data study that used a questionnaire to collect data. The questionnaires were distributed to 313 random sample respondents from G7 CIDB registered contractors in Kuala Lumpur, of which 38 of them were completed and returned. The data is then analysed using SPSS software. The findings indicated that crane accidents have three significant cost impacts namely costs of project delays, medical expenses, and repairing damages to completed works and adjacent buildings. All of these effects obtained a mean value greater than 3.5. In view of this, crane accidents must be taken absolutely and seriously by the construction parties concerned, particularly the contractor and the client, in order to avoid rising costs that may eventually result in project delays and overruns.

**Keywords:** Construction Cost, Crane, Accidents

## Introduction

The construction industry is one of the most dangerous business enterprises in the world. According to DOSH (2021), the construction sector recorded more hazardous accident cases compared to other sectors, with crane accidents also causing some severe construction accident occurrences. Most construction activities needed to employ cranes for their daily use such as for lifting or hoisting materials. With regards construction accident cases, cost is directly proportional with time. It is reported in Chim et al (2018) that the main negative impact of construction accidents is delaying the duration of construction project completion. Charytonowicz (2018) has also provided similar evidence, describing how accidents can reduce output and extend completion times for projects. As a result, accidents, especially

those involving cranes, are more likely to lengthen the duration of a construction project. As construction takes longer than expected, so the time lost may actually result in more delays and higher construction project costs. According to Lee et al (2018) accidents on the site can have a major effect on both cost and schedule of the construction project. Time in construction is equal to cost where it would increase various expenditures relatively. Hence, it is essential to identify the impact of crane accidents towards the construction cost so that the contractors will consider the matter more seriously. Therefore, the objective of this study is (1) To determine the significant cost impacts of crane accidents in Malaysia among contractors.

### **Overview of Crane Accidents**

Construction accidents will significantly impact the construction project in terms of project delay and other costs, and crane accidents specifically affect the site in terms of stop work, as noted in Adnan et al (2012). The crane is a very important piece of equipment used in the building and construction industry. Cranes are required in all construction projects, especially those involving high-rise buildings. Cranes play an important role in the transportation of building components and materials as they are a common tool in construction projects, primarily for transferring construction materials, particularly heavy construction materials, to a specific location (Ali et al., 2016).

According to DOSH (2019), the tower crane had the highest number of accident cases registered in 2019 compared to other types of cranes, which totalled approximately seven of the number of accident incidents in Malaysia. One of the criteria, according to Rosenfeld (2021), is the height. The tower crane is higher than other cranes, such as mobile cranes, and its height is usually higher than the projected building for carrying out the task of lifting construction materials on-site. As a result, the tower crane has a greater chance of collapsing due to wind pressure. As reported in Zhang et al (2021) 23 percent of 1125 crane accident cases in the world between 2000 and 2010-were caused by wind pressure. However, the wind pressure can be overcome by securing the tower crane platform or base. Table 1 shows the summary of cross-case analysis of the four main factors leading to crane accidents. They are human factors, mechanical factors, structural factors and design factors.

Table 1

*Summary of cross-case analysis on the factors leading to crane accidents*

<b>Factors</b>	<b>Description</b>	<b>Description</b>
Human Factors	Lack of Supervision	Hamid et. al., 2019; Ravindra, 2020; Ramalan et al., 2021,
	Lack of Safety Measure	Chim et al., 2018; Ravindra, 2020; Ramalan et al., 2021
	Crane Operator	Manzoor et. al., 2021; Zaini et al 2020; Gharaie et. al., 2015
Mechanical factors	Machinery Failure	Briotix, 2019; Gharaie et. al., 2015 Briotix, 2019; Patel, 2019
	Poor Maintenance	Arslan et al., 2008; Gharaie et. al., 2015; Buls, 2015
	Overloading/ Excessive load	
Structural factors	Foundation failure	Almarwae, 2017; Arslan et. al., 2008; Hamid et. al., 2020; Zaini et. al., 2020,
	Poor Stability	Almarwae, 2017; Ginsburg, 2020; Shin, 2015
	Improper Platform	Ginsburg, 2020; Zaini et. al., 2020
Design Factors	Detailed Planning	Gharaie et. al., 2015; Kazenske, 2015; Ali et al., 2016

According to DOSH, there have been numerous crane mishaps in Malaysia; three accidents happened where the hook block of the tower crane crashed down on the victims and killed them in 2014, 2016 and 2017 in Kedah, Kuala Lumpur, and Johor respectively. Other than that, lifting weight beyond the crane weight requirement or restrictions with no proper risk assessment had ultimately resulted in several crane accidents in Malaysia in 2011, 2013 and 2014.

Arsalan et al (2008) claimed that the majority of tower crane building mishaps are caused by the restriction of a normal platform to hold the crane base or foundation securely, particularly during early crane preparatory work. This is due to the fact that the function of this component, which is to support a crane's standing, will protect a crane from collapsing. It was also reported in DOSH that two accidents occurred in 2011 and 2014 because of ground support failure. That in Pulau Pinang in 2011 when a tower crane toppled onto a store house where the victim was sleeping and he died on the spot. The second incident occurred in Selangor while a tower crane was hoisting a pile of reinforced bar it suddenly lost its balance and overturned, striking a person. This collision resulted in one fatality. Based on the New Straits Times (2021), a crane collapsed onto some nearby homes and cars causing serious injury to four civilians including a baby. Another crane accident occurred at SUKE construction site involving three drivers (The Star, 2021). In view of this crane accidents are found to be extremely hazardous to both the construction and its surroundings. Accordingly, the cost impact also includes the compensation charge that the contractor and other construction parties must pay the victims if they are responsible for the accident.–Outcome of crane

accidents will eventually affect the entire construction project and the most obvious impact is in relation to construction cost, primarily in terms of loss of construction project time completion. This would actually lead to delay in the whole construction project resulting in overrun cost due (Mariam, 2013; Kadir et al., 2014; Asanka et al., 2015). Zaini et al (2020) noted that the highest percentage of the crane accidents effect is time loss of project execution amounting to 48.57%. This goes to conclude that crane accidents cause approximately half the time wasted leading to delay and extension of completion time. The facts are proven in Zaini et al (2020) and Lee et al (2018) that serious crane accidents actually delay project completion. The project's budget will also increase because the project work is interrupted. Commonly, the cost of the delay in the construction project will exceed the construction budget including compensation, workmen insurance, liquidated ascertained damages cost as well as cost of extended use of plant and machinery maintenance.

### Methodology

This study employed quantitative method and simple random sampling to collect data for this investigation. A set of online questionnaires on Google Form were distributed to randomly selected contractors who are registered in the CIDB online database. The instrument was developed using a 5-point Likert scale ranging from strongly disagree to strongly agree and that was validated by academic experts suggested in the Literature Review. It was then subjected to a reliability test using Cronbach's Alpha in the SPSS Software. The questionnaire data were retrieved in several ways via email and online survey, as well as from the various contractor firm informants in person.

The study focused on contractor firms in Kuala Lumpur that are mainly registered as building category G7 totalling 1609 contractors in the CIDB database. Table 2 shows the data acquisition for this research. The optimum sample size required for this population based on Krejcie & Morgan (1970) table is 313 respondents. However, Medway & Fulton (2012) cautioned that the response rate for surveys distributed online or through the mail is usually between 10% and 20%. Considering both views, the number of responses we received are acceptable where out of the 320 administered respondents only 38 completed the questionnaires with a response rate of 12%. We found that a number of factors contributed to the low response rate. Primarily there is no incentive whatsoever for the respondents to participate. Because of their heavy daily workload, many of them simply ignored the questionnaires.

Table 2

#### *Data acquisition*

<b>Data Acquisition</b>	<b>Number of Respondents</b>
Samples Distributed	320
Samples Required	318
Samples Received	38
Response Rate	12%

### Analysis and Findings

#### *Reliability Test*

The reliability test using Cronbach's Alpha was conducted for the cost impacts of crane accidents as shown in Table 3. The value of alpha coefficient obtained is 0.731 which is greater than the 0.7 criterion value. Therefore, according to Arof et al. (2018), this reliability level of

Cronbach's Alpha is acceptable. This also indicates that all the participants have consistently agreed that the variables given have very significant impact on the construction cost.

Table 3

*The result of reliability analysis using Cronbach's Alpha*

<b>Cronbach's Alpha</b>	<b>N of items</b>
.731	15

#### *Respondents Demography*

Work experience figures and academic qualifications of the respondents are listed in Table 4. The respondents have all obtained a tertiary level of education, comprising 26 (68.4%) with a bachelor degree and the remaining 12 (31.6%) having a diploma. In terms of position level, the majority of the respondents are Site Supervisors with 12 in number, making up 31.6 percent of the total. This is followed by Project Managers (8, 21.1%), Quantity Surveyors (6, 15.8%), Site Engineers (5, 13.2%), Safety Officers (4, 10.5%), and Safety Managers (3, 7.9%).

In addition, a majority of 21 (55.3%) respondents have at least 2 years of working experience in the construction industry. 11 (28.9%) have worked for 2-5 years, 5 (13.2%) for 5-10 years, and only 1 (2.6%) for more than a decade. Based on the years of experience, it is found that only 15.8% of the respondents have more than 5 years work experience compared to 55.3% of below two years.

Table 4

*Demographics results of respondents*

<b>Demographic</b>	<b>Items</b>	<b>Frequency (n)</b>	<b>Percentage (%)</b>
Education Level	Diploma	12	31.6
	Bachelor degree	26	68.4
Position Level	Site Supervisor	12	31.6
	Site Engineer	5	13.2
	Project Manager	8	21.1
	Safety Officer	3	7.9
	Safety Manager	3	7.9
	Quantity Surveyor	6	15.8
Years of Experience	Below 2 years	21	55.3
	2 – 5 years	11	28.9
	5 – 10 years	5	13.2
	More than 10 years	1	2.6

#### *Analysis for Cost Impacts of Crane Accidents*

The respondents were asked to rate six variables based on their agreement from strongly disagree to strongly agree regarding the cost impacts of crane accidents in general. The results are shown in Table 5 below.

Table 5

*Results of cost impacts of crane accidents*

Variables	Frequency (%)				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Cost due to project delays	0	1 (2.6%)	0	13 (34.2%)	24 (63.2%)
Cost of repairing the damages to the completed works and adjacent buildings	0	2 (5.3%)	0	15 (39.5%)	21 (55.3%)
Supervision cost to investigate and report the crane accident	0	4 (10.5%)	0	14 (36.8%)	20 (52.6%)
Cost of new workers recruitment <del>for replacement</del> due to replace the injured workers	1 (2.6)	8 (21.1%)	0	15 (39.5%)	14 (36.8%)
Cost of providing the safety training to the new and existing workers	0	6 (15.8%)	0	16 (42.1%)	16 (42.1%)
Cost of medical expenses for injured people	0	4 (10.5%)	0	11 (28.9%)	23 (60.5%)

The findings highlighted a majority or 97.4% of the respondents who agreed or strongly agreed that crane accidents would affect the cost due to project delay compared to only 2.6% who disagreed on this statement. In terms of cost of repairing damages to completed works and adjacent buildings due to collapse of the crane, as many as 36 respondents (94.8%) agreed or strongly agreed while 10.5% disagreed with supervision cost and 29 respondents who agreed or strongly agreed.

The respondents were also asked to rate their level of agreement on the cost impact due to new replacement of any workers injured by the crane accident. A slightly higher number disagreed at 23.7% compared to 15.8% who strongly disagreed on cost due to new workers recruitment and safety training. Lastly, in terms of cost of medical expenses for the injured parties, 89.4% agreed and/or strongly agreed.

#### *Mean Analysis for Cost Impacts of Crane Accidents*

Table 6 indicates the mean scores and their ranking of all the six costs impacted by crane accidents. Altogether there are three variables with a mean value of above 3.5: (1) Cost due to project delays (3.61), (2) Cost of medical expenses (3.50) and (3) Cost of repairing the damages to the completed works and adjacent buildings (3.50). These three variables constitute the key cost impacts of crane accidents found in this investigation. In comparison, cost for recruiting new hires to replace the injured workers ranked the lowest with a mean value of 3.11.

Table 6

*Ranking of cost impacts of crane accidents*

<b>Variables</b>	<b>Mean</b>	<b>Rank</b>
Cost due to project delays	3.61	1
Cost of medical expenses for injured people	3.50	2
Cost of repairing damages to the completed works and adjacent building	3.50	3
Cost of supervision for investigating and reporting the crane accident	3.42	4
Cost of providing safety training to the new and existing workers	3.26	5
Cost of hiring new recruits to replace the injured workers	3.11	6

**Discussion**

From the results obtained in this study we can conclude that the biggest cost affected by crane accidents at the construction projects is cost due to project delays. As stated in Zaini et al (2020) and Lee et al (2018), the fundamental aspect of a crane accident is that it extends the amount of time needed to complete a construction project as scheduled. This upshot will most likely cause the total project expenditure to escalate dramatically, and the delay will in fact result in overrun costs owing to overrun project time (Mariam, 2013). Furthermore, all parties involved in the construction process, including the client and the contractor, are accountable for paying any and all costs that are incurred as a result of the delayed project. These charges include expenditures for labour, materials, and machinery.

Medical costs ranked second in this questionnaire survey. According to Pillay et al. (2008), although direct costs such as medical expenses are covered under construction accident compensation nevertheless, it will increase the insurance policy for subsequent projects in the future to cover this risk. A crane mishap is often more likely to cause destruction to surrounding structures or completed construction project operations. Surrounding structures may sustain damages in the event of an accident involving a crane as was reported in the New York Times (2015) in Midtown Manhattan. Besides, according to the findings obtained in Arslan et al (2008) in their investigation into of a tower crane accident case study, an overturned tower crane had crashed on top of an adjacent building, inflicting substantial damage to the roof and superstructures of both buildings. Unfortunately, the insurance policies did not include a provision to cover losses from damages to structures that belong to a third party. Ultimately, the companies involved in the construction project are the ones who are solely responsible for bearing these costs and providing compensation for the damages that are sustained. On the other hand, in the event that a crane were to topple onto a structure that is currently undergoing construction, builder risk insurance would pay for all of the resulting damages. This may be the reason why it is rated by the construction contractors in the questionnaire as third in rank.

According to Arunkumar et al (2018), one of the effects that construction accidents on the site has is an increase in the cost of investigating accidents. One instance is the cost for employing an expert to investigate the accident. This type of investigating or supervisory work can also cause the project to run behind schedule because it requires extra time and space for it to be carried out successfully. In terms of new recruitment of workers, according to Trotto (2016), new hires poses a greater danger than their more seasoned counterparts, being



that they had not been given any prior training in construction safety procedures. Thus this lack of proper training is a high accident risk in construction on site.

Lee et al (2018) agreed with the above statement regarding the inadequate safety and health training of workers, especially for new recruits who are one of the major contributors of construction accidents. This kind of training is crucial for both new and old workers because it equips them with the skills and knowledge they needed to perform their jobs safely and sensibly. However, this factor was not considered to be a big issue among contractors in Malaysia since such workers are all required to take a course in safety and health provided by training agencies such as OSHA, CIDB and DOSH before being allowed to work on the construction sites. Therefore, safety and health training was not rated a high priority in this questionnaire survey.

### Conclusion

In conclusion, the study found that there are three main cost impacts of crane accidents that warrant building contractors in paying extra attention to the usage of cranes from the beginning to the end of the whole operation. This encompasses initially in installing an appropriate and strong platform to firmly secure the hefty cranes, in addition to providing highly skilled crane operators to work and manage them safely. Thirdly, the leasing companies must conduct regular crane maintenance to ensure that the machinery does not break down but is fit and capable to conduct the operation that it is assigned to undertake as scheduled.

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