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Exploring the Direct & Indirect Costs of Accident: An Empirical Analysis for KVMRT Projects in Malaysia

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Abstract: The Klang Valley Mass Rapid Transit (KVMRT) System is set to be one the most important and largest transport infrastructure projects in Malaysia. Since its inception in 2011, the rapid development of the KVMRT System has contributed to a substantial amount of costs related to safety and health issues. Fatalities, serious injuries, and damage to properties have occur every year due to the rapid construction of this project. Work injuries create significant economic and humanitarian consequences to our society, especially to this project where it involves billions of Malaysian Ringgit (RM). The awareness of the accident, especially the payment cost, is absent because the contractors, clients and the consultants leave these matters to the insurance company. They always ignore the indirect costs due to an accident without realising the true losses to them. Therefore, this paper studies the types of indirect costs of accident incurred during the construction of KVMRT Projects. Sixty (60) reported accident cases were examined to measure the level of significance for those items from the safety personnel experiences. The study found that the most significant type of accident contributing to the indirect costs is the Management Cost Component and Accident Report Cost where it involved the cost of the investigation process item until to the preparation of report. The findings of the study may assist stakeholders in estimating the accident costs during construction projects, and, hence, enable them to plan their investments in terms of safety measures in a more insightful manner.

Keywords: Indirect costs of accident, significance level, KVMRT projects

1. Introduction

Construction sites are frequently considered to be among the riskiest places for both workers and visitors (Minglong et al., 2023, Choi et al., 2020). The locations could be dangerous in many ways, and many of them are difficult to anticipate ahead (Japan Construction Safety and Health Association). Alcumus (2022) estimates that the average fatality rate in the construction sector is more than twice as high as that in all other industries. In addition, construction workers have a three to six times higher risk of fatal accidents than workers in other industries, according to Choi et al. (2020). In Australia, the construction sector had the third-highest fatality rate relative to its workforce and was accountable for 153 work-related deaths between 2013 and 2017 (Safe Work Australia, 2018). Construction accidents are not only frequent but also expensive. Safe Work Australia reports that from 2013 to 2014, the average settlement for a construction injury or illness case was AUD$13,700. Over 10% of the total yearly cost of work-related injuries in Australia was incurred by the nation in the form of construction injuries during this time, costing the country AUD$2.86B in total (Safe Work Australia, 2015).

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Ibarrondo-Dávila et al. (2015) defined safety costs as the expenses related to the health and safety of construction companies. The two recognized components of health and safety costs are revention costs and accidents costs. It have also been extensively studied by academics (Feng et al., 2015; Gurcanli et al., 2015; Harshbarger, 2001; HSE, 2015; Ibarrondo-Dávila et al., 2015; Labelle, 2000 & Cheng et al., 2010a,b). Costs associated with accident prevention include those incurred to adhere to regulatory requirements, put safety precautions in place during construction, and enhance conditions for health and safety across the board.

While the cost associated with accidents are divided into two categories: direct (insurable) and indirect (uninsurable) costs. When an accident happens on a building site, costs are incurred. The direct costs of the accidents show the expenses incurred as a result of a work-related accident, which can be insured and calculated using typical cost accounting techniques. According to Yilmaz & Kanit (2018), Aminbakhsh et al. (2013), and Gosselin (2004), the direct costs of accidents are those which can be insured but are typically not measurable in terms of money or have no performance indices for assessing their effects on the organisation.

Many research investigations have been conducted on the various losses that companies might suffer after an accident. In accordance to many researchers (Corcoran, 2002; Dorman, 2000; Heinrich, 1959; LaBelle, 2000; Michaud, 1995; Monnery, 1999; Neville, 1998; Siegel & Shim, 2000; Goestsch, 2013; Asan, n.d.; Pellicer et al., 2014; Feng et al., 2015), the company's actual accident costs are significantly higher than the direct costs. Feng et al. (2015) highlighted in their discussion that other financial losses to the victims, their families, employers, and society may also be present, including damage to the company's reputation, low employee morale, labour issues, or market loss. Indirect costs of an accident may be 36 times higher than direct expenses, according to a study done by the Health and Safety Executive (HSE) of England. In other words, when compared to overall expenditures, the direct costs of an accident are only the tip of the iceberg (Cheng et al., 2010b). It has been demonstrated that compared to direct expenses, indirect costs typically contribute higher costs.

It is remarkable to discover the lack of empirical studies to analyse urban rail infrastructure projects, despite the fact that the cost of safety and health has been extensively researched. Major infrastructure construction projects frequently involve a variety of various activities with a wide range of features, in contrast to small and medium-sized construction projects (Shiferaw et al., 2012). Budget overruns (Kean, 2011), project delays, and hidden transaction costs have all occurred as a result of the particular site characteristics (Sha, 2011). Due to the involvement of numerous workers, large, heavy plants and equipment, a significant amount of materials, complex construction activities, and multi-interface and complex management, the possibility of an increase in accidents for these massive projects is also greater than that for the common construction projects (Guo *et al*., 2013). The significant gap in this study is towards the empirical study on the types direct and indirect costs of accident which are significant in terms of the costs incurred for urban rail infrastructure projects.

2. Accident Cases at KVMRT Projects in Malaysia

Zhan et al., (2017) explained that the vigorous development of the railway industry in China has led to numerous accidents although a lot of labour and financial forces have been put into safety. Similarly, several major accidents have been reported during the construction of urban rail infrastructure projects in Malaysia, the results seriously impacted the construction progress and led to several fatalities. MRT and LRT are the biggest projects in Malaysia, so when an accident is reported it becomes a big issue in terms of safety in the workplace during construction activities. Table 1 summarises 13 major accidents that were reported in the newspapers (online) during the construction of those projects.

Table 1 – Accident Cases during Construction of KVMRT Projects

Year of Accident	Accident Cases	Sources
6 June 2018	A bored pile casing slipped from a trailer while it was being lifted about one metre above and fell back onto the trailer near the LRT3 work area at Sri Andalas Klang. No damage to public property or injury to motorists.	Light Rail Transit 3a (2018)
1 April 2018	The mobile crane that tilted while lifting a tank at an LRT3 site near Sri Andalas, Klang was brought back to the ground. No injury or any damage to public property in the incident.	Light Rail Transit 3b (2018)
3 March 2018	A Malaysian worker was killed while two of his co-workers were injured when a launching girder crane collapsed at the Jinjang MRT construction site.	Free Malaysia Today News (2018)
10 October 2017	Two of the workers lost their legs in the accident while the other	The Star Online (2017)

	suffered injuries to his arms and legs after an explosion at a construction site in Bandar Malaysia South MRT site.	
24 February 2016	One worker was killed after he was pinned down by steel while installing the ceiling at the Kwasa Damansara station construction site.	The Malay Online (2016)
31 August 2015	Three workers from Bangladesh were killed at a Kota Damansara site when a 38m-long span weighing 650 tonnes was dislodged from a guideway under construction and fell to the ground below.	Lin (2015)
10 June 2015	Man plunges to death from MRT scaffolding in Jalan Duta.	Astro (2015)
24 May 2015	One worker died when a temporary structure collapsed at the Tun Razak Exchange (TRX) MRT underground construction site.	Malaysia Kini (2015)
27 February 2015	One worker was killed, and another was hurt at the MRT construction line's Semantan site.	Lin (2015)
25 August 2014	Several precast concrete segments fell off a trailer onto a road, causing traffic congestion near the Billion roundabout flyovers along Jalan Cheras, Kuala Lumpur.	The Straits Times (2014)
18 August 2014	Three MRT construction workers are dead after being trapped under a 300-tonne concrete span that collapsed at the MRT worksite.	Murad and Rodzi (2014)
27 Jun 2014	Sub-contractor and staff sacked after metal slab falls on car at the Pusat Bandar Damansara MRT construction site.	Brown (2014)
19 April 2014	Four workers were injured at the MRT site "Drill" at the underground station site along Jalan Cochrane.	Daniel (2014)

3. Costs of Accidents during Construction Projects

In order to comprehend the true costs of construction accidents better, a lot of study has been done (Ryan et al., 2019). Heinrich (1931) more than 80 years ago was a pioneer in the research of accident costs. Direct and indirect costs associated with the accident were separated out. With a ratio of 1:1 between direct and indirect costs, indirect costs are substantially higher than direct costs. In other words, the indirect costs of accidents might be up to four times higher than the direct expenses. Other researchers suggested the terms insured costs and uninsured costs to describe accident expenses (Simonds & Grimaldi, 1956). Heinrich's (1931) definition of indirect costs was criticised by Simonds & Grimaldi (1956), who argued that many expenses, including overhead insurance charges, are direct costs because they are shown in a company's financial statements.

However, some of them redefine the direct and indirect costs as insured and uninsured expenses (Head & Harcourt 1997). Some of the later scholars agree with the definition of accident costs by Simonds & Grimaldi (1956). The expenses associated with workplace accidents have been divided into two main types by Rohani et al. (2015): direct costs and indirect costs. Because it was more suitable for usage in the construction sector, the authors opted to use direct costs and indirect costs for this study. It was also widely utilized by safety professionals in Malaysia.

a) Direct Costs

The term "direct cost" describes the expenses connected to a workplace accident. Direct costs can really be analysed or calculated using typical cost accounting techniques. In addition, employers are able to recognise this cost. KLIACS_JKKP (2013) defined direct costs as expenses incurred as a direct result of the accident. Accident expenses that must be paid directly often include medical bills for treating injuries and any benefits provided to injured personnel. The Social Security Organisation (SOCSO) and the involved insurance firms normally cover the direct cost.

b) Indirect Costs

Indirect costs are expenses that must be calculated after an accident occurs, but they are hidden and challenging to estimate, and employers frequently overlook and underestimate them. Additionally, it can be difficult to separate apart the elements of these expenses (Jallon et al., 2011a). However, according to Gosselin (2004) and Jallon et al. (2011a), indirect costs are those that cannot be quantified in economic terms or for which there are no performance indices to assess the impact on the business, such as harm to the brand of the company, low employee morale, labour disputes, or market loss. In addition, indirect expenses are produced by things like lost productivity after returning to work, downtime, damage to equipment or items, time lost by other employees due to the accident, and downtime. Direct expenditures can be significantly exceeded by indirect costs, which are not insured. The summary accident cost components for direct and indirect costs in construction projects are shown in Table 2.

Table 2 - The Summary Direct & Indirect Costs of Accident Components

Bil.	Direct & Indirect Costs of Accident Components	Definition	Author
	Direct Costs of Accident		
1.	First-Aid Treatment Costs	• Immediate medical treatment costs. This cost includes medical equipment used when the accident happened, including the cost to refill, payment to the person who arranges for emergency services and transport to the hospital and the salary of the first aider.	KLIACS_JKKP (2013)
2.	Hospital Costs	• This cost includes transportation cost to the hospital, hospitalisation costs which includes hospital bills, payment for the person who escorts the victim to the hospital, payment for the person who visits the victim at the hospital and the cost of follow-up treatment after the victim is admitted from the hospital.	
3.	Damage/Repair Costs	• The damage to machinery, material, and equipment. Commonly, an accident not only involves injuries but also comprises damage to machinery, material, and equipment. This damage can be lost or can be repaired. The repair cost includes the salary of labour to repair and the cost of the spare part. The cost of cleaning to ensure the site area is back to operational working is also counted in this cost component.	
4.	Fine Costs	• If an accident is caused due to violations of safety procedures or even breaking the law, the company may be exposed to fines by a court or by local authorities like the Department of Safety and Health (DOSH).	
	Indirect Costs of Accident		
1.	Investigation Costs	• Internal and external investigation teams will be dispatched to the accident location once the workplace accident happened. This team will assess the cause of the accident before taking any further actions. Deployment of this investigation team involved certain costs since they need to spend their time focusing on this accident rather than doing their normal job.	Rohani et al. (2015)
		• These are costs arising from the investigation of the accident's cause and the completion of associated legal and administrative documentation.	Jallon et al. (2011b)
		• All accidents should be investigated to meet administrative and legal requirements. A multi-disciplinary team may investigate the accident's cause, prevent a future recurrence, and complete the documentation of the incident. The investigation cost includes any safety measures required to prevent an accident from recurring.	Sun et al., (2006)
2.	Incident Costs	• Incident costs include the salary cost of the first aider, the salary cost of the person taking the injured person to the hospital, the salary cost of the injured worker, the cost of activities to make the area immediately safe and so on.	KLIACS_JKKP (2013)
3.	Accident Costs	• To estimate the accident costs, it was necessary to establish how many people involved in accidents were admitted to the hospital and their level of injury (fatal or injury).	Department of Transport and Regional

			Services (n.d.)
4.	Replacement Costs	• Any injured or dead workers need to be replaced to maintain production output. Additional workers would incur hiring costs and costs associated with staff training	Rohani et al., (2015)
		• An absent employee must be replaced to maintain productivity. Costs will be incurred to transfer, hire, and train staff.	Jallon et al., (2011b)
		• The replacement of an absent employee can be done by transferring or hiring a new employee. In either case, there is a cost associated with preparing the newcomer for the required job. This component includes the recruitment process for the new employee and the training required until this person is capable of the same productivity and quality as the injured worker.	Sun et al., (2006)
5.	Legal and Administration Costs	• Resources that need to be allocated by the employers in terms of manpower or financial aspects. The resources are utilized to do data entry in the accident registry, issue accident notification reports, compile accident statistics and cost monitor the file.	Rohani et al., (2015)
		• The employer must allocate human and financial resources to set up and monitor the file, enter data in the accident registry, compile accident statistics, and issue a report.	Jallon et al., (2011b)
		• The employer must assign human and financial resources to handle the administrative and legal issues of an accident. This component includes follow-up, record keeping, clean-up and claim pro- cessing and does not include fines imposed on the employer by the Occupational Safety and Health Agency (OSHA) which determines if there was any negligent behaviour on the part of the employer.	Sun et al., (2006)
6.	Schedule Costs	• When an accident happened, the slowdown in production will affect the timetable schedule and cause damage to the client. Clients can cancel the contract or demand a lower contract price. The company will create the absented product by the contractor that will help the company to handle the schedule.	KLIACS_JKKP (2013)
7.	Productivity Costs	• When an accident occurs, the company may need to shut down their plant with a directive from DOSH. This will require overtime when the plant is set to resume its operation to fulfil customer demand and cause production delays at the same time.	Rohani et al., (2015)
		• An accident disrupts workplace equilibrium, which can impact productivity by requiring work shutdowns, overtime, and production delays.	Jallon et al., (2011b)
		• The productivity of the organization is affected by an accident, for example by reducing the pace of the workstation. Employees near the scene of an accident may stop their work to help in the case of an accident. Overtime might be required to complete previously scheduled work in order not to disrupt overall production planning. Nonetheless, productivity effects go beyond the moment of the accident.	Sun et al., (2006)
8.	Work in Progress Costs	• The costs involved by workers or staff need to consider the work progress at the same time, they may be only concerned with improving some critical unsafe to ensure that normal work progress not be affected.	Lu et al., (2016)
9.	The Victims Costs	• The loss of comfort by accident victims because of the physical, mental, and behavioural problems arising from the work-related accident.	KLIACS_JKKP , (2013)
10.	Recruiting Costs	• The costs of hiring additional workers to replace the injured ones include the time invested in recruiting and training the new workers.	
11.	Work Time Costs	• The work managers invest in investigating the accident. Work time is also dedicated to the instruction of the simple workers and the additional work hours that are needed to replace the injured worker.	
12.	Capacity Lost Costs	• An accident can cause a slowdown in production and even halt it for a period, for example, evacuation of injured workers and damage to the	

		equipment that should be handled immediately (fire). Besides that, an accident may result in a new bottleneck causing production processes to slow down and imposing additional costs.	
13.	Uninsured Medical Costs	• Medical costs paid by the employer that are not covered by the insurance such as treatment facilities, personnel, equipment, and supplies.	
		• Uninsured medical costs are borne by the company.	Simonds and Grimaldi (1956)
14.	Management Costs	• The salary cost of management and staff carry out the investigation.	KLIACS_JKKP (2013)
15.	Prevention Costs	• Prevention costs depend on the budget of the construction project and the percentage of the budget invested in prevention.	Pellicer et al. (2014)
16.	Reputation/Company Image	• A drop in employee motivation or tarnished company image can be very difficult to quantify or contribute only marginally to the indirect cost of an accident.	Jallon et al., (2011b)

4. Methodology

The procedures used for data gathering and analysis are referred to as the methodologies (Fellows & Liu, 2008). The work packages contractors (WPC) from the viaduct (guideway) package of the KVMRT Sungai Buloh Kajang (SBK) Line Project were the subject of this investigation. The sample for the study was chosen from eight (8) numbers of WPCs that represented eight (8) projects (V1-V8). Those projects were the main packages amongst others and involved the high risks and costs incurred when the accident happened.

The safety personnel at the KVMRT projects who were the responders were asked to complete a questionnaire based on the accident cases that had occurred in those projects. The questions addressed the respondents about the types of indirect expenses that were thought to be significant at the time the accidents happened. There are three (3) parts of the question in the survey: 1) Organisation background; 2) Respondent particulars; and 3) Types of the direct & indirect costs of accident items incurred during the construction project. In order to confirm the accuracy and dependability of the survey items, a pilot study was conducted with a small number of professionals in the industry and academics.

5. Results and Discussion

a) Reliability Analysis of the Main Survey Instrument

In the preparation of the questionnaire for the main survey, content validity needs to be fulfilled. The purpose of content validity for this study is to evaluate the relevance of the variables to achieve the research objectives. In this process, the experts look at the items in the questionnaire, i.e., the types of indirect cost components incurred when the accidents occurred during the construction projects. A total of 20 representatives were selected from the two groups, namely, doctorates and experts on the research topic. The list of doctorates involved in the study are doctorates from a similar specialisation (safety and health), doctorates from different specialisations, and PhD candidates. While the related experts that were selected for this process, are clients for the MRT and LRT Projects, private partnership delivery (PDP) for the MRT and LRT Projects, contractors for the MRT and LRT Projects, OSH Calculator team members, and authorities from DOSH and CIDB.

Table 3 shows the results from the piloting of the questionnaire from the selected representatives. The comments given by the representatives are divided into two items, namely, regarding direct & indirect costs of accident items and the questionnaire form. The representative from the OSH Calculator research team, the client, and the PDP of the MRT project suggested adding other types of safety and health items and sub-items. Moreover, representatives from the DOSH, CIDB, contractor for the MRT and LRT project, PDP for the LRT project and doctorates in the safety and health field recommended cross-checking for all the items with the current practice used and related documents provided by the authorities.

The representatives from the Client of the LRT project, the OSH Calculator research team, and the PDP for the MRT project agreed that, overall, the safety and health items in the questionnaire are complete, comprehensive, relevant, and significant. This view is also supported by the representative from the other OSH Calculator research team member. For the comments on the questionnaire form, the contractor suggested checking the particulars of the company and the respondent's background in sections A and B of the questionnaire. While the other doctorate in the safety and health field and OSH Calculator research suggested including the objective for each section of the questionnaire. However, the doctorate from the field of statistics recommended using another approach for this study, which was econometric analysis. This suggestion can be considered for future studies. All the input gathered from this content validity was taken into consideration to improve the main survey instrument.

Table 3 - Results from the Content Validity

Main topic	Justification	Representative
Safety & Health Cost Items	Add other types of safety and health items and sub-items.	OSH Calculator research team, a client (MRT) and PDP (MRT)
	Cross-checking all the safety and health items with: • Public Work Department (PWD) • OSH Schedule of Rate (CIDB) • Factory and Machinery Act (FMA) • Current practice	DOSH, CIDB, contractor (MRT & LRT), PDP (LRT) and doctorate (safety & health)
	Overall, the items in the questionnaire are complete and comprehensive and the researcher also considered the items that are relevant and significant.	Client (LRT), OSH Calculator research team and PDP (MRT)
	A complete and detailed explanation of the terms direct cost and indirect cost.	OSH Calculator research team.
Questionnaire Form	Add a Likert scale in the questionnaire form to facilitate the analysis of the data.	Doctorate (statistics) and doctorate (safety and health)
	Add types of injury codes.	Doctorate (safety and health) and OSH Calculator research team
	Follow the types of accident classification for the MRT Projects.	Client (MRT)
	Justify the description of the Likert scale.	Doctorate (safety and health)
	Add certified SHO in the informant's background	Doctorate (safety and health)
Questionnaire Form	Check the particulars of the company and respondent background section.	Contractor (MRT 1 & MRT 2)
	Create an objective for each section of the questionnaire.	Doctorate (safety and health) and OSH Calculator research team.
	Study the econometric model.	Doctorate (statistic)

b) Background of the Unit of Analysis

Data for the study's analysis came from a total of 10 projects for the MRT 2 (SPP Line) and 8 projects for the MRT 1 (SBK Line). The project, company, contract value, and safety budget are displayed in Table 4. According to the table, the MRT 1 (SBK Line) Project's contract value ranges from RM499.9 million (V7) to RM1.17 billion (V4), while the MRT 2 (SPP Line) Project's contract value ranges from RM558.6 million (V207) to RM1.47 billion (V203).

The MRT 2 (SSP Line) Project has the largest contract value for the construction project, totalling RM1.47 billion, while the V7 Work Packages Contractor (WPC) has the lowest contract value, totalling RM499 million. The MRT 1 (SBK Line) Projects' safety and health budget was less than 2% of the contract value, whereas the safety and health budget for the MRT 2 (SSP Line) Projects was greater than 2% of the contract value. This situation resulted from the client's insistence that the MRT 2 (SSP Line) Project's minimum safety and health budget be 2% of the contract value. As a result, the contractors were required to reduce the number of accidents that occur on-site in order to improve the project's quality.

Table 4 - Contract Value and Safety and Health Budget of MRT Project

Project	Company	Contract Value (RM)	Safety and Health Budget (RM)	Percentage (%)
MRT 1 (SBK Line) Project	V1	1,092,330,000	7,376,135	0.68
	V2	863,390,000	12,930,090	1.50
	V3	816,240,000	11,894,383	1.46
	V4	1,172,750,000	8,645,434	0.74
	V5	974,780,000	13,021,659	1.34
	V6	764,910,000	12,134,625	1.59

	V7	499,980,000	9,218,998	1.84
	V8	951,090,000	7,257,020	0.76
MRT 2 (SSP Line) Project	V201	1,213,000,000	34,333,835	2.83
	V202	1,439,530,000	49,744,268	3.46
	V203	1,470,000,000	60,827,797	4.14
	V204	890,000,000	33,138,036	3.72
	V205	858,180,000	46,747,413	5.45
	V207	558,600,000	30,128,482	5.39
	V208	678,680,000	22,741,323	3.35
	V209	715,990,000	27,800,222	3.88
	V2010	648,000,000	24,449,645	3.77

According to earlier research by Gurcanli et al. (2015), 1.92% of the overall construction project expenditure is allocated to safety and health. The budget for safety and health, according to Pellicer et al. (2014), only made up about 5% of the entire cost of the construction project. They also disclosed that other academics, using the United States insurance system, discovered higher percentages of the safety and health budget (between 6% and 8%). Therefore, it can be concluded that the country and the client's requirements affect this safety and health budget.

The contract duration (month) and overall workforce for the study's participating projects are shown in Table 5. According to the table, the MRT 1 (SBK Line) Projects' construction period ranged from 44 months (V3) to 53 months (V5, V6). The longest construction period for that project was 60 months for almost all of MRT 2 (SSP Line) Projects. Between 430 people (V6) and 1,124 workers (V5) are employed by the MRT 1 (SBK Line) Project. While the number of workers in the MRT 2 (SSP Line) Project range from 131 workers (V205) to 550 workers (V207, V208). Due to the early stages of completion, there are fewer employees working on the MRT 2 (SSP Line) Project than on the MRT 1 (SBK Line) Project.

Table 5 - Construction Period and Total Number of Workers for the MRT Project

Project	Company	Construction Period (Months)	Total Number of Workers
MRT 1 (SBK Line) Project	V1	45	100
	V2	45	750
	V3	44	600
	V4	45	500
	V5	53	1,124
	V6	53	430
	V7	48	550
	V8	46	600
MRT 2 (SSP Line) Project	V201	55	524
	V202	57	300
	V203	60	511
	V204	60	400
	V205	60	131
	V206	60	342
	V207	60	550
	V208	60	550
	V209	60	160
	V2010	60	260

Based on the accident cases for the viaduct (guideway) package at the KVMRT SBK Line Project, a total of 68 questionnaires were given to the contractors for this study. The contractors returned a total of 60 questionnaires. According to Table 6, this outcome represents a total response rate of 88.2% from the respondents. The sample for this study included thirty (30) accidents from Class 8 (Dangerous Occurrence), eight (8) accidents from Class 1 (Fatality), four (4) accidents from Class 2 (Permanent Disability), eighteen (18) accidents from Class 3 (Temporary Disability), and thirty (30) accidents from Class 8.

Table 6 - Questionnaire Survey Response Rate

Project	Total No. of Accident Cases	No. of Accident Cases (Collected)	Accident Classification			
			1 (Fatality)	2 (Permanent Disability)	3 (Temporary Disability)	8 (Dangerous Occurrence)
A	17	17	2	2	5	8
B	7	7	-	-	2	5
C	6	4	-	1	2	1
D	14	11	2	-	3	6
E	6	6	1	-	-	5
F	8	7	2	-	3	2
G	4	4	-	1	2	1
H	6	4	1	-	1	2
Total	68	60	8	4	18	30

The research's respondent profile is shown in Table 7. The Safety Manager post received the most (62.5%) duties, followed by the Safety & Health Officer position (25.0%). As a result of their role as safety managers, the majority of respondents (62.5%) came from middle-level management. A person's position within a company gives an understanding of their professional experience. This indicates that the majority of respondents (50.0%) had work experience of between 11 and 15 years, and that 37.5% had more than 20 years of experience in construction safety.

Table 7 - Respondents' Profiles

Items	Sub-Items	Frequency (N)	Percentage (%)
Job Position	Safety Manager	5	62.5
	Environment Manager	1	12.5
	Safety & Health Officer	2	25.0
Job Category	Top-level Management	2	25.0
	Middle-level Management	5	62.5
	Low-level Management	1	12.5
Working Experience	11-15 years	4	50.0
	16-20 years	1	12.5
	> 20 years	3	37.5

c) Determination of Direct & Indirect Costs of Accidents Which Are Considered Significant for KVMRT Projects

Table 8 shows the mean rank score for the significance level on the direct & indirect costs of accident components and items during the construction of the KVMRT projects. The result shows that Hospital Costs Component was the *most significant* item that incurred cost when the accident happened with a mean=4.24 (SD=.916). It was followed by the Property Damage Costs Component (mean=3.51, SD=1.203) was the *significant item* rated by the respondents. Parallel with the previous study undertaken by Haupt and Pillay (2016), as based on the Department of Labour (2012) report, the construction sector paid out more on claims for injuries and illnesses that were work-related in the period ending March 2012. This large payment was for the compensation of employees and medical costs associated with injuries and illnesses, such as the hospital/medical costs incurred during the injured worker's treatment. Whilst for the Damage/Repair Costs Component, the cost should also be considered by the employer due to the high cost incurred from the machine and equipment damage and the cost to repair including the cost of labour. Battaglia et al. (2014) revealed that for complex accidents, the cost for the damage and replacement of equipment was significant, with a value of 16.3%.

For the findings of indirect costs of accident, the most major cost incurred during the accident, with a mean of 4.11 (SD=.512), was the Management Costs Component, which included the Health, Safety & Environment (HSE) Committee Cost. It followed by the Accident Report Costs Component with a mean of 4.09 (SD=.343). The respondents also examined the following factors as significant, which are Victim Costs Component (mean=3.48, SD=1.135), Administrative Work Costs (mean=3.66, SD=.921), and Time Loss Costs (mean=3.49, SD=.931). However, the Recruiting Cost for the Relocation of the New Workers to Replace the Injured Workers had the lowest mean rank (mean=2.66, SD=.950).

The findings were in line with earlier research by Rohani et al. (2015), where the investigation cost components were deemed statistically significant because the p-value was less than 0.05 ($\beta = -0.14$, $p < 0.05$). Once a workplace accident occurs, an investigative team will be sent to do investigation at the location. Prior to making any further

decisions, this team will evaluate the accident's cause. Since they must devote their time to this accident rather than their regular work, the positioning of this investigation team comes at a cost.

Other research has reported similar findings. According to Shalini (2009), there were additional costs associated with the investigation process, such as taking pictures and collecting statements from victims, witnesses, and management. She provided a formula based on the daily salary of the investigating team to determine the amount spent on them. Additionally, Jallon et al. (2011) found that for larger companies, it would be beneficial to include processes for a more thorough internal inquiry, drug and alcohol testing, disciplinary sanctions, or OSHA and insurance reporting to the investigative phase. For this cost component, the additional procedures will result in increased costs. Employers must include in the accident report costs in their calculations when an accident happens, despite the fact that they were less expensive. The accident report is crucial when an accident happens, according to Haupt and Pillay (2016). This is so that the expenses related to each accident may be determined. The report gave a complete description of the accident chronology, which was then scrutinized. The Corporate H&S department receives all incident reports first.

This contrasts with the findings of Rohani *et al.*, (2015), who studied in the manufacturing sector. She discovered that the legal and administrative cost components ($\beta = -0.26$, $p < 0.05$) and the productivity loss costs component ($\beta = 0.73$, $p < 0.05$) were both deemed statically significant. Accidental occurrences frequently have an impact on the production process. This will adversely affect an organization's production and, in the worst-case scenario, delay the company planning. The worker replacement cost was also discovered by Rohani et al. (2015) to be statistically significant ($\beta = -0.11$, $p < 0.05$). In contrast to the construction industry, which is based on interviews with respondents, when an accident happens on a construction site, the existing workers frequently fill the victim's position instead of hiring new ones.

Table 8 - Mean Rank Score for the Level of Significance on the Direct & Indirect Costs of Accident Components

Bil.	Direct & Indirect Costs of Accident Components	Direct & Indirect Costs of Accident Items	N	Mean	Std. Deviation	Rank
	Direct Costs of Accident					
1.	First-Aid Treatment Costs	On-Site Medical Treatment Costs	60	3.24	1.283	3
2.	Hospital Costs	Hospitalization Costs	60	4.24	.916	1
3.	Damage/Repair Costs	Property Damage Costs	60	3.51	1.203	2
4.	Fine Costs	Authority Fine Costs	60	2.99	1.299	4
	Indirect Costs of Accident					
1.	Accident Report Costs	Accident Report	60	4.09	.343	2
2.	Replacement Costs	Hiring Existing Workers	60	3.02	1.238	13
		Training Existing Workers	60	2.99	1.064	15
3.	Legal & Admin	Administrative Works	60	3.66	.921	3
	Costs	Legal Proceedings	60	2.82	.965	16
4.	Schedule Costs	Schedule Requirement	60	2.78	.975	17
5.	Productivity Loss Costs	Capacity Loss	60	3.14	.988	9
		Time Loss	60	3.49	.931	4
		Reduced Productivity	60	3.18	.880	7
6.	Work in Progress Costs	Recovering Works	60	3.06	1.098	10
		Investigation Tools	60	3.25	1.159	6
7.	The Victim Costs	Victims lost	60	3.48	1.135	5
		Compensation by Employer	60	3.04	1.140	11
8.	Recruiting Costs	Relocate New Workers	60	2.66	.950	18
9.	Uninsured Medical Costs	Uninsured Medical	60	3.18	1.142	8
10.	Management Costs	HSE Committee	60	4.11	.512	1
11.	Prevention Costs	Ad hoc Safety Training	60	3.01	.857	14
12.	Reputation/ Company Image	Company Performance	60	3.03	1.164	12

d) Correlation Analysis Between the Direct & Indirect Costs of Accident Components

Table 9 - Correlation Between Direct Costs of Accident Components

Types of Direct Costs of Accident Components	First-Aid Treatment Costs	Hospital Costs	Damage/Repair Costs	Fine Costs
First-Aid Treatment Costs	1.000	-	-	-
Hospital Costs	.738**	1.000	-	-
Damage/Repair Costs	-.076	.421**	1.000	-
Fine Costs	-.049	.146	.234	1.000

The significant correlations between the variables were found using a Pearson correlation test (see Table 9&10). Even though some of the direct & indirect costs components and items had low correlation strengths, it was discovered that both cost of accidents' components and items were most positively associated. The Hospital Costs Component and the First-Aid Treatment Costs Component had the strongest correlation coefficient (r=0.738). It shows that an immediate medical treatment service that include the cost of medical equipment used when the accident happened, payment to the person who arranges for emergency services and transport to the hospital and the salary of the first aider were needed before victim goes to the hospital. While for the indirect costs of accident, the Replacement Cost Component and the Productivity Loss Cost Component had the strongest correlation coefficient (r=0.982), which was followed by the Replacement Cost Component and the Schedule Cost Component (r=0.970). Due to insufficient workers completing the work, this outcome suggests that when the contractor changes additional workers to cover the jobs, it will have an impact on the production and scheduling expenses. This problem ought to motivate the contractors to investigate it thoroughly.

Table 10 - Correlation Between Indirect Costs of Accident Components

Types of Indirect Cost of Accident Components	Accident Report Costs	Replacement Costs	Legal& Admin Costs	Schedule Costs	Productivity Loss Costs	Work in Progress Costs	Victim Costs	Recruiting Costs	Uninsured Medical Costs	Management Costs	Prevention Costs	Company Image Costs
Accident Report Costs	1.000	-	-	-	-	-	-	-	-	-	-	-
Replacement Costs	-.202	1.000	-	-	-	-	-	-	-	-	-	-
Legal & Admin Costs	-.089	.798**	1.000	-	-	-	-	-	-	-	-	-
Schedule Costs	-.044	.970**	.827**	1.000	-	-	-	-	-	-	-	-
Productivity Loss Costs	-.145	.982**	.733**	.952**	1.000	-	-	-	-	-	-	-
Work in Progress Costs	-.242	.940**	.905**	.904**	.919**	1.000	-	-	-	-	-	-
Victim Costs	-.139	.894**	.670**	.854**	.944**	.863**	1.000	-	-	-	-	-
Recruiting Costs	-.120	.938**	.815**	.961**	.918**	.898**	.836**	1.000	-	-	-	-
Uninsured Medical Costs	-.348**	.811**	.854**	.764**	.765**	.913**	.723**	.785**	1.000	-	-	-
Management Costs	.512**	.079	.099	.198	.113	-.025	.167	.068	-.226	1.000	-	-
Prevention Costs	.290*	.534**	.638**	.673**	.518**	.545**	.425**	.562**	.457**	.344**	1.000	-
Reputation/Company Image Costs	-.114	.912**	.681**	.833**	.920**	.870**	.846**	.861**	.722**	-.008	.471**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

6. Conclusion

According to the findings, Management Costs incurred while the HSE team was conducting its investigation are the most significant categories of accident related to the indirect costs. It was followed by the Accident Report Costs and Administrative Work Costs. The least important expense incurred when the accident occurred on the job site was the Recruiting Costs for the relocation of the new workers to replace the injured personnel. Overall, the results could increase awareness and assist contractors in properly planning their investment in safety measures in accordance with the associated accident cost components. The future work of this study will include similar research covering a bigger regional scale, covering the whole of Malaysia is necessary as the findings could be further extended.

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