

# REDUCING ACCIDENTS IN LARGE CONSTRUCTION PROJECTS IN SRI LANKA

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## ABSTRACT

*Construction industry is considered as one of the leading industries in Sri Lanka, which contributes a significant percentage to the economy. At the meantime, it causes wide range of impact on health and safety of worker. On the other hand, construction industry is well known as an accident-prone industry. Nowadays, large scale construction projects are commonly distributed throughout the world. Hence, it is highly important to ensure proper safety management in the building process with the rising complexity of the projects.*

*Different types of accidents, contributing factors to the accidents, causes for the accidents and control measure to reduce the accidents were identified through a literature review and it was substantiated through a pilot survey among five safety experts. Subsequently, a questionnaire survey was carried out among the safety practitioner who are involving with construction safety, to assess the pre-identified causes, strategies and mostly occurred construction accidents. A quantitative research analysis was carried out to assess the factors which are assess through pilot survey. Specially, RII was used for data analysis to prioritize the factors and one sample t-test was carried out to identify the significant factors by using SPSS. Finally, the analysis results were used to develop the framework. Sixteen different types of accidents, thirty-four causes for the accidents and thirty-five control measure/ safety practices were identified in this study. Among them seventeen causes and nineteen control measures were finalized as critical factors and those factors were used to develop final framework in order to mitigate the accidents in large construction projects in Sri Lanka.*

**Keywords:** Construction Safety; Construction Site Accidents; Framework; Large Construction Projects; RII; Sri Lanka.

## 1. INTRODUCTION

Construction is generally known as the process of formation of physical infrastructure, superstructure and related facilities (Bertelsen and Koskela, 2004). Construction industry is referred as major part of an economy growth of a nation and generally considered to be the driving force of economy in developing nations. Contribution of construction industry to the main economic factor, Gross Domestic Product (GDP) of a country ranges from 7% to 10% in developed countries, whereas it ranges from 3% to 9% in developing countries (Lowee, 2003). In Sri Lanka, it gives 6.8 % of contribution to GDP, which shows a considerable size of impact to Sri Lankan economy. Therefore, most of the countries are considering construction industry as an important sector. Even though construction industry flourishes the country's economy, it is also considered to be most hazardous in terms of degree of injury and lost time of work caused by it (Dembe *et al.*, 2008). Further, construction sites are widely known for its occupational hazard and risk of work, which classifies this line of work to be one of the most dangerous activity on earth (ILO, 2005). Therefore, occupational safety and health have always been sensitive issues in the construction industry, particularly considering its high number of accidents. However, Sri Lanka is considered to be one of the vulnerable country, and is ranked at a little level for occupational Safety and health (OSH) performance due to lack of improvement in safety practices (Gunawardena and Priyangika, 2005). Therefore, this study aims to develop a framework to reduce the accidents in large construction projects in Sri Lanka.

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## **2. DIFFERENT TYPES OF ACCIDENTS WHICH OCCURS IN CONSTRUCTION PROJECTS**

“An accident is an unplanned, undesired event, which may or may not result in injury or property damage that interferes with the completion of assigned task” (Lancaster *et al.*, 2003). Accidents are classified into different types in construction industry, hence, there can be many kinds of accidents in relation to their classification the degree of severity of an accident varies according to the classification of such accidents (Rameezdeen *et al.*, 2003). Ferret and Hughes (2007) classified accidents in the construction industry as fatal and non-fatal (major and minor injury). Further to him, accidents in construction industry occurs at work sites and most common accidents and injuries are slips, trips and falls from the same level of work and from separate levels (from higher levels), being hit by moving or falling objects (falling debris), blunt force trauma due to impact on stationary objects, cuts due to sharp objects, abrasions due to rough surface, electrical hazards.

Occupational injuries from construction activities in general are defined by Davis and Tomasin (1990) as: danger of physical injury and fatality; and health problems. On the other hand, Hinze (2002) identified eight group of construction accidents resulting in physical social injuries and fatalities. They are, fire explosion, power tool accidents, excavation related accidents, struck by moving objects, struck by falling object, falling from height, electrical accidents and others (lighting strike, oxygen confined spaces).

## **3. CAUSES OF ACCIDENT IN LARGE CONSTRUCTION PROJECTS**

Every accident occurs as a result of several underlying causes and originate via a source. Therefore, having a clear understanding about those causes of accidents are crucial to develop the proper platform for health and safety management, in order to minimize the causes of accident and relevant costs. When those causes are understood, it will let to take corrective actions to avoid the recurrence of accident and take preventive actions to prevent the occurrence of accident again. Generally, there are two types of factors resulting the accidents, i.e. behavioural and environmental factors. Behavioural factors comprising attitudes, skills, behaviour and knowledge while environmental factors comprising workplace hazards and procedures which causing injuries (Taylor *et al.*, 2004).

Most of the research studies of construction accidents are focusing on causes, consequents of those accident. Broadly those accident's causes consisting of worksite management and culture; training and competency level of workers; their attitude and behaviour; condition of equipment; improper working procedures; lack of safety regulations and legislation and environmental condition (Gibb *et al.*, 2006). Accidents are originated from lack of awareness of managers on safety, lack of training, incautious operations and fear to commit resources for safety. Further, Rahim *et al.* (2008) found that inexperienced workers and lack of understanding about the construction accidents and relevant risks are the main causes for the accidents and risks on constructions. Further, survey identified unsafe method of operations, which consisting of incorrect and disobeying procedures and the poor knowledge level are the major causes for the frequent occurrence of construction accidents. While construction accidents are take in place result of improper training, deficient enforcement and regulation of safety, lack of safety equipment, improper equipment handling, unsafe working conditions, not using provided safety equipment and poor attitude towards safety are considered as reasons for the accidents on construction site by Toole (2002).

## **4. AVAILABLE STRATEGIES/ CONTROL MEASURES TO REDUCE THE ACCIDENTS**

Number of strategies applied to prevent the construction accidents, those focused depend on technical, organizational and human factors, with many prevention strategies focused on particular accident, the construction company when prevent the particular accident which affect the level of emphasis and resource allocation across various factors (Lancaster *et al.*, 2003). To improve the work place safety, it can prevent those accidents and also it helps to analyse, how these accidents and injuries are generated. Rameezdeen *et al.* (2003) developed an accident prevention programme, which indirectly implicate to productivity and quality, as work procedures are better organized and free from unnecessary intrusions. Further, they expressed that a successful accident plan scheme is required accompanying four fundamental exercises, i.e. a risk assessment to investigate the risk available on the sites, study of operating practices and techniques, provide specialized training, incentives and guidelines and carry out accidents investigation to minify recurrences. In any kind of health and safety management program, the first step could be to identify the hazards or disaster situations in the work environment and place. In this sense, a detailed evaluation and a critical analysis of accidents in the

construction industry is of immense importance (Rameezdeen *et al.*, 2003). Furthermore, the importance of health and safety risk management of the construction projects has repeatedly been shown to save lives, time, and money, and to increase business goodwill and good protection (Kikwasi, 2010).

## **5. RESEARCH METHODOLOGY**

The research was structured in several steps. First, the existing literature were reviewed preliminary discussions were held with five (05) safety practitioners who has experience more than 10 years and final questionnaire survey was conducted to find the OSH strategies to formulate the questionnaire and framework development. Majority of the questions in the questionnaire were included with 1 to 5 Likert scale. The remaining questions were included with short answer “yes” of “No” answers. First section of the questionnaire was used to identify the general information on the respondent organization. Section two consists general information of respondents. Further in the third and fourth sections, gathered information on different types of accidents and causes for the accident on construction sites. The last section was focused on the strategies to mitigate the accidents on large construction sites.

The survey sample was included Safety Managers, Safety Officers, Safety Engineer and Safety Consultants from list of large building construction projects. The snow ball sampling under non-probability sampling method was used to determine the sample. A list of all CS2 and CS1 contractors were selected from the CIDA (Construction Industries Development Authority) contractor’s grade listing. For the main survey, respondents were selected from larger construction projects, who are currently involved with safety management practices. Totally 50 respondents were asked to voluntarily complete their particular questionnaire using 1 to 5 Likert scale and 36 responses were returned out of 50 questionnaires.

Prior to the main survey a pilot survey is always recommended to improve the validity and reliability of questionnaire. Pilot survey result was obtained by using Relative Important Index (RII). In order to get relative ranking of the factors.

The final questionnaire was developed after the expert comments and the following changes were made:

- Addition of one cause that were most significant to reduce the construction accidents and deduction of five irrelevant causes from the questionnaire
- Deduction of five least significant strategies from the questionnaire

The one addition was “lack of monitoring and supervision” and the deductions were “Complexity and the diversity of site, in adequate visibility, reckless operation of system, continues changing work site and deficient knowledge of project manager on safety of construction site”. Those were eliminated due to irrelevant to direct causes and it’s related to other listed causes. Finally, 30 causes were selected for the final questionnaire. The five strategies were deducted due to their least practices by construction industries. They were guarding system for machinery, first aid training, and proper permission prior to do the task, insurance policy and training for protecting site when any accident happens. Finally, 30 strategies were elected for the final questionnaire.

## **6. DATA ANALYSIS AND FINDINGS**

### ***6.1. RANKING OF MOST FREQUENT OCCURRED ACCIDENTS IN CONSTRUCTION SITE***

Respondents were asked to mention about the types of accidents that were occurred in their own sites. Results were obtained after the analysis and shown in Figure 1.

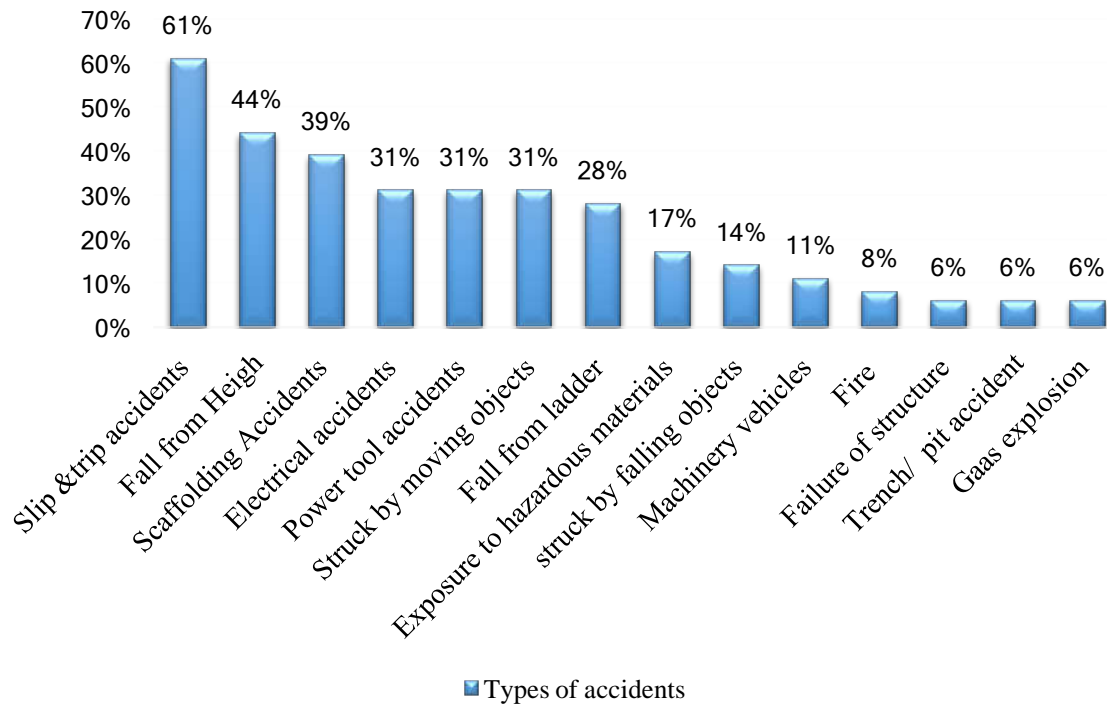


Figure 1: Most Common Types of Accidents in Percentage with Ranking Order

## 6.2. RANKING OF CAUSES OF ACCIDENTS FOR THE CONSTRUCTION PROJECTS IN SRI LANKA

The respondents were asked to rate the degree of agreement and disagreement on scale using 1 to 5. The relative importance index (RII) test was used as a tool to prioritize the factors both the causes and strategies. After the prioritizing one sample t-test were carried out in order to assess the most critical factors.

Table 1: One Sample t-test and RII Value After Prioritized the Causes of Accidents

No	Factors on causes	RII	Rank	t-value	Significant
1	Non-implementation of rules & regulation	0.94	1	21.76	Yes
2	Limited funds for safety management	0.68	16	2.02	Yes
3	Inadequate policy & standards	0.87	4	8.64	Yes
4	Inadequate safety precaution & procedure for the assigned job	0.90	2	12.21	Yes
5	Not enough rest time during the task for workers	0.77	12	4.51	Yes
6	Deficient knowledge & unqualified officers	0.84	8	8.72	Yes
7	Safety items/tools/Resources are not available on site	0.85	5	9.74	Yes
8	Misuse or Correct tools are not used for the task.	0.64	18	1.31	No
9	Lack of appreciation after completion of task by workers	0.51	26	-3.22	No
10	No training program for workers/ Lack of weekly safety meeting	0.83	9	7.97	Yes
11	Lack of monitoring & supervision	0.84	7	8.47	Yes
12	Lack of top management commitment	0.85	5	10.24	Yes
13	No safety officer at site	0.79	11	6.34	Yes
14	No unity among job crew / no cohesiveness	0.63	19	0.84	No
	<b>Average RII for management related factors</b>	<b>0.78</b>			

No	Factors on causes	RII	Rank	t-value	Significant
15	Lack of knowledge by workers	0.87	3	9.08	Yes
16	Some workers are sufficient from health problems	0.53	22	-2.09	No
17	Due to Fault and misjudgement of workers	0.56	21	-0.98	No
18	Workers are over confident	0.71	14	4.34	Yes
19	Workers willing to take overtime	0.50	27	-3.41	No
20	Workers avoid to wear personal protective items	0.66	17	1.76	Yes
21	Physical fatigue (Tired)	0.53	22	-1.78	No
22	Work load over physical capabilities of workers.	0.68	15	2.86	Yes
23	Quick working (Work is performed while rushing)	0.48	30	-3.32	No
24	worker's attitudes and behaviour	0.62	20	0.43	No
25	Some workers are suffering from mental fatigue on the job	0.62	29	-3.16	No
	<b>Average RII for workers related factors</b>	<b>0.614</b>			
26	Worker have no satisfactory with the nature of the job	0.51	25	-2.93	No
27	Hazards / risk available in the site	0.81	10	6.55	Yes
28	Extreme weather condition	0.49	28	-3.08	No
29	Inadequate housekeeping	0.53	22	-1.67	No
30	Deficit welfare facilities for the workers (House, foods & transportation)	0.74	13	4.86	Yes
	<b>Average RII for project related factors</b>	<b>0.616</b>			

### 6.3. RANKING OF MOST SUITABLE SAFETY STRATEGIES

Table 2 shows the RII values and the rankings status of each factors and the results of the t-test for the factors influence on “strategies for mitigate the accidents” among all the respondents. After the t-test value there are nineteen strategies were identified as significant.

Table 2: One Sample t-test and RII Value after Prioritized the Strategies for Accidents

No	Factors on strategies	RII	Rank	t-value	Significant
1	Pre-project / Pre-task Planning	0.95	1	23.90	Yes
2	Safety orientation and specialized training	0.89	5	11.998	Yes
3	Safety incentives, reward and Punishment	0.86	9	10.345	Yes
4	Drug and alcohol testing	0.42	30	-5.01	No
5	Conduct the accidents investigation after happening the accidents	0.86	8	12.548	Yes
6	Top Management commitment	0.91	2	12.705	Yes
7	OSH management policies, standard & set targets	0.84	11	10.163	Yes
8	Safety audits or inspection	0.89	5	13.506	Yes
9	Employee involvement and empowerment towards safety management	0.84	12	7.78	Yes
10	Safety equipment & supportive devices (PPE)	0.88	7	9.06	Yes
11	Follow check list related to safety measures	0.55	24	-1.19	No
12	Adequate maintenance for equipment	0.67	18	1.82	Yes
13	Resource availability to address the health and safety problem	0.57	23	-0.86	No
14	Proper documentation of OSH issues	0.54	26	-1.53	No
15	Arrange the site environment- (Clean up)	0.55	24	-1.19	No

No	Factors on strategies	RII	Rank	t-value	Significant
16	Use skilled workers to prevent accidents	0.69	17	3.83	Yes
17	Sub-contractor's management for contribution to accident prevention	0.70	16	3.41	Yes
18	Implement occupational Health and Safety Act and Regulations	0.86	9	9.84	Yes
19	Upgrade the constructions worker's education for understand the importance of safety.	0.90	4	13.748	Yes
20	Adequate storage for hazardous material	0.53	27	-1.61	No
21	Budget allocation for the safety and health	0.67	18	2.32	Yes
22	Dedicated safety officers in your projects	0.76	15	5.39	Yes
23	Safety administration and Welfare of labour force	0.53	29	-1.77	No
24	Emergency procedure	0.61	20	0.13	No
25	Safety communication & decision making	0.79	14	8.37	Yes
26	Adequate supervision, Safety monitoring and control for workers	0.91	3	15.057	Yes
27	Accident recording and reporting (fatal & Non- fatal)	0.57	22	-0.75	No
28	Job hazard analysis / risk assessment	0.82	13	8.12	Yes
29	Management safety training	0.53	27	-1.61	No
30	Supportive work environment/ safe environment	0.59	21	-0.27	No

## 7. CONCLUSIONS

The construction industry contributes to the national economy by considerable amount which has high amount of accidents record than in other industries. A Construction site can be considered as hazardous environment due to its complexity and temporary nature. Further, health and safety consideration is always ignored than in product oriented industry. Therefore, there is high demand on safety management on construction industry. In Sri Lanka, many accidents are happening on site, but not reported. These have an adverse effect on a countries economy. The purpose of this research study was to develop a framework to reduce the accidents in larger construction projects in Sri Lanka.

The proposed framework can be used to reduce accidents and it shows a path to create a safe culture in constructions sites. First identification of contribution factors/facts which creates an accident. These contributing facts and factors can be assessed to identify their direct and indirect impact through impact assessment. Where impact is higher the accident preventive measures shall be taken. These can be reflected and be included in policy statements and objectives of an organization. When an accident happens again factors/causes can be identified as per its type through detailed investigation. The identified causes should be recorded to identify direct and indirect impact of accidents. Then reactive measures/control measures can be taken. The feedback should go through policy statement by comparing the pre-identified contributing factors for accidents and find root causes for continues improvement. Through feedback, the proactive control strategies need to revise. The framework is shown in Figure 2.

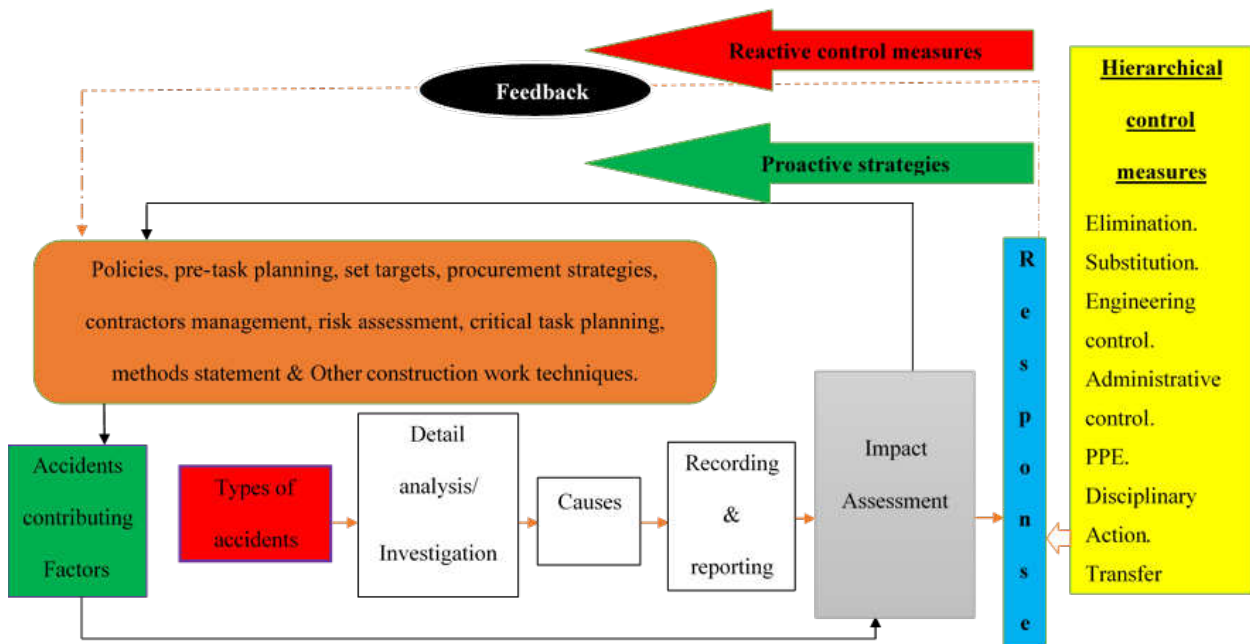


Figure 2: Most Common Types of Accidents in Percentage with Ranking Order

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