A Study on Identification of Causes and Effects of Accidents in Construction Industry- Indian Scenario

Sakthi Ganesh. G[#1], Rajesh. M[#2],

[#1]*Department of Construction Engineering and Management, Erode, Tamilnadu, India*
[#2]*Assistant Professor, Department of Construction Technology and Management, Wollega University, Nekmte, Ethiopia*

Abstract
The purpose of this study is to find out the most possible factor which causes accidents in the construction industry and thus affecting the safety management in the construction firm. It also includes identifying the effects of accidents in construction industry. A questionnaire was framed, in which a total of 44 causes and 11 effects of accidents were included and then a respondent of 137 construction firm was received. The causes of accidents were grouped into five groups; the group of causes of accidents were unsafe act, unsafe working condition, communication barrier, management commitment, and training. The questionnaire survey was analysed by means of determining the mean value for each factors using SPSS software, thereby finding the most possible factor which cause accident in the construction industry. The most possible factor that causes accident in the firm were failure to follow safety rules, ignorance of PPE (Personal Protective Equipment), space congestion, improper use of safety items, improper equipment. Then the most possible effects of accidents in the construction industry were cost of medical expenses, time loss of project execution, productivity loss, distrust of firm, cost of training given to new worker. The study concludes by giving recommendations for controlling safety and evading accidents in construction industry.

Keywords - *Accidents, Causes of Accidents, Effects of Accidents, Safety, Construction.*

I. INTRODUCTION

Construction industry mainly relies on human control and their effectiveness makes the project a successful one. Without human factor construction industry becomes questionable. Therefore, to enrich the construction industry the management or construction firm should ensure their safety in their working environment. Accidents are unexpected events that occur at any circumstances even when the firm was in safer conditions, the aim to be minimize or control the accidents. The safety just not handles the safety of the workers itself, it ensures the workers to trust on the firm and also if the workers feel that they are working in a safer environment the productivity and effectiveness of the workers gets higher to the project. There might be several factors which affects the construction safety directly or indirectly. A safety officer or Project manager should develop a safety plan for the firm and should inspect the safety regulations that are following in the project regularly.

Objectives of the Study

- To find out the major causes and effects of accidents in the construction industry.
- To predict the causes based on different respondents.
- Suggesting general methods and techniques to minimize the accidents in the construction industry.

II. LITERATURE REVIEW

A. Safety Management System

The work related to safety management system was predicted by means of analysing the perception of the accident among various characteristics [1]. Accidents and incidents that occur on the construction office and accidents occur on workshops which records about 19 and 52 accidents respectively in the period of 2011- 2013. It states that about 81% of accidents get increased on 2013 compared to 2011 in UAE.

To neglect the hazards in the construction site it is essential to neglect the hazardous activity from the construction site [2]. They discussed the importance of safety in construction and need for safety in construction. By means of inspecting a construction site with that of a time scale for the observations they recorded on the site. The time scale fixes the time to take action on a particular observation and also the control measures for the observations were studied.

B. Safety Measures

The human power which gets affected by means of accidents in the construction industry can be prevented by means of using several safety measures [3]. Safety measures include a safety plan established by the management to the organization. Appropriate safety programs, safety trainings to the workers and also safety meetings should be conducted to give awareness to the workers regarding safety rules and

regulations. By means of field survey the resultant control measure to minimize accidents on the construction sites are provisions of first aid facility, provision of helmet or hard hat, provision of hard hats or helmets, provision of traction boots and provision of hand gloves.

C. Causes of Fall Hazards

Primarily accidents that occur in the construction are due to fall hazards [4]. An analysis on the construction site includes majorly the fall hazards scenario thereby identifying the types of fall hazard and their mode of accidents. The modes of accidents due to fall hazard are accidents due to unsafe act, accidents due to unsafe working conditions, poor communication barrier, due to management commitment, due to lack of training, due to fall protection system and due to safety management system[18].

III.METHODOLOGY

In this paper, based on the previous study a questionnaire was prepared and the questionnaire was undertaken a survey on the construction firm. The respondent includes client, contractor and consultant in the construction firm. Whereas the causes of accidents and effects of accidents were analysed using SPSS software and suggestions related to the causes were explained.

A. Questionnaire Setup

The questionnaire includes 44 causes of accidents [4] [5] [6] [7], which were framed based on the literature review and also by means of case study. The effects of accidents were also framed in the questionnaire which includes 11 effects of accidents [8] [9]. Questionnaire was distinguished into two sections; first section implies the respondents profile and in the second section there includes the causes and effects of accidents[17]. The causes of accidents was divided into groups based on their respective origin, the groups we assigned in the questionnaire was

- Unsafe act
- Unsafe working conditions
- Management commitment
- Training
- Communication barrier

The respondents were asked to mark the causes of the delay based on the frequency and severity. A five scale importance index (Likert's Scale) was used to analyse the setup which implies 5 as very often, 4 as often, 3 as sometimes, 2 as seldom and 1 as never. Table 1 display the effects of accidents that occur in construction industry and Table 2 display the causes of accidents in the construction industry.

Table 1: Effects of Construction accidents

No	Effects of Accidents
1	Time loss of project execution
2	Reputation of firm
3	Mental illness of workers
4	Cost of medical expenses
5	Cost of recruiting new worker
6	Cost of training given to new worker
7	Compensation Cost
8	Repairs
9	Additional Supervision cost
10	Productivity loss
11	Cost of accident investigation time

IV. QUESTIONNAIRE ANALYSIS

A. Causes of Accidents

The questionnaire survey was conducted in Construction projects and firms of Tamilnadu and Bangalore. After the questionnaire survey was done the resultant response was analysed in the SPSS software. The mean of all the factors in the questionnaire were found. A total of 154 questionnaires were distributed and out of it 137 was obtained. The respondent rate was 88% for this study. Figure 1 shows the input of the questionnaire in the software and Figure 2 shows the input of the respondent value given to the each factors.
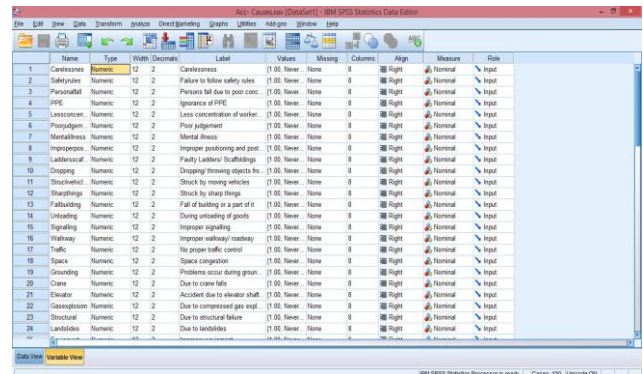
Figure 1: Input of the Questionnaire in SPSS

Table 2: Causes of accidents and their respective groups

| No	Causes of Accidents	Group
1	Carelessness	Unsafe act
2	Failure to follow safety rules	Unsafe act
3	Persons fall due to poor concentration	Unsafe act
4	Ignorance of PPE	Unsafe act
5	Less concentration of workers or drivers	Unsafe act
6	Poor judgement	Unsafe act
7	Mental illness	Unsafe act
8	Improper positioning and posture during working	Unsafe act
9	Faulty Ladders/ Scaffoldings	Unsafe working conditions
10	Dropping/ throwing objects from high rise projects	Unsafe working conditions
11	Struck by moving vehicles	Unsafe working conditions
12	Struck by sharp things	Unsafe working conditions
13	Fall of building or a part of it	Unsafe working conditions
14	During unloading of goods	Unsafe working conditions
15	Improper signalling	Unsafe working conditions
16	Improper walkway/ roadway	Unsafe working conditions
17	No proper traffic control	Unsafe working conditions
18	Space congestion	Unsafe working conditions
19	Problems occur during grounding	Unsafe working conditions
20	Due to crane falls	Unsafe working conditions
21	Accident due to elevator shaft falls	Unsafe working conditions
22	Due to compressed gas explosion	Unsafe working conditions
23	Due to structural failure	Unsafe working conditions
24	Due to landslides	Unsafe working conditions
25	Improper equipment	Management commitment
26	Improper housekeeping	Management commitment
27	Improper stacking	Management commitment
28	Inflammable materials unsecured	Management commitment
29	Material component failure	Management commitment
30	Inadequate Construction Planning	Management commitment
31	Harsh Deadlines	Management commitment
32	Improper use of safety items	Training
33	Incompetence	Training
34	Inexperience	Training
35	Rash driving	Training
36	Lack of proper training	Training
37	Welding accidents	Training
38	Due to substance Abuse	Training
39	Lack of Coordination	Communication Barrier
40	Unclear of the information	Communication Barrier
41	Language barrier (speaking, writing and reading)	Communication Barrier
42	Poor understanding of signage (safety information and warning signs)	Communication Barrier
43	Poor line of communication among safety officer and employees	Communication Barrier
44	Forms of message transferred cause confusion	Communication Barrier
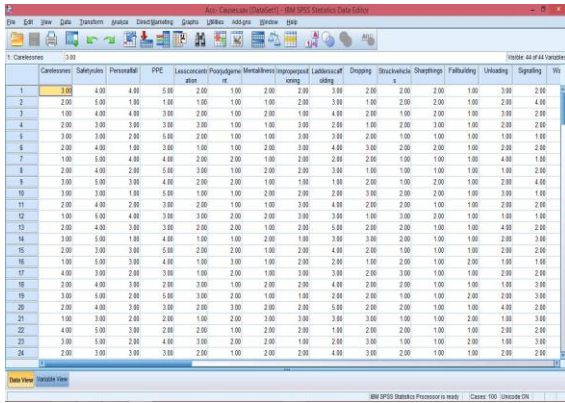
Figure 2: Input of The Respondent Value in SPSS

V. ANALYSIS OF DATA

After the respondent response was entered into the SPSS program a reliability analysis was to be used. Reliability test is conducted to check the stability and consistency of a data by using Cronbach alpha method that is widely adopted. Cronbach's alpha will generally increase as the intercorrelations among test items increase, and is thus known as an internal consistency estimate of reliability of test scores. Because intercorrelations among test items are maximized when all items measures same construct, Cronbach's alpha is widely believed to indirectly indicate the degree to which a set of items measures a single unidimensional latent construct. Reliability of the data is considered at low level when Cronbach alpha is less than 0.3 which means the data is not reliable and cannot be adopted. In this study, Cronbach alpha was calculated using statistical software SPSS Version 23 and the result thus obtained was 0.717 and it is presented in the figure 3. Reliability is at high level when Cronbach alpha is more than 0.7 [10].
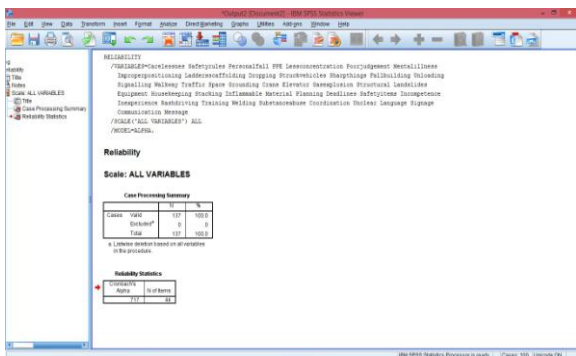

Figure 3: Reliability Analysis Using SPSS

After finding the reliability value, the mean values of all the factors were identified using SPSS. The output of the factors was presented in the Figure 4, Figure 5, Figure 6 and Figure 7.
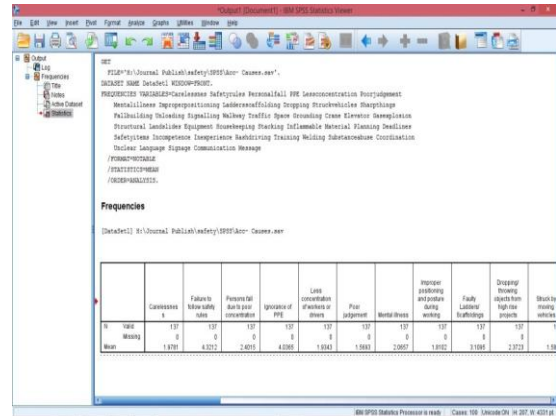

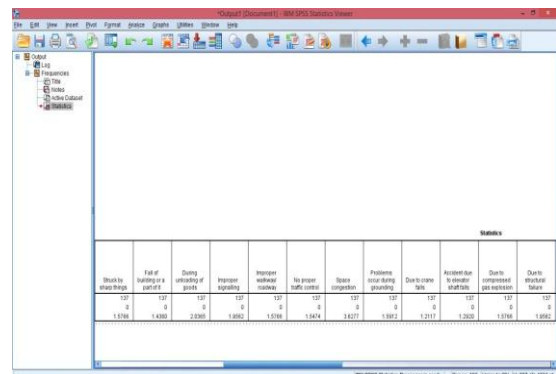**Figure 4: Mean Value Output for the Causes of Accidents (Page-1)**

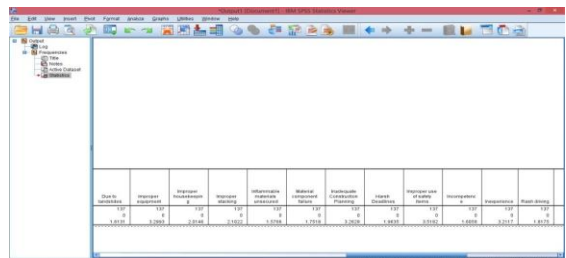**Figure 5: Mean Value Output for the Causes of Accidents (Page-2)**

Figure 6: Mean Value Output for The Causes Of Accidents (Page-3)
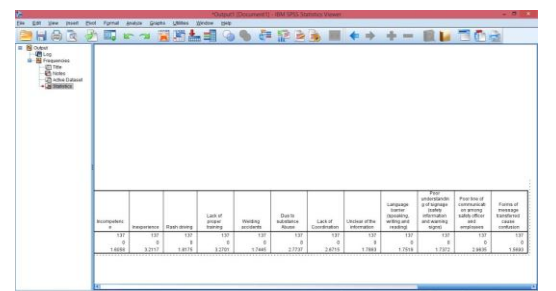

**Figure 7: Mean Value Output For The Causes Of Accidents (Page-4)**

Based on the mean value, the causes of accidents were ranked and were tabulated in the Table 3. The mean value denotes the average value among all the respondents response.

Table 4: Ranking and Mean Value of Causes of Accidents

Causes of Accidents	Mean Value	Ranking
Failure to follow safety rules	4.3213	1
Ignorance of PPE	4.0365	2
Space congestion	3.6277	3
Improper use of safety items	3.5182	4
Improper equipment	3.2993	5
Lack of proper training	3.2701	6
Inadequate Construction Planning	3.2628	7
Inexperience	3.2117	8
Faulty Ladders/ Scaffoldings	3.1095	9
Poor line of communication among safety officer and employees	2.9635	10
Due to substance Abuse	2.7737	11
Lack of Coordination	2.6715	12
Persons fall due to poor concentration	2.4015	13
Dropping/ throwing objects from high rise projects	2.3723	14
Improper stacking	2.1022	15
Mental illness	2.0657	16
During unloading of goods	2.0365	17
Improper housekeeping	2.0146	18
Carelessness	1.9781	19
Harsh Deadlines	1.9635	20
Due to structural failure	1.9562	21
Improper signalling	1.9562	21
Less concentration of workers or drivers	1.9343	22
Rash driving	1.8175	23
Improper positioning and posture during working	1.8102	24
Unclear of the information	1.7883	25
Language barrier (speaking, writing and reading)	1.7518	26
Material component failure	1.7518	26
Welding accidents	1.7445	27
Poor understanding of signage (safety information and warning signs)	1.7374	28
Due to landslides	1.6161	29
Incompetence	1.6058	30
Problems occur during grounding	1.5912	31
Struck by moving vehicles	1.5839	32
Struck by sharp things	1.5766	33
Improper walkway/ roadway	1.5766	33
Due to compressed gas explosion	1.5766	33
Inflammable materials unsecured	1.5766	33
Poor judgement	1.5693	34
Forms of message transferred cause confusion	1.5693	34
No proper traffic control	1.5474	35
Fall of building or a part of it	1.4380	36
Accident due to elevator shaft falls	1.2920	37
Due to crane falls	1.2117	38

Effects of Accidents

The effects of accidents were also analysed based on the questionnaire response using SPSS. The mean value of the effects of accidents were tabulated and ranked in the table 5 and also the output analysed in SPSS was presented in the Figure 8.
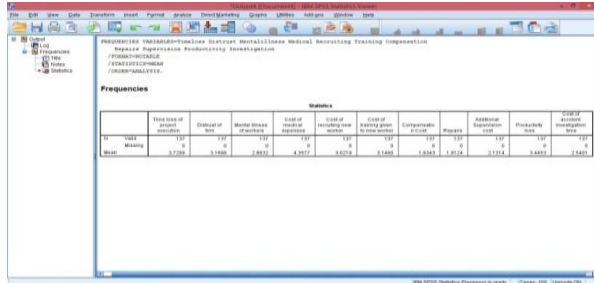
Figure 8: Output of Effects of Accidents in SPSS

Table 5: Ranking and Mean Value of Effects of Accident

Effects of Accident	Mean Value	Ranking
Cost of Medical Expenses	4.3577	1
Time loss of project execution	3.7299	2
Productivity Loss	3.4453	3
Distrust of Firm	3.1898	4
Cost of training given to new worker	3.1460	5
Cost of Recruiting new worker	3.0219	6
Mental illness of workers	2.8832	7
Cost of Accident investigation time	2.5401	8
Additional supervision cost	2.1314	9
Compensation Cost	1.9343	10
Repairs	1.9124	11

Leading factor which causes accident in the construction industry in each group was tabulated in the Table 6.

Leading Cause of Accident	Group
Failure to follow safety rules	Unsafe Act
Space congestion	Unsafe Working Condition
Improper use of safety items	Management Commitment
Lack of proper training	Training
Poor line of communication among safety officer and employees	Communication Barrier

VI.DISCUSSIONS OF RESULTS

Based on analysing the questionnaire in SPSS we found the major causes and effects of construction accidents. The top 5 ranked causes and effects of accidents are listed as follows.

A. Top Ranked Causes of Accident

- Failure to follow safety rules
- Ignorance of PPE
- Space congestion
- Improper use of safety items
- Improper equipment

B. Top Ranked Effects of Accident

- Cost of Medical Expenses
- Time loss of project execution
- Productivity Loss
- Distrust of Firm
- Cost of training given to new worker

VII.CONCLUSION

The safety program for a construction firm is essential, the study states several factors which grounds for the accident and directly destroys the safety programs. Nevertheless the construction industries have the right and responsibility to avoid such accidents in their site, therefore the effects of accidents in the construction firm can be prevented. The effect of accident will affect the workers and construction firm directly with huge impact, to overcome this impact the firm or particular worker needs some improvement in their working method. They should ensure that they were working with all safety regulations and also following the safety regulations. Furthermore, the recommendations to prevent construction firm from the accident and to ensure the safety of the workers were listed as follows.

VIII. RECOMMENDATIONS

A. Documentation of Safety Clauses in Contract

While forming a contract itself the safety regulations to be followed should be mentioned in the documents [11]. Ensuring that the owner and contractor should know what are all the safety regulations to be followed throughout the project. In terms of contractor they should give a detailed view about the documentation to the workers regarding the safety aspects [19]. The owner has the right to allocate the safety regulations but in terms of an accident occurs the contractor safety officer is the responsibility of it. Therefore using the safety clauses in contract documenting there awakes a clear idea and knowledge of the safety to be followed and the benefits of safety.

B. Safety Planning

A safety plan should be guaranteed to the construction firm which includes the tasks to be done

by each individual comprising in the construction firm [12] [15]. The safety plan infers every task to be done with what sort of safety precautions. Hazard prevention will be directly abetted to the workers and this will helps the construction firm to prevent from construction accidents and ensuring safety management on site.

C. Safety Audit

An audit related to ensure the safety in the construction firm was to be conducted. This helps to deduct the source of accidents by means of direct inspection on the working area. As a rule there has the possibility to predict the source of accident by means of analysing the previous safety audit undertaken in the site [13]. The foremost advantage of safety audit is the safety management can be followed and maintained throughout the management. If there needs an improvement in safety aspects the audit itself make the caution to the governing members of the site in terms of safety.

D. Safety Programme

A safety programme mention about the common safety policies followed in the construction firm. This leads the workers to work to attain the safety goals and safety programme of the firm [14] [16]. In the event of an accident occurrence the safety programme will helps to aid the emergency provisions to be followed by workers. Concerning the safety programme it effectively describes the safe work practices and procedures this will make the firm free from accident and maintains an enriched safety workplace.

E. Pre-job Meetings

A safety schedule should be prepared for a project and it should be discussed before the commencement of work. The meeting participants should be of safety officer, project managers, and executive engineers. The meeting mainly discusses about the nature of work to be carried out and based on that the safety precautions should be advised by the advisory committee to the workers. Every pre- job meetings should be recorded and documented this will helps to analyse the safety programme to be followed in future projects.

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