



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

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ABSTRACT

Construction industry is one of the most hazardous industries. Accidents may occur during construction which results in serious injuries and death to employees and also may cause severe damage to equipment. Hence it is important to prevent or minimize accidents in the construction site. Safety during construction is very important for each employee. This project deals with job site safety analysis in construction site by identifying the causes for accidents and implementing solutions for preventing the accident in the construction industry. From the literatures it was studied that statistical analysis is better way to analyse the construction jobsite safety and important factors that are affecting the safety in construction is identified from the literatures. Questionnaire regarding the factors affecting safety in construction site is also prepared. Then primary data should be collected from the various construction companies and secondary data should be collected from their clients. Then the data's are ranked by two different techniques, primary data was ranked by using Relative important index method and secondary data was ranked by the Garrett's ranking technique. Then the companies which are following safe safety procedures should be found out using Statistical analysis. This data is analysed in Statistical Package for Social Science (SPSS) software and the major factors which affect safety in construction should found out through comparison of primary and secondary data by paired sample t-test. With this approach, it is possible to evaluate the uncertainty regarding safety in construction.

1 Introduction

1.1 General

Construction industry is considered as one of the most hazardous industries. The development of construction industry has been plagued by the accidents or injuries that are frequently occurred. It is estimated that there are around 60,000 construction fatalities occurred worldwide each year, which equates to one accident happen every nine minutes. Human error is a main reason for up to 80% of all incidents and accidents in high risk industries. According to the Occupational Safety and Health Administration (OSHA), the construction industry is responsible for more than 20% of all worker fatalities, fall from elevation, struck-by objects, electrocutions, and caught in/between are among leading causes. Also, accidents related to scaffolding account for a large proportion of the causes of the safety hazards. It is desirable that all potential safety hazards are identified in the early and planning stages and preventive actions are taken. Planning for safety typically consists of the



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

identification of all potential hazards, as well as the decision on choosing corresponding safety measures. A job site safety analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, and the working environment. The basic procedure for conducting job site safety assessment includes.

- (1) Identifying all job steps of a given activity.
- (2) Identifying potential hazards related to these different job steps.
- (3) Proposing action procedures to eliminate, reduce, or control each hazards.

The complexity and uncertainty inherent in the nature of the construction industry requires safety planners to adopt technologies as recent and innovative as available to make sure they are covering predictable surprises as much as possible.

The aim of the project is to present a decision making model for implementing safety by finding out the factors and comparing them by implementing those factors in the software. This was used to avoid or minimize the adverse impacts on public health and safety of employees during the project life cycle from both routine and non-routine circumstances during the design construction and design phase.

1.2 Objectives

- To find out the risks and accidents in the construction projects.
- To develop solution for eliminating accidents.
- To find the important factors affect safety in the site.

1.3 Environment safety and Health management

- Companies that likely to be eco-friendly agents invest in strong environmental, health and safety management, otherwise known as EHS.
- From an environmental standpoint, it involves creating a efficient approach to managing waste, complying with environmental regulations, or reducing the effect of pollutions and also manage to safeguard labours from major and minor accident.
- EHS is nothing but a well-planned management system which is used to make the construction safely and eco-friendly.

1.4 Basic hse rules and Requirements

- Report all injuries to you site in charge immediately, no matter how slight they may be.
- If in doubt the safe or proper way to do a job, talk to your site engineer/supervisor before starting.
- Be on the alert for unsafe conditions or acts. Correct hose, which you can and report the rest to your site in charge immediately.



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

- Be familiar with your surroundings, the operations and the locations of other personnel. Know the emergency phone number and the locations of other personnel. Know the emergency phone number and the location of first aid kits, fire extinguishers and other emergency equipment.
- Do not leave your work area unless your work personal needs require it.
- When you are relieved from your job that has unusual, partially, or fully concealed hazards, inform your replacement. Be specific and make sure they understand the location and nature of the hazards they face.
- Horseplay on the job is prohibited. Do not distract or interfere with another person who is performing his/her job. This is when injuries occur.
- Do not report for work under the influence of intoxicants, alcohol, illegal drugs, or any substance that can affect your capability to work.
- Do not enter or allow others to enter areas, which have been barricaded.
- Wear safety harness in all elevated areas (above 2m) that require fall protection.
- Hardhat and Safety shoes are a must however; labour working with slush and cement will be permitted to use waterproof (ankle) shoes.
- Child labour will not be entertained.
- Electrical connection to be made only by an authorized electrician.

1.5 General hse Requirements

- Where work activities may conflict with or impacts upon other work activities take steps to discuss the matter with relevant parties and establish a consensus. Ensure that both parties and their teams are fully aware of potential hazards together with appropriate precautions.
- All plant and equipment's shall be inspected before work commences and at periodic intervals thereafter. All plant and equipment shall be safe before and during use.
- Only competent personnel are permitted to operate plant and equipment and such persons shall be tested by a competent person and issued with an Appointment Certificate authorizing them to operate specified plant and equipment.
- Method statements/risk assessments shall always examine the people, equipment, materials and the environmental aspects of the proposed work.
- Such method statements/risk assessment shall always be referred to subcontractor/contractor safety departments for review and comment.
- Ensure that an emergency/rescue plan to cater for any mishap is available, known to all people and capable of immediate activation.
- Maintain good housekeeping at all times. Provide and maintain adequate hygiene and welfare facilities such as toilets, hand washing measures, drinking water, and canteen shelter, food waste bins and defined smoking areas.



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

- Hazardous area should be barricaded with the attachment of appropriate warning symbols.
- Work area should be always kept clean. Unwanted scrap or tools should not be left unattended that may be hazardous to others.

1.6 Introduction to software

SPSS (Statistical Package for Social Science) software is using in this study for analysing the data from the field survey. The SPSS Statistics Base program covers all basic statistical needs. It includes crosstabs, frequencies, descriptive statistics, correlations, and all comparisons of mean scores (e.g., t---tests, ANOVAs). It also includes the ranking methods of factors and cluster analysis, linear and ordinal regression analysis, etc.

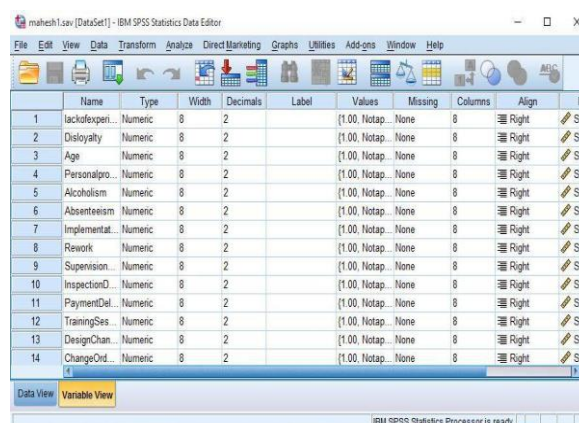


Figure 1: Interface of the SPSS opening window in variable view

2 Literature Review

2.1 General

A review of the literature is an essential part of your academic research project. The review is a careful examination of a body of literature pointing toward the answer to your research question. Literature reviewed typically includes scholarly journals, scholarly books, authoritative databases and primary sources. Sometimes it includes newspapers, magazines, other books, films, and audio and video tapes, and other secondary sources. Primary sources are the origin of information under study, fundamental documents relating to a particular subject or idea. Often they are first-hand accounts written by a witness or researcher at the time of an event or discovery. These may be accessible as physical publications, as publications in electronic databases, or on the Internet. Secondary sources are documents or recordings that relate to or discuss information originally presented elsewhere. These, too, may be accessible as physical objects or electronically in databases or on the Internet.



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

The main purpose of literature survey is to give an idea about the work conducted world over in the field of the project work. Several studies have been conducted in the areas of safety management in construction industry. The following are some of the studies which describe the proper safety planning before the execution of the project, and proper safety requirements will be fulfilled in the projects. Literature pertaining to occupational diseases and their prevailing conditions has been presented here.

2.2 Literature Review

Jain, Dr. S. K et al. (2007): demonstrated that in India the construction industry is the second biggest boss alongside farming though it is beside the street mischances in our country. Each site represents its own extraordinary difficulties regarding mechanical wellbeing prerequisites which must be handled by earnestness and polished methodology. Present day Modern management are useful in accomplishing these targets when utilized as a part of a taught way.

Abdul, Bassioni, Bawazeer et al. (2007): took enthusiasm for wellbeing mindfulness among development companies. Safety management must build up and implement security polices security frameworks. They ought to regress their exercises by including all the more checking of security execution at the site and administer intermittent and irregular wellbeing examinations to guarantee the usage of wellbeing guidelines. Besides, the productivity of site security reviews by utilizing more qualified wellbeing directors with full specialist ought to be expanded. In-house normal reviews ought to be completed by skilled supervisors.

Mohamed (1999): conducted an empirical investigation of construction safety management activities and performance in Australia. He investigated the effectiveness of safety management activities currently adopted by Australian contracting organizations. A safety management survey has been conducted in the contracting organizations operating in the State of Queensland, Australia. Based on a research model depicting statistical analysis techniques, a safety management index reflecting the intensity of level of safety management activities has been developed to provide a means whereby individual organizations can be assessed and graded on their safety management commitment and attitudes. The author reported a detailed empirical analysis carried out to examine the relationship between the intensity of safety management commitment and the overall safety performance, pro-activeness and record.

Hassanein and Hanna (2008): studied Safety Performance in the Egyptian Construction Industry. This study presents the results of a questionnaire survey that was conducted among a selected sample of large-size contractors operating in Egypt, as well as a comparison of the safety approaches in both the United States and Egypt. The results revealed that safety programs applied by large-size contractors in Egypt were less formal than those applied by their American counterparts. Only a few companies out of the surveyed sample had accident records broken down by projects and provided workers with formal safety orientation. The



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

author recommended that reforms in the way of the employer's contribution to social insurance were necessary; thereby linking accident insurance costs to the contractor's safety performance. This is meant to serve as a strong incentive for safety management.

Liang Wang et al. (2010): recognized that the viability of safety management in construction and establishment engineering venture decides the future and fortune of included enterprises. By fortifying the construction management office's safety management work, characterizing obligation of each gathering engaged with construction task, and reinforcing the supervision of government departments, safety management can be done and safety mishances in construction undertaking can be prevented. As an outcome, the generation safety in construction and establishment activities can be ensured.

Kumar, Vishnu et al. (2014): discovered that Jobsite safety management alludes to the cyclic procedure of planning, executing and looking into, control of work and manpower to decrease the accidents. The accidents happening in India is high compared to the remote nations with strong planning, successful implementation and continual training with centred safety management a decent safety record could be achieved comparable to international level. Therefore all the necessary factors which affect the jobsite safety management in constructional projects and factors affecting safety conditions of labours are formulated.

Mohammed, Shamsul, Bakri et al. (2017): identified that safety management is related with the arrangements, targets, techniques, strategies, parts and capacities that go for controlling peril and hazard in socio-specialized systems. The mindfulness and impression of workers toward safety, wellbeing and their workplace are essential perspective to upgrade the building construction to the better condition to the workers. Knowledge or attention to safety management framework is an imperative thought to viable safety management framework on location as high safety and wellbeing execution could enhance the association picture through less mishap, less truants of workers from work, less doctors visit expenses, etc.

Nielsen Kent et al. (2014): in his International research demonstrates that internal health and safety associations (HSO) and health and safety boards (HSC) don't have the expected effect on organizations' safety performance. The investigation gives confirm that the HSO can enhance organization safety culture by concentrating on safety-related interactions.

Choudhry and Fang (2008): carried out a research on the behaviour focus and found that workers are involved in unsafe behaviour because of lack of safety awareness, putting on a tough image, work pressure, co-workers' attitudes, organizational, economic and psychological factors. The author suggested recommendations for improving site safety by listening to the viewpoints of the subcontractor's workers. The reason behind this was that the subcontractors deal with different situations that judge their action on how best to work safely on a construction project. The objective was broken down into three parts: workers viewpoint, unsafe behaviours and safety behaviour. The author's goal was to understand the workers viewpoint as to why accidents happen and this was accomplished by performing in-depth interviews with workers. Gaining understanding of why construction workers engage in



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

unsafe work behaviour and identifying factors that influence their safety behaviour was part of their study.

Zubair, Kanya Lal and Allah Bux (2013): carried out a study to identify the critical factors affecting the safety program performance in Pakistan construction industry. A questionnaire survey was conducted to highlight the influence of the Construction Safety Factors. The questionnaire survey was analyzed using AIM (Average Index Method) and rank correlation test was conducted between different groups of respondents to measure the association between different groups of respondent. The author finding that management support is the critical factor for implementing the safety program on projects. From statistical test, the author further concluded that all respondent groups were strongly in favour of management support factor as CSF (Critical Success Factor).

Demirkesen and Arditi (2015): proposed the effectiveness of safety training practices is an important part of safety management on a construction site. Safety professional's perceptions of the effectiveness of training practices in safety training sessions were sought in a survey administered to the top 400 contractors in the U.S. The study shows that contractors are sensitive to organizational, feedback, content, process, and worker issues. Whenever they encounter language problems, they use visual aids, and provide translators and safety guidelines written in workers own language. Very few statistically significant differences are observed when the findings are analyzed from the point of view of the demographic characteristics of the respondents.

Anbari et al (2015): identified the factors affecting safety in construction. Risk Assessment of Safety and Health RASH method for building construction has been developed with risks classified into Safety Risk and Health Risks. Safety and Health specialists were involved in carrying out risk assessment using the existing method of 7 risk analysis RA and the proposed RASH method. It was found that RASH method resulted in superior accuracy for assessment of risk zones than the existing RA method. The accuracy by RASH was almost twice the accuracy by RA. The overall percentages of the correct answers for the four scenarios funded by using the RASH method and the RA method. Wilcoxon Ranked test showed that the two methods are significantly different. The RASH is statistically acceptable and it resulted in better response in terms of estimating the risk than the RA method.

2.3 Summary of Literature review

1. Questionnaire survey method is adopted for jobsite safety assessments.
2. Factors affecting jobsite safety in construction is identified from the journals.
3. Warning signs, guides or reflector should be displaced where necessary on site.
4. Personal protective equipment, falling objects, fire and explosion, heavy equipment's and electrical accidents are the most affecting jobsite safety.
5. Likert scale is adopted for the ranking of questionnaire.
6. Relative importance index is adopted for ranking of primary data.



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

7. Garrett's ranking technique is adopted for ranking of secondary data.
8. For data analysing SPSS software is generally preferred in most of the journals.
9. Continuous safety development should include 6 steps. These steps involve creating safety regulation, identify hazard, assess and evaluate risk, decide precaution, record findings, and updating finding in relation to the work condition
10. Paired sample t-test is adopted for comparison of primary and secondary data.

3 Methodology

5 Key Elements of Methodology Section of a Research Paper

- Logic of Inquiry (Qualitative or Quantitative).
- Research Setting and participants.
- Methods and Procedure of Data Collection.
- Methods and Procedure of Data Analysis.
- Ethical Issues

3.1 Questionnaire

A questionnaire is an exploration instrument consisting of a progression of inquiries to accumulate data from respondents. They can be considered as a sort of composing a written interview or meeting. They can be completed up close and personal, by phone, post, or computer. From the literature survey important factors that affecting the construction jobsite safety is identified and questionnaire is also prepared based on the factors affecting the jobsite safety in construction that's are Jobsite, Construction area secured access, site keeping and sanitation, personal protective equipment's, falling objects, falls, fire or explosion, heavy equipment, masonry and electrical.

3.2 Questionnaire model

Background and General Information

Please fill in the blanks and tick options are provided

1. Name of the company :
2. Position in company :
3. Respondent's experience in construction projects:
4. Which is the age of organization?
☐ < 5 years ☐ 6-10 years ☐ 11-20 years ☐ >20 years
5. What is the size of your organization you work in?
☐ < 100 staffs ☐ 101-250 staffs ☐ 251-500 staffs ☐ >500 staffs

The questionnaires are based on the jobsite, construction areas secured access, site keeping and sanitation, personal protective equipment's, falling objects, cave-ins, falls, fire and explosion, heavy equipment, masonry, concrete construction and electrical works.



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

3.3 Formation of Questionnaire

A questionnaire is an exploration instrument consisting of a progression of inquiries to accumulate data from respondents. They can be considered as a sort of composing a written interview or meeting. They can be completed up close and personal, by phone, post, or computer. Questionnaire surveys are a technique for gathering statistical information about the attributes, attitudes, or actions of a population by a structured set of questions.

The general instructions need to include the following:

- Introduction of researcher.
- Purpose of the questionnaire.
- Confidentiality Statement.
- Voluntary participation.

7 steps of questionnaire design

- Step 1: Decide what information is required.
- Step 2: Make a rough listing of the questions.
- Step 3: Refine the question phrasing.
- Step 4: Develop the response format.
- Step 5: Put the questionnaires into an appropriate sequence.
- Step 6: Finalise the layout of the questionnaire.
- Step 7: Pertest and revise

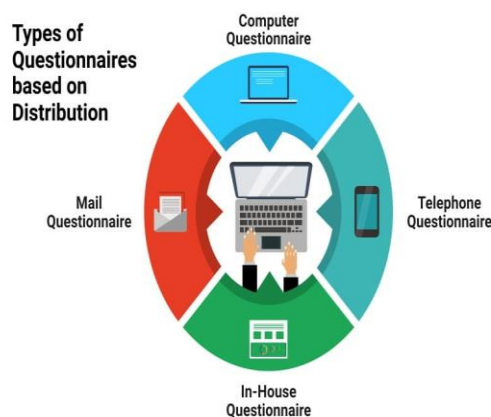


Figure 2: Types of Questionnaires

3.4 Likert Scale

A Likert scale is a type of rating scale, often found on survey forms or questionnaires that measures how people feel about something which can be useful in many different situations. Developed in 1932 by Rensis Likert to measure attitudes, the typical Likert scale is a 5- or 7-point ordinal scale used by respondents to rate the degree to which they agree or disagree with a statement (table).



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

5-Point Likert scale: - A type of psychometric response scale in which responders specify their level of agreement to a statement typically in five points: (1) Strongly disagree; (2) Disagree; (3) neither agree nor disagree; (4) Agree; (5) Strongly agree.

Strong positive	Positive	Neutral	Negative	Strong negative
(1)	(2)	(3)	(4)	(5)

Strongly agree	Agree	More or less agree	Undecided	More or less disagree	Disagree	Strongly disagree
(1)	(2)	(3)	(4)	(5)	(6)	(7)

Figure 3: 5-Point Likert scale and 7-Point Likert scale

3.5 Data collection

Data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. Data may be grouped into four main types based on methods for collection: observational, experimental, simulation, and derived. The type of research data you collect may affect the way you manage that data.

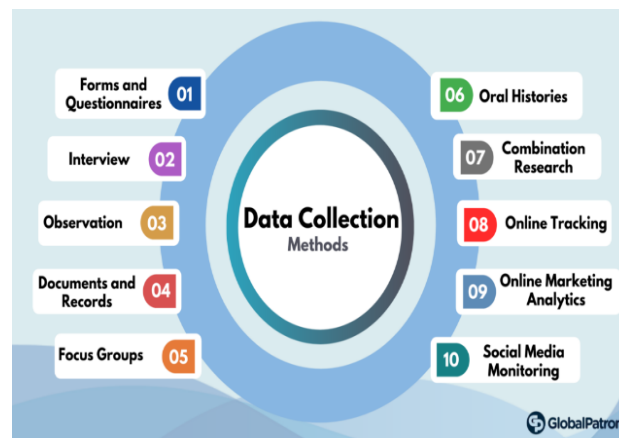


Figure 4: Data collection

3.6 Ranking of Questionnaire

A ranking question is a type of survey question that asks respondents to compare and arrange multiple options based on their preferences. The arrangements are most to least preferred, or vice versa. Usually used to analyze ranking questions, it involves determining which answer choice is most preferred overall by finding the average of all the responses with respect to the values assigned to each rank. The answer choice with the largest average ranking is the most preferred.



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

Rankings provide an incentive for better data collection within institutions, they can expose pockets of institutional weakness and confirm areas of strength, and they are useful for benchmarking against like institutions. Rankings encourage institutions to re-examine mission statements

3.6.1 Relative important index

Relative Important Index (RII) is a non-parametric technique widely used by construction and facilities management researchers for analysing structured questionnaire responses for data involving ordinal measurement of attitudes. The RII value ranges from 0 to 1 not inclusive. It shows that higher the value of RII, more important was the sustainable criteria and vice versa. The comparison of RII with the corresponding importance level is measured from the transformation matrix.

$$RII = \frac{\sum W}{AN} = \frac{\frac{100 (R_{ij} - 0.5)}{N_j} (5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1)}{5N}$$

Where,

W = Weightage given to each factor by respondent

A = Highest weightage

N = Number of respondents

3.6.2 Garrett's ranking

Garrett's ranking technique was applied to study the preference, change of orders of constraints and advantages into numerical scores. The prime advantage of this technique over simple frequency distribution is that the constraints are arranged based on their severity from the point of view of respondents. The technique was used to rank the preference mentioned by the respondents on different factors and aspects of the construction safety. It is used to find the most significant factor which had influenced the respondent in their practices. Founded on the Garrett's ranking technique, the study had the respondents rank different problems and outcome based on their impact thereby converting into score value and rank with the help of the following formula.

Percent position =

Where, R_{ij} = Rank given for the i^{th} variable by j^{th} respondents

N_j = Number of variable ranked by j^{th} respondents



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

3.6.3 Garrett's rank calculation

Garrett's method is often used to complete the ranking of an alternative based on the ratings of respondents that are converted into certain ranks. This ranking is done by determining the most significant factor from the respondent's answer. The ranking of alternative using Garrett's method is done by calculating the respondent's data as a factor of the percentage position value using the percentage position formula.

3.7 Analysis

3.7.1 Reliability test

The Cronbach's Alpha coefficient of reliability was computed to determine the internal consistency of the survey. This type of psychometric test is recommended by various researchers when a Likert scale of survey is adopted.

The purpose of computing the Cronbach's Alpha coefficient is to confirm that the criteria associated with Likert scale actually measures the construct that were aimed to measure, which is importance and frequency of safety attributes in the construction industry. Cronbach's Alpha values are between 0 and 1. A value of 0.7 is considered to be acceptable and 0.8 or higher indicates good internal consistency. Cronbach's Alpha value ranges are shown in table.

Table 1: *Cronbach's Alpha values*

Cronbach's value	Internal consistency
0.91 – 1.00	Excellent
0.81 – 0.90	Good
0.71 – 0.80	Acceptable
0.61 – 0.70	Moderate
0.01 – 0.60	Non acceptable

3.7.3 Analysis by SPSS

SPSS provides data analysis for descriptive and bivariate statistics, numeral outcome predictions and predictions for identifying groups. The software also provides data transformation, graphing and direct marketing features. The software interface displays open data similarly to a spreadsheet in its main view.

3.8 Comparison

The T-test is a common method for comparing the mean of one group to a value or the mean of one group to another. T-tests are very useful because they usually perform well in the face of minor to moderate departures from normality of the underlying group distributions. The



Article Title: Statistical Analysis of Jobsite Safety Assessment in Construction

five basic methods are mean, standard deviation, regression, hypothesis testing, and sample size determination.

4 Conclusion

Construction industry is considered as the back bone of the country. Its contribution in the development of the country is very crucial. The main motive of the study is focused on identifying the influential safety attributes affecting the construction industry. There is lack of knowledge about how to use equipment's on site and also lack of management. Construction Company should look to improve their policy or the construction design so as to cope with the environmental factors. Construction industries are faced with the challenge of having close monitor of their labour safety management systems to minimize occupational .For the data analysis, I was prepared questionnaire that attributes, namely use of personal protective equipment and following of safety rules and procedures, providing safety trainings, campaign and awareness to employees by contractor, conducting safety meetings, encouraging contractors to set and achieve safety.

Safety is everyone's responsibility it is a "way of life" for 24 hours/day. Individual will be skilled and equipped to have the skills and facilities to make sure an accident free workplace. Managers should frame the safety policies for their enterprise and train the employees to achieve the goal of zero accidents. Finally all parties in construction project must contribute their rightful parts towards making construction sites healthy and safe.

4.1 Future study

The distribution of the questionnaire and its study are limited within Kerala and the data used in this study is from small companies executing small building projects. Future study could be done in other parts of the Country and could emphasize specific types of building construction, including commercial, education, government buildings, skyscrapers, etc. There is a need to study the safety in other types of projects.

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