Cost-Benefit Analysis of Safety Policies on Construction Sites in India

Thesis Report by Anurag Sarda (4914287)

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Executive Summary

This thesis explores Indian construction industry safety measures and their benefit to cost ratios. In India, the construction sector is the second largest employer after agriculture. Around 50 million workers work in the construction sector to earn easy money at the end of the day. About 48,000 workers die in India due to occupational accidents every year, and around 38 construction accidents occur every day in India. This thesis analyses the social impacts of safety policies and their employers' financial implications. No such studies have been done previously for the Indian construction market. There have been studies regarding estimating the number of accidents in India, respective safety measures, etc. Implementation of safety policies can reduce the number of casualties up to 20%-30%. The performance of safety policies will benefit the workers, their families, friends, relatives, and society. It is common for Indian construction companies not to invest in construction health & safety measures because it is cheaper for them to pay the costs of compensation for accidents than modernizing their facilities to make them safer. It seems essential to understand the need to invest in safety measures from a societal perspective. Thus, this research is a study about the impacts of safety policies with cost-benefit analysis (CBA) and how the CBA results can be utilized in the decision making for the policymakers, employers, and other stakeholders in the industry.

First, a literature review was conducted to better understand the Indian construction industry's problems and probable solutions. Literature was also undertaken to understand the concepts regarding the cost-benefit analysis. Additionally, interviews were conducted to get the required data to perform the cost-benefit analysis and partly answer the research questions. For the research, eight interviews were conducted with people who closely work in the Indian construction industry. Based on the interviews, five significant safety policies were identified to be implemented at the construction sites in India to reduce accidents. These five safety policies were considered as a package to perform a societal cost-benefit analysis. The societal cost-benefit analysis was performed to find the impacts of safety measures only from the societal perspective. Next to this, a business financial impact analysis for the safety measures was conducted to see their effects only from the employer's perspective. In general, the interviewees believed that the number of accidents occurs in Indian construction sites due to the lack of safety measures provided by the companies and the illiteracy of most workers and their unorganized way of working. They also suggested that these accidents can be reduced by implementing safety policies, as shown in the table below. Most of them estimated that taking these safety measures could reduce the number of accidents by almost one-fourth.

Safety Policies
Safety Training and Education
Safety Supervision
Provision of Personal Protective Equipment
Clean Site Conditions
First Aid Training

The societal cost-benefit analysis (SCBA) and financial analysis gave the following results, as shown in the table. In both the analysis, the results found were extreme to each other. The SCBA gave positive results, and the financial analysis delivered negative results. The results differ from each other because of the benefits included in both the analysis differ from each other. The SCBA consisted of benefits such as the value of statistical life, statistical injuries, etc. In comparison, the financial analysis included benefits that an employer would save on compensation on injuries and deaths. When these factors are compared, the benefits when a worker's life is saved are huge to society compared to the benefits to the employer. In terms of numbers, the benefit over the value of statistical life is INR 14 million. The benefit over compensation for the employer is INR 0.18 million, and that is why the results were positive in SCBA and negative in the case of financial analysis. From the following tables, it can also be seen there is a massive difference between net present value (NPV) in SCBA and financial analysis. The results also show that there is no economic reason to invest in safety policies from employers. According to the interviewees, this is one of the significant reasons the construction companies in India don't invest in safety policies. However, societally there a reason that safety policies should be implemented. In such scenarios, the government (politicians and government officials) must intervene as safety policies could be very useful. Still, the employers who are supposed to invest would not be ready to invest. The interviewees also suggest that government officials and politicians could play a significant role in taking strict standards to make employers invest in health & safety on construction sites and reduce accidents. According to the interviewees, the involvement and collaboration between different stakeholders like government, construction companies, contractors, workers, and labor union organizations can minimize the Indian construction industry's problem.

From Societal Perspective

Net Benefit	INR 83 million
Net Cost	INR 32 million
Net Present Value	INR 51 million
Benefit/Cost Ratio	2.6

From Employers Perspective

Net Benefit	INR 8 million
Net Cost	INR 32 million
Net Present Value	INR -24 million
Benefit/Cost Ratio	0.25

From the research, it is recommended that investing in safety policies could be very beneficial for society. The study is helpful for India's politicians and government officials, who are the leading policymakers. The research could help them understand how important it is to take proper safety measures on construction sites. In the study, it was found that for a particular real-life construction project, the lives of four workers could be saved, and some workers could be saved from getting injured. Suppose that is the case for a single project. In that case, the policymakers can eventually understand how beneficial it would be to take proper safety measures on all India's construction sites. With the number of workers who die on construction sites in India, it is advisable that taking appropriate measures can reduce those numbers. Policymakers can make strict laws regarding investing in safety measures. They have regulations regarding other things such as land clearance permission, land taxes, and some other taxes that the construction companies mandatorily have to pay. For all these taxes, the amount is fixed, say 5% or 2%. Similarly, policymakers should enforce a mandatory safety investment, around 0.5% of the total project cost. Once it is made compulsory, employers will have no choice and will have to invest in safety measures. Unless the employer shows that the firm has already allotted some percentage for workers' health & safety, the project will not be sanctioned. Policymakers can also argue for their decision regarding mandatory safety investment that safety measures bring enormous benefits to society, which is a prime factor of importance.

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Firstly, I would like to extend my heartfelt gratitude to my first supervisor Dr. JA (Jan Anne) Annema, for being a constant stream of support and guidance for the past seven months. His advice, feedback & thoughtful discussions helped me stay motivated throughout the thesis timeline. He was actively responsive to my emails and would always immediately agree to meet to discuss the thesis. Secondly, I would like to thank my second supervisor K.L.L (Karolien) van Nunen for her valuable suggestions regarding my thesis's safety part. The feedback by her was constructive for the thesis. She was also very active whenever I wanted to meet with her and discuss the difficulties I was facing with my thesis. Next, I would like to thank the chair of my thesis committee, Prof. dr. GP (Bert) van Wee for his guidance in the very beginning phase of the thesis. I remember he immediately liked my thesis idea in the first meeting and agreed to chair my thesis committee. I am thankful to him for his support and guidance.

"Family is everything," they say. In my case, my uncle & aunt are the most important people in my life. Just because of them, I could come here to pursue a master's in one of the top universities in the world and the best in the Netherlands. I have been blessed to have got parents in my uncle and aunt, who have supported me throughout my life no matter the situation; they always stood by every decision of mine despite my failures. I want to dedicate my thesis and my master's degree to them, for always believing in me, supporting me, loving me & standing by me.

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Anurag Sanjay Sarda
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List of acronyms

CBA - Cost-Benefit Analysis
SCBA - Societal Cost-Benefit Analysis
NPV - Net Present Value
VSL - Value of Statistical Life
VSI – Value of Statistical Injury
ILO – International Labor Organization
OSHA – Occupational Safety and Health Administration
HSE – Health and Safety Executive
NGO – Non-Governmental Organization
UK – United Kingdom
PPE – Personal Protective Equipment
INR – Indian Rupee
USA – United States of America
EHS – Environmental, Health, and Safety
NCC-CL – National Campaign Committee for Central Legislation on Construction Labor
RTI – Right to Information
DSP – Deputy Commissioner of Police
FIR – First Information Report
DISH – Director Industrial Safety and Health
IIT – Indian Institute of India

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1 Introduction

This thesis explores safety measures and their benefit to cost ratio to make the Indian construction & development industry safer. Occupational accidents cause significant social and financial issues with deaths of workers & physical injuries. The construction & development industry includes high hazards because of the processes involved & workers concentrated characteristics. Because of these accidents, the initiative raises substantial economic and social losses. In developing countries, construction & development is one of the most significant segments with an incredible commitment to financial advancement with its business limit and enhanced economy (Yilmaz & Celibi, 2015). The International Labour Organization (ILO) found that around 337 million work-related accidents occur worldwide each year, which eventually causes the death of 2.3 million workers & 160 million individuals get harmed (ILO, 2014). The money related misfortune brought about by these accidents is assessed at 1.2 trillion $. There is a monetary weight; for example, the government managed savings framework and treatment costs on the rear of society because of work-related mishaps and sicknesses (Yilmaz et al., 2015). The probability of industrial accidents exists in all different industries, in any case, in the construction & development segment, which is, for the most part, relied upon for strenuous physical exercises of specialty laborers accidents that happen more frequently (Kazaz, Acikara, & Ulubeyli, 2017).

Construction in developing countries such as India is more labor-intensive than that in the globe's developed regions. In India, there is a massive contrast between huge and little temporary workers and construction companies. Most enormous firms do have a health & safety strategy on paper; in any case, laborers don't know about their existence (Mehra, Hussain, & Fatima, 2016). Nevertheless, different huge constructors show concern for health & safety and have set up various safety strategies. They also offer training to laborers and keep up security at the building site. The Construction Industry in India is significantly disposed of with the dangers identified with the site exercises, and development ventures include an enormous number of contractual construction workers. These laborers mainly originate from provincial territories and farming foundations who don't have legitimate preparation in construction & development health & safety and are not instructed enough to calculate the dark dangers of working on a construction site (Mehra et al., 2016). While working at the site, these laborers are presented to various hazards connected with construction works and other business-related illnesses and safety dangers, which cause injuries and, some of the time, deaths. Therefore, construction projects get extended due to lost working hours and other legitimate issues. This, at last, increases the project valuation & project duration. Hence, it is fundamental for any construction & development venture to have explicit health & safety rules and techniques to be followed for site exercises and make workers, site engineers, site supervisors, safety engineers, safety supervisors, and architects aware of safe working.

Construction & development is one of the significant monetary exercises in India. It offers business possibilities to all classes of people directly from significantly capable of totally bumbling

construction workers. In the urban division, expanding quantities of laborers have taken up construction & development work as a method for prompt business, which gives cash salary at the end of a working day (Hamid & Singh, 2014). The rural populace moves towards urban zones, searching for work, and being related to India's second most significant occupation. In metropolitan urban networks, construction & development work is predominantly a male-overwhelmed task because of the laborers' risky work idea. Construction health & safety in developing nations is lingering behind the developed nations because of countries' angles, such as unfit safety rule, the absence of safety training & education, and less priority given to health & safety. The higher need is given to finish off with the high reading of the safe & secure working conditions on construction location (Shah, Chedda, Mehta, & Hirani, 2017). Precise coordination between contractor Precisenstruction companies and the workforce is required for a healthy work environment, incredibly weak in Indian construction & development organizations. Even though work safety law mishaps happening at the building locations are continuing. The chiefs' duty towards the health & safety of the laborers is moreover slacking.

1.1 Research Problem

The primary societal problem is that many construction workers die every day because of India's lack of safety. There are no strict guidelines formed by the government to ensure safe & healthy working conditions for these workers. As far as I could find, no scientific research has been done to estimate the advantages & disadvantages of providing safety measures to reduce the number of accidents and reduce the death rate & injury rate. The knowledge gap is explained in detail in chapter 3 in the Indian construction scenario, where few additional research gaps have also been identified.

1.2 Research Objective

This research aims to find the societal & financial impacts of safety measures/policies in the Indian construction industry with Societal Cost-Benefit Analysis (from now on CBA). CBA is useful in decision making, but the tool is highly debated. This research will also contribute to the knowledge if CBA can help make safety-related decisions in the Indian construction & development sector. This research will also focus on how government officials, politicians & stakeholders in the construction & development sectors might use the CBA results.

1.3 Research Questions

Given the idea of the research problem & the research objective of the study, there are two main research questions as follows:

"What are the societal and financial impacts of adequate safety measures taken against unsafe safety practices on India's construction sites?"

"In which way could CBA results be useful in making decisions regarding reducing risks at the Indian construction sites?"

1.4 Thesis Outline

Following the introduction in this chapter, the thesis is structured along these lines: Chapter 2 will focus on the methodology used for this thesis. Chapter 3 focuses on the theoretical background needed to understand different aspects of the factors related to thesis research. Chapter 4 focuses on CBA for a purely societal benefit perspective and financial analysis from its perspective. Chapter 5 will focus on the sensitivity analysis performed for the same safety measures with different assumptions. Chapter 6 reflects on the thesis by discussing the various aspects of the research & use of India research. Finally, Chapter 7 focuses on the conclusion & recommendations.

2 Methodology

This chapter gives a detailed description of the approach that has been taken to assemble the required information for the thesis research. The research mainly consisted of a literature review, conducting interviews & performing SCBA & financial analysis based on the data collected from interviews. These three steps were primarily required to answer the research questions. This chapter will focus on how the literature review, interview & cost-benefit analysis were conducted. The first phase of the research was a literature review, and the approach for the same is explained in section 2.1. Further, section 2.2 gives an insight into how the interview procedure was carried out. Section 2.3 describes the cost-benefit analysis method, which was used in the research to calculate the results. Section 2.4 explains the reference case, which was used for the cost-benefit analysis.

2.1 Literature Review Approach

The literature review was mainly conducted to find the research problem factors such as significant causes of construction accidents, required safety measures to reduce the accidents, an overview of the Indian construction & development industry, and accidents in the Indian construction & development industry. The SCBA & financial analysis was performed for the safety policies, so a literature review was also done to understand the effectiveness of safety measures and reduce the number of accidents on construction sites. Before performing CBA, it was necessary to know how the selected safety policies package would reduce accidents. A literature review was also partially done to answer the second research question on how CBA results can be used for decision-making. So, literature, to an extent, gave an idea of how CBA could be used in the decision-making processes, how politicians make use of CBA was also referred from some research papers.

A literature review is "the choice of accessible records (both distributed and unpublished) on the theme, which contains data, thoughts, information, and proof composed from a specific point of view to satisfy certain points or, on the other hand, express certain perspectives on the idea of the point and how it is to be examined, and the powerful assessment of these archives comparable to the exploration being proposed" (Sekaran & Bougie, 2016). The primary motivation behind leading the literature survey is to make a logical exploration base dependent on the past examination's theoretical perspective. A literature review for research is directed to comprehend the central ideas of the theme dependent on the research goal and questions. Different results were acquired by leading the literature review. Some of them were characterizing the information gap and importance for the exploration. Three scientific databases such as Scopus, ScienceDirect & Elsevier & Google Scholar search engine were also used to find the literature. Some of the websites of organizations such as Occupational Safety & Health (OSHA), Health & Safety Executives (HSE), National Safety Council, India, etc. The very first step was to find information on the relationship between construction, accident & safety. The keywords such as "construction AND

accident," "safety, AND construction were used. This resulted in almost 6000+ articles. Titles of the articles were examined altogether dependent on the necessity required for the research, and this came about in around 74 pertinent articles. Later snowball technique was utilized to expand the literature review. The next step was to understand construction accidents' theoretical background, safety, and health factors on construction projects. First, "Construction health AND safety" was used to find how these factors affect the construction accident on the construction sites. This resulted in around 4200 articles. On screening through the titles of the articles, 38 articles were selected to be used. The second search string, "Cost-Benefit Analysis AND construction accidents AND safety," was used in Scopus, ScienceDirect & Google Scholar, which provided around 700 articles. After screening through articles' titles, approximately 32 articles were found to be used for the research.

2.2 Interview Approach

Similar to the literature review, interviews were also conducted to get the required information for this research. Some crucial factors necessary to perform SCBA & financial were explored through the interviews. To answer the first research question, it was needed to perform CBA for which assumption had to be made, and these assumptions were made based on the information collected through the interviews. Additionally, information on factors such as actual scenarios on construction projects in India, safety allocations on those projects, accidents taking place on those projects, safety measures are taken to reduce those accidents on the projects, etc. were collected through interviews. To answer the second research question, the interviewees were also asked how the results would be used in India. Their insights on how this thesis can be used further in India are given in the interview transcript, which can be seen in Appendix A. So, both the research questions were answered based on the data collected from the interview. In total, eight interviews were conducted to collect the required information.

The interview is the most widely recognized strategy utilized for information assortment in a research study (Alshenqeeti, 2014). There are right now three sorts of research interviews: structured interview, semi-structured interview & unstructured interview. Structured interviews are those conducted when it is known at the outset what information is needed. The content of a structured interview can be prepared in advance. As the respondents express their views, the researcher notes them down. The same questions will be asked to everybody in the same manner. The semi-structured interview comprises a couple of critical inquiries and is a more adaptable variant of a structured interview. This kind of meeting is utilized for covering numerous factors & detailed data from the interviewee (Gill, Stewart, Treasure, & Chadwick, 2008). Unstructured interviews are so labeled because the interviewer does not enter the interview setting with a planned sequence of questions to be asked of the respondent. A possible objective of an unstructured interview is to bring some preliminary issues to the surface so that the researcher can determine what factors need further in-depth investigation (Sekaran et al., 2016). The unstructured interview's primary purpose is to explore and probe into several factors in the situation that might

be central to the broad problem area. During this process, it might become evident that the problem, as identified by the client, is but a symptom of a more serious and deep-rooted problem. Conducting unstructured interviews with many people could result in the identification of several critical factors in the situation. These would then be pursued further during structured interviews for eliciting more in-depth information on them. This helps identify the fundamental problem as well as ways of solving it.

2.2.1 Interview Structure

The interview procedure's initial step was to gather the theoretical point of view and data from the literature and create an initial understanding of what is required. The subsequent action was planning interview questions; this was finished by utilizing the information developed based on the literature and what information was needed to form a reference case for cost-benefit analysis. The interview questions are likewise related to information found from the theoretical point of view. The third step was to locate the correct kind of people for the meeting. The candidates were mainly safety engineers, safety managers from some of the construction companies in India. Additionally, there were candidates from some of the NGOs in India who work for the welfare of the construction workers. The reason for selecting them as they have been working for so long for the welfare of the workers and I wanted such people with whom I can share my work with and then it can be utilized well in India to reduce the construction accidents and increase the social benefits for the workers. The reason for selecting safety engineers and safety managers for the interview was to know in detail how things work on actual construction projects to stop/reduce the accidents. They are the people who work on the existing site, so they know much better what is required in Indian construction conditions. They have a better knowledge of what needs to be done to prevent accidents from happening.

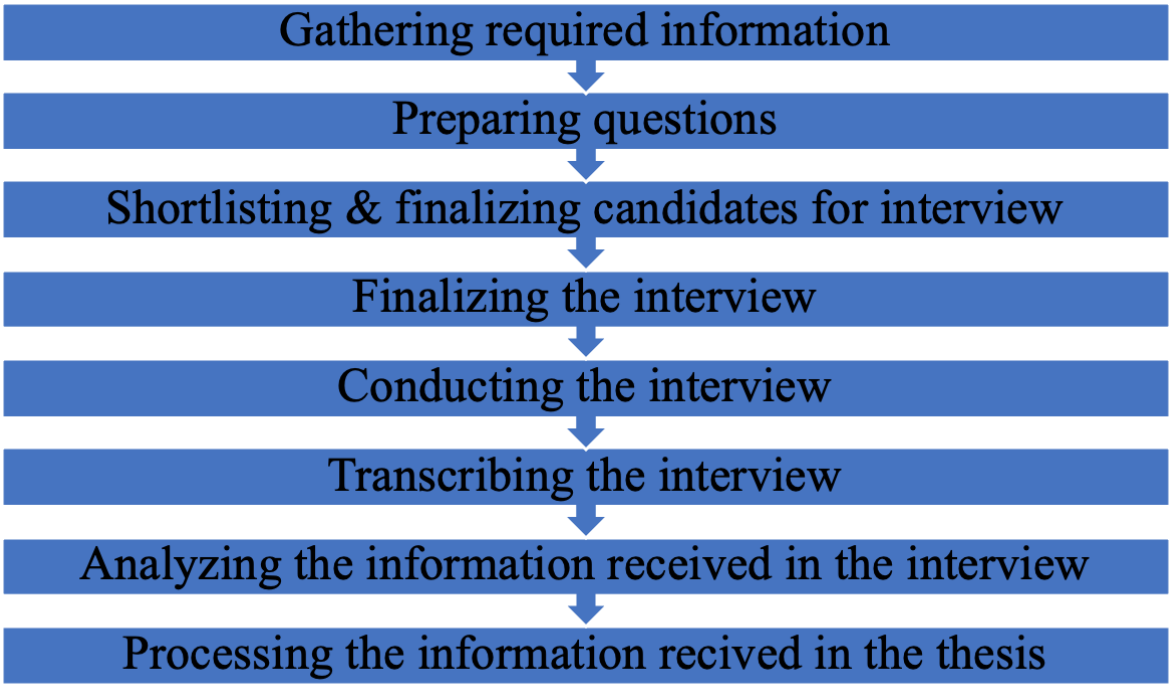
The next step was to send all the selected candidates a detailed email about the thesis topic and request them for the interview. Nine interviews were conducted; all of them were conducted online either on Zoom or Skype. It was a time-consuming process, first mail them, request them for the interview, wait for their reply, and then follow up with them, but eventually, the talks were completed. Some of the selected candidates did not respond to the mail, then I somehow managed to get their contact details and called them, messaged them, but even did not get any response over there. So eventually, 3-4 candidates from the list were left because they did not respond at all. The information collected from the other candidate during the interviews was helpful for the thesis's further work. All the interviews were recorded after taking permission from the candidates, and also, their consent was taken that the information gathered from the interview would be used in the thesis. The recorded interviews were transcribed later. No online software could be used to convert the recordings into transcripts. Almost all the interviews were conducted in Hindi (One of India's official languages) because the interviewees did not speak English. Again, that was a very lengthy process to convert Hindi's recordings to the transcript in English. The transcripts were also

sent back to the interviewees to confirm that what they told during the interview was correct, and the same was written in the transcript.

The following points were considered before doing the interview:

- Brief information regarding the research topic, research objectives were given to all the candidates/respondents before the interview so that they have some time before the interview to get familiarized with the research topic
- It was mentioned to the respondents that the information provided by them would be used in the thesis and the interview will be recorded and later converted into the transcript
- Each interview began with an introduction, research objectives & questions were disclosed to each respondent & inquired as to whether they had any doubts about being explained before starting with the questions.
- Toward the finish of the meeting, the respondents were asked as to whether they had any questions and their last decision on what they think about how the results will be used in India, will the results be helpful.

Figure 2.1: Sequence of Interview Approach



2.2.2 Sampling & Candidate Selection

"The way toward choosing the opportune people, articles, or events as delegates for the whole population is known as sampling" (Sekaran et al., 2016). It is essential to choose the correct kind

of components from the population for the information assortment. Else the gathered information will be one-sided if the respondents are not acquainted with the theme (Sekaran et al., 2016). The nonprobability sampling strategy was utilized in this exploration as the likelihood of picking from the population is obscure; this prompted discoveries found from the research that could be summed up to the whole community. Rather than choosing the readily accessible components for this research, it was essential to pick elements and get data from a specific objective target population (Sekaran et al., 2016). It was necessary to get information from people who are experts on the topic of the research. In the beginning, I contacted an NGO working for the welfare of construction workers. The NGO is based in Ahmedabad city in the Indian state of Gujarat. Once I got them, they connected me with NGOs from other Indian cities, working for the same cause. The reason I chose to communicate with NGOs was they are the only ones who want to reduce the pain the construction workers have to bear. It was also possible to get some data from them to understand how construction accidents occur in India. I also contacted some of the safety engineers, safety managers working on actual ongoing construction projects. Getting in touch with them was easy because of my civil engineering background. My work experience working in the construction field for ten months, plus my family is also into the construction business for the past 25 years, which was an advantage for me. Also, I know people who work in one of India's largest construction companies, so they connected me with some of the company's safety managers. The following table gives information regarding the respondents, but their identity & company & NGO profile has been kept anonymous as per their request.

***Table 2.1**: Details of Interviewees*

Code for the candidate	Role of the candidate
A	Director of Operations at an NGO A in India
B	General Secretary of an NGO B in India
C	Safety Engineer in a Construction Company X in India
D	Safety Manager in a Construction Company Y in India
E	Political Editor of a News Paper in India
F	Owner of a construction company in India
G	Member of an NGO C in India
H	Safety Manager in a Construction Company Z in India

2.3 Cost-Benefit Analysis Approach

The CBA was used to answer the first primary research question. The main idea of using CBA was to analyze the benefits & costs of safety policies to be implemented on construction sites. A reference case was prepared before performing the CBA, and then, based on the reference case, the CBA calculations were done. The reference case was made using the data collected from the interviews. Along with the CBA, a financial analysis was also performed from the company's perspective. CBA for societal interest consisted of essential factors from the social welfare point of view, and financial analysis consisted of elements that can save money for the employer. In the financial analysis, factors such as compensation benefits over death & injuries were considered. Factors like medical cost, which in India are paid by the employer & transactional costs, are the costs made by the employer to handle the accident and its consequences for them and to hire new people were used in both the analysis.

A sensitivity analysis was also performed along with CBA to make changes in some of the factors and check how sensitive the results were when assumptions have changed. The assumptions made for performing CBA are purely based on the information from the interviews. CBA was committed to the safety policies (In this research, safety policies are the safety measures to be taken on the construction sites). This reference case was made on a real-life construction project in India. The reason for selecting a real-life project was to get appropriate information regarding project cost, safety investment cost, safety policies & the total number of workers working on the project. The detailed calculation can be seen in Appendix B. CBA was carried out after the interviews were done. CBA was selected as, with CBA's help, it is possible to estimate the benefits against the desired policy's value. It can give an idea about if investing in any system is sound or not, and by how much its benefits outweigh its costs. In this research, the same logic was applied. The value of safety measures was calculated, and then its societal Cost-Benefit analysis was conducted, which eventually gave an idea of whether investing in safety measures is sound. The benefits and costs of safety measures, net benefits of the safety policies/safety measures, benefits cost ratio all these factors were calculated, which can be seen in Chapter 4. The theoretical background related to CBA is explained in detail in Chapter 3.

2.4 Reference Case Approach

A reference case was selected to get details of some factors on a real-life construction project. A real-life construction project was selected of a company owned by Mr. F, whom I interviewed. To calculate the cost-benefit analysis, it was necessary to make some assumptions. It is essential to know some factors like the number of workers working on a construction project, the construction project's duration, project cost, etc. Information for all these factors was collected from the reference case. Case studies aim to gather information about a specific object, event, or activity, like a particular business or organization (Sekaran et al., 2016). Case studies help obtain a clear picture of real-life situations from various angles and perspectives using multiple data collection

methods (Sekaran et al., 2016). Research reference case has been used to help analyze how the implementation of safety policies will reduce the number of accidents. The number of workers working on the project was known, so it was possible to calculate the number of lives saved and the number of injuries avoided. As it was possible to calculate it for a single real-life construction project similarly with the help results, it can be used in other projects. In the reference case, it was also assumed that some percentage of the total project cost would be spent on implementing the safety policies. It was found that even if the company spends around 0.5%-1% on the safety measures, that would be sufficient to save a few lives. Another application of performing CBA and financial analysis on a real-life construction project is that similar projects or other companies can get an idea if they invest in safety policies what could be the outcomes in real-time. It could also help the policymakers who can realize the benefits of applying safety policies on construction projects and then think of how it can be used for almost all the construction projects in India.

3 Research Problem & Theoretical Background

This chapter consists of four subchapters. 3.1 focuses on the scenario of the Indian construction & development industry, which is also the research problem for this thesis and eventually finds the research gaps. 3.2 focuses on the theory related to risks involved in the construction sector. And the relevant risk prevention factors. 3.3 explains the theory of accident risk prevention and its benefits. 3.5 illustrates the different theoretical aspects associated with CBA.

3.1 The Problem in the Indian Construction & Development Industry

The construction and development segment is the second biggest employer in India; it is evident that numerous accidents happen in the Indian construction & development industry because of the complex & less controlled working conditions (Patel & Jha, 2014). Approximately 53.45 million workers work in India's construction & development industry & there is an enormous lack of skilled workers (Indian Labor Statistics, 2012). Being one of the biggest businesses, a casualty in the construction & development industry is multiple times more than in the manufacturing business. The danger of severe injury is 2.5 times greater (Shah, 2019). A research study led by the British Safety Council uncovered that India's construction laborers have no lawful assurance. The death rate on construction sites is approximately 20% higher than those in the UK (Shah et al., 2017). Almost 80% of Indian construction & development laborers work in dangerous conditions. India has a population of approximately 1.38 billion individuals, out of which the steady workforce comprises 465 million. Unfortunately, just 20 percent of them are secured under the health and safety legitimate system (British Safety Council, 2017). Even though there are laws that address these health & safety concerns, their execution is a critical activity resulting from the absence of an adequate workforce.

The construction sector in India contains an enormous number of associations that fall into different segments of mastery. There are around 700000 development organizations in India, and it is seen that solitary top-level organizations follow health & safety rules. Its execution is scarcely found in low-level organizations (Shah et al., 2017). Health & safety is of less importance in the spending plan portion in large numbers of organizations in India and which prompts numerous mishaps/wounds on the site, in some cases bringing about the death of laborers (Shah et al., 2017). Around 48000 laborers are dead in India because of work environment mishaps, out of which 38 lethal accidents occur each day in the construction industry (Express News, 2017). The casualties can be diminished to an enormous degree. For that, the contractual workers and construction organizations need to contribute more to health & safety frameworks (Chheda et al., 2017). The value of life is also somewhat less in India than in other developed countries, which is also one reason workers' safety is neglected (Express News, 2017). The current situation of safety in the Indian Construction industry is in a very dire state (Hirani et al., 2017). That is why there is a lot of scope for improving health and safety across the Indian construction sector. As of now, nothing much has been done in the Indian construction sector regarding accident prevention measures, and

that is why this research work focuses on the Indian construction sector. So far, only Patel & Jha (2016) have tried to estimate the number of construction accidents in India but nothing that focused on the impacts of safety measures with CBA help. CBA might help make the decision making more effective regarding the safety measures. Still, nothing has been done in that field in India, and therefore, this research aims to perform the CBA of India's safety measures.

The construction and development industry is the second largest employer in India. Still, the accidents taking place in India on construction sites are not appropriately and regularly recorded and published, and that is why they are not readily available (Hamalainen, 2010). In any case, it is expected that numerous fatal & non-fatal mishaps would occur in Indian construction & development because of its attributes, for example, the dynamic nature and contribution of multiple migrated workers in a venture, and a less controlled condition (Patel & Jha, 2015). In general, the inclination of construction companies, developers & contractors in India is to avoid announcing mishaps to the relevant civic authorities. Thus, it gets hard to consider the pattern of casualties and study the health & safety performance of the industry state and public level (Patel et al., 2015). Therefore, it also gets hard to look at India's health & safety execution compared with different nations. In any case, Indian Labor Statistics (2012-2013) comprises the records of fatal & non-fatal mishaps of mines, production lines, railroads. Nonetheless, it does exclude the assessments of fatal & non-fatal construction & development mishaps. Very few researchers like Mehra et al. (2016), Shah et al. (2017), Hirani et al. (2017), have focused on the safety importance in the Indian construction & development sectors. No researcher has done a study on finding the impacts of safety measures. Even CBA has not been used to date to find the efficiency of the safety measures taken on the construction sites. This is the knowledge gap that, to date, no one has ever explored CBA's field in calculating safety measures' impacts. This research will focus on filling this knowledge gap by utilizing the CBA method to analyze safety measures' economic & social effects.

3.2 Construction Safety Risks

The construction and development business is viewed as high-hazard. It includes risky and challenging work, such as excavation at the foundation, erection of structural steel, and working at generous heights (Hwang et al., 2017). The high mishap and casualty rates in the construction & development industry can be credited to risky conditions and quickly changing practices (Fan et al., 2014). Gyi et al. (1996); Abdelhamid and Everrett (2000); HSE (2004); Ferret and Hughes, 2007) distinguish the reasons for mishap as the consequences of unsafe exercises and conditions. Abdelhamid and Everett (2000) credit the dangerous conditions to four fundamental causes; Administration/management's responsibility/irresponsibility, hazardous working habits of laborers/associates, occasions not legitimately human-related, and unsafe site conditions. Abdelhamid and Everret (2000) alluded these dangerous demonstrations of workers and hazardous conditions as prompt or essential drivers of a project's mishap. The unsafe rallies, hazardous situations, and the administration related elements have appeared in Table 3.1. These reasons for

an accident on building locales, as occurred in Table 3.1, may prompt loss of lives, severe injuries, and genuine expenses for the contractor & the companies (Lancaster et al. 2003). For example, HSE (2005) exhibited that mishap influences efficiency rates, increment medical costs, and may prompt lawful activity against the firm. Besides its effect on costs for a contractor, accidents may also lead to health implications for a worker such as musculoskeletal injury, vibration, dermatitis, radiation diseases, and skin borne infections, respiratory problems, asbestosis, eye problems, hearing damage, and psychological stress (Gyi *et al*. 1996). Kartam (1997) fortifies this argument that mishap also causes numerous human misfortunes, demotivates construction & development laborers, impacts various activities, defers the project's progress, and influences the notoriety of the company. Based on these contentions, it has accordingly been set up that the reasons for mishap may prompt cost that can affect the proficiency and viability of development activity.

***Table 3.1**: Causes of Accidents on Construction Sites*

Unsafe Acts	Dangerous Site Conditions	Administration Related Cause
Inability to utilize or wear PPE	Missing guardrails	Deficient planning & arrangement
Inability to caution others of risks/hazards	Defective tools & equipment	Deficient design plan
Leaving gear/equipment in a hazardous condition	Insufficient fire cautioning system	Absence of health & safety training & awareness
Utilizing unsuitable equipment/gear	Contact with power/electricity	Absence of effective communication
Utilizing gear/equipment in an incorrect manner	Risky environmental site conditions	Deficient safety supervision
Contact with moving equipment	Fire risks	Inadequate health & safety approach of the administration
Struck by moving vehicles	Dangerous air conditions	Inability to comply with the working guidelines
Struck by moving items	Insufficient light to see to accomplish tasks	
Struck against fixed objects	Exposure to blast	
Inability to lift stack/material accurately	Residual conditions	
Consuming liquor or drugs on building sites	Contact with destructive substances	

Due to lack of safety, many workers suffer, but along with the workers, other individuals also suffer from society. When an accident occurs on the construction site, the worker is the first to get

affected, but other parties also get involved along with the worker. The other people affected are family, friends, relatives of the worker, employer, construction company, contractor or sub-contractor, co-workers of the injured worker, and, finally, society. The following table 3.2 gives information about how these all stakeholders are affected by the cost of accidents on construction sites.

***Table 3.2**: Stakeholders Affected due to Lack of Safety*

Stakeholder	Intangible cost	Tangible cost
Workers	Pain and enduring, mental enduring (mainly on account of death and permanent disability)	Loss of pay, a decrease of expert limit, the misfortune of time (clinical treatment), site consistency of health & safety issues
Worker's Family	Moral & mental misery, clinical burden, family trouble	Money related misfortune, additional costs, loss of time to deal with the harmed laborer
Society	Decrease of the human work potential, and decrease of personal satisfaction, decrease in the quality of life	Reduced productivity, harms to the machinery, materials & equipment, quality misfortunes, hiring & preparing of new workers, increment in production cost, the increment of protection premium; managerial expenses; suit expenses, and absenteeism
Colleagues	Terrible inclination, stress, or frenzy (in the event of a genuine mishap)	Loss of working hours, the increment of the remaining task at hand, and preparing of temporary workers
Employer	Reputation damage, litigation expenses, protection/insurance cost, and remuneration cost	Reduction in productivity, hiring new workers, the cost for increasing productivity, absenteeism of workers

3.3 Construction Risk Prevention

Accident prevention begins with having a clear idea of those variables that may play critical roles in their causation (Hinze et al., 1997). As per Ferret and Hughes (2007), without the administration's responsibility, there won't be powerful usage of health & safety measures. The administration gives the inspiration and assets to manage work environment mishaps on the construction & development projects. Lancaster et al., (2003) contended that it could carry financial advantages to contractors & construction companies whenever required health & safety measures. This subsequently shows that the health & safety measures' social benefits can be brought to the politicians & government officials' consideration. It is advisable that if the financial

advantages of safety measures are presented to the administration, they will be more inspired to invest in health & safety measures, making mishap prevention more feasible. Some of the factors influencing the health & safety measures are listed in the table below, and their cost implications & impacts. Table 3.3 gives an idea of the factors that affect the implementation of safety measures for accident risk prevention.

***Table 3.3**: Factors Influencing Construction Health and Safety Measures*

Factors	Cost Implication or Impacts
Legal Commitments	Fear of persecution, the expense of compliance
Health and safety exposure	Reputation & credibility; criteria for prequalification
Connection to different frameworks	Quality, dependability, and intensity
Expected expenses	Direct & indirect expenses
Experience of mishaps & injuries	Increment mindfulness and appreciation about risks, safety training & education, safety motivation
Customer/client pressure	Potential for future construction projects
Size of the company	Safety workforce & management to oversee health & safety capital accessible to put resources into construction health & safety
Other factors (e.g., trade unions/association pressure)	Safety guideline, data provided by the design team, association of contractors during the design stage of the project

3.3.1 Benefits of Accident Prevention

The benefit is characterized as any gain to an individual (Brent, 2003). The primary benefit of accident prevention is that workers can be saved from getting injured and getting dead. When a worker's life is saved, it eventually avoids the suffering workers' family, friends, and relatives have to go through. In a way, it is a benefit for society. Contractors & construction companies can enjoy these benefits in reducing deaths, significant injuries & ill health of workers through safety measures taken to avoid/reduce the on-site construction accidents. When fewer workers are met with an accident, the productivity at the site will be less affected, and as a result, the projects will not be delayed. So, workers, employers, and society, in general, is benefitted from the accident

prevention on construction sites. These benefits are mainly of two types: direct benefits & indirect benefits of accident prevention.

❖ Direct Benefits

The direct benefits of health & safety measures on sites mainly focus on reducing accidents and cost savings (HSE, 2006). The most significant advantage of implementing safety measures is that workers' lives will be saved, and fewer workers will be injured. When workers are protected, eventually, their families, friends & relatives are also happy, which is social welfare for society (Ikpe et al., 2009). Extra saving funds past the expense of mishaps incorporate sparing time and sparing the use spent on harmed laborers' clinical consideration. The direct benefits include bringing down the death & injury rate, lessening premiums, diminishing prosecution costs, and hiring new workers. The most important benefit is that workers' lives would be saved, and eventually, their families won't have to suffer financially after workers' death. Table 3.3 below gives some of the direct benefits that accident prevention provides.

❖ Indirect Benefits

The indirect benefits of safety measures include diminishing workers' absenteeism, improving the company & contractor's corporate reputation, improving work fulfillment, decreasing sick payment, reducing the working hours lost on site, etc. (Mishan, 1982). The focal points originating from the improvement of health & safety measures in the construction & development sector are most likely to help the temporary workers, construction organizations & society. This could be viewed as the motivation behind why improving health & safety in the sector is worthwhile. A decrease in the expense produced because of mishaps can be legitimately transformed into an advantage for all the stakeholders involved in a development project (Ikpe, Potts, Proverbs, & Oloke, 2007). In the construction & development business, organizations need better incentives & a sensible amount of benefits to guarantee their future in the long run (Egan, 1998). Temporary workers and development organizations should be convinced of the business benefits for placing assets into health & safety measures confirmation that there is remuneration back in monetary terms and workers' satisfaction. Indirect benefits are not much of a use for the society but for the stakeholders in the construction & development sector from saving money. Some of the indirect benefits are mentioned below in table 3.4.

***Table 3.4**: Direct and Indirect Benefits of Accident Prevention*

Direct Benefits	Indirect Benefits
Less number of deaths & injuries	Efficiency improvement
Less suffering & sadness	Saving on reputation improvement
Savings in medical cost	Savings in sick payment
Saving money on prosecution	Saving money on lost working hours
Saving money on mishap investigation	Staff spirit/motivation to work
Saving money on compensation	
Saving money on material	

The most important benefit is that fewer workers will be injured and dead because of which there will be less suffering and sadness for their families and friends. These are the significant benefits from the worker's point of view and societal perspective. Medical cost-saving is the amount of money that the employer will save when any injured person is taken to the hospital. Saving on prosecution and mishap investigation is a transactional cost that the employer will save. When fewer accidents, fewer workers will have to be compensated; other legal formalities will be less, so the employee looking after such tasks will be reduced. Employers may hire fewer employees for such activities, so there will be savings in transactional cost. Indirect benefits mainly include better productivity & less damage to the image of the employer. When workers die, it affects productivity, and when the news comes out, it also damages the reputation of the company so that these things can be avoided. Fewer accidents will also result in less lost wok hours on sites, so employers don't have to pay workers for the extra working hours to get the construction activities in line.

3.4 Cost-Benefit Analysis

3.4.1 Introduction

Making policies consists of making choices. CBA is an essential tool for use in the assessment of policy choices. CBA is a generally utilized economic appraisal tool that aims to help lawmakers decide projects & policies (Boardman et al., 2013). It is a deliberate information tool for studying

and assessing the advantages & disadvantages of a policy measure for society in general. This backs decision-making on proposed policies so that decisions on policies can be as objective as possible. CBA can be applied to various measures in all fields (Romijn & Renes, 2013). In this research, the CBA is used in the construction sector to scrutinize safety policies. CBA reviews the impacts, dangers, and vulnerabilities of a measure/policy and the subsequent costs and benefits to society. By measuring these advantages & disadvantages as much as possible and assigning values to them (in INR for this research), CBA gives knowledge into social-welfare impacts of the policy/measure calculated as the balance in INR of net benefits minus the net costs (Romijn et al., 2013).

CBA isn't just valuable for judging whether a choice to continue or not with an approach measure can be supported based on the parity of advantages and expenses. Yet, it can likewise be utilized to structure the approach readiness itself. Questions, for example, 'What is the issue?', 'What will occur if no measures have been taken?' and 'What potential arrangements are there?' help make the conversation about the proposed measures as expected under the circumstances. This is valid for all arrangement fields and all approach measures. To make a decent CBA requires not just information on government assistance financial matters, yet also an intensive comprehension of the policy field under scrutiny (Romijn et al., 2013). On some occasions, there might be questions about whether it is alluring or even conceivable to do a CBA. Questions about the attractive quality of doing a CBA may emerge if financial proficiency is of little or no significance. The principle thought is about social poise or good values (for example, abortion, euthanasia, slavery).

3.4.2 Principles & Background

A CBA explores whether the benefits of a policy/measure exceeds its costs. It is a methodical technique for recognizing the costs and benefits to society of a policy. If the total net benefits to society are more noteworthy than the total expenses, the outcome is that society as a whole benefit. A negative balance of benefits & costs demonstrates that a policy reduces social welfare & from that point of view, should not be executed (Romjin et al., 2013). CBA is grounded in economics, specifically in social welfare economics. At the center of welfare, the theory is the social-welfare function, in which individual interest is aggregated to obtain an expression for the welfare of society in general. On a basic level, this social welfare consists of all that is of incentive to individuals; nothing is ruled out in advance. This is known as the broad welfare concept. CBA depends on the possibility that social welfare increments when those who see their welfare increasing due to a policy can compensate those who see their interest decreasing (Romjin et al., 2013).

Individual preferences lie at the core of welfare economics. These preferences are depicted utilizing the idea of 'utility.' A person's utility is the extent to which their choices are fulfilled, such as the joy or fulfillment received from the circumstances. In welfare economics, a person's degree of utility is equivalent to their 'welfare' (Romijn et al., 2013). The individual utility is impacted by

the decisions an individual make. These decisions concern the allocation of the assets/resources accessible to the person for the utilization. Considering the topic of the thesis topic, in that case, the workers' utility will be impacted by the decisions their employer makes regarding the allocation of safety policies/measures. CBA is a tool for estimating all the people in a society's aggregate utility, 'social welfare.' Social welfare can be expressed as the sum of the utilities of all the individuals in society. We call a policy welfare-increasing if the total social welfare increases, even if this is not the situation for each person (Boadway et al., 2006). In this thesis case, the CBA will be estimating the aggregate utility for the construction workers, their families, and the construction industry. In the Societal Cost-Benefit Analysis (SCBA), individuals' family and friends are also considered. Their joy & fulfillment in life will be impaired when a worker dies or suffers from an injury. Even the construction industry is included in the SCBA as implementing safety policies might lead to expenses for them and some benefits in fewer transaction costs, less compensation expenditure, less medical cost, etc.

The adjustments in the degree of utility resulting from a policy measure can be estimated as the most extreme sum somebody is prepared to pay for a positive change in their utility. This is called the 'willingness to pay' for the concerned measures (Boardman et al., 2014). The CBA balance for a policy is the total willingness to pay all people in a society for the progressions in utility coming about because of its implementation. This is the welfare economic basis of a CBA (Romijn et al., 2013). In the case of the thesis topic, stakeholders' willingness to pay would play a crucial role in construction workers' welfare. The contractors & construction companies' desire to invest in safety policies will be essential in construction workers' welfare. While estimating the amount someone is willing to pay, it is necessary to determine what impacts the policy will have and how these impacts will be felt. Considering the thesis topic, to estimate how much contractors & companies are willing to pay for implementing safety policies, it is essential to know the impacts these safety policies will have. Like with the implementation of safety measures/policies, the number of construction accidents can be reduced to some extent, eventually avoiding workers' deaths & injuries.

Statistical life value is also an essential factor to be considered while performing a CBA for safety policies to be implemented. The value of statistical life (VSL) is the tradeoff rate between casualty danger & money. When the tradeoff values are derived from decisions in the market settings, the VSL fills in as both a proportion of the population's willingness to pay for a decrease of hazard and the marginal cost of upgrading safety (Kniesner & Viscusi, 2019). Given its central economic role, policymakers have received the VSL as the economically right proportion of the advantages people get from upgrading their health & safety. The VSL is additionally related to the idea of the value of statistical injury (VSI), which also penetrates the labor & health economics literature (Kniesner et al., 2019). In this thesis, both VSL & VSI have been used to perform the CBA. The use of VSL policymaking and assessment is broad in developed nations as compared to developing nations. The VSL estimates for developing countries like India are not adequate, and hence

policymakers find it challenging to use VSL (Majumder & Madheswaran, 2018). The principal focal point of health, safety, and numerous public related policies are to upgrade individual health & safety, where most special effects frequently relate to decreases in mortality hazards. Policymakers looking to survey society's eagerness to pay for expected health & safety enhancements need some measure of associated benefit values to adapt the risk reductions and compare benefits & costs. Standard monetary practices for esteeming mortality risks are generally centered around the human capital approach. The estimation of a casualty is linked with the present value of loss in income and clinical expenses related to death (Kniesner et al., 2019).

3.4.3 Role of CBA in Decision Making

CBA is a tool that underpins the policy process and political decision-making on a policy or policy alternative by introducing information about its effects, risks & vulnerabilities, the outcomes of these for its costs & benefits and for social welfare & information about who are benefitted & who encounters unfriendly impacts (Boardman et al., 2006). A CBA's essence is that diverse ventures or policy options can be surveyed by looking at their effects on society's welfare as a whole: the economic & social cost & benefits. The CBA gives a sign of a policy's economic efficiency: do the benefits exceed the costs? Does the CBA likewise offer bits of knowledge into the viability of a measure like how much it tackles the issue, and are there some other impacts? CBAs provide politicians & stakeholders with data they can utilize to help them choose a policy/measure, making CBA a significant input to the decision-making process (Romijn et al., 2013).

When settling on a political choice, decision-makers are quick to have all the data they need to depict, measure & assess the social impacts as precisely as possible. The objective is to make the advantages & disadvantages of an issue as justifiable as possible to come to a fair decision. This is decisively what CBA does (Boardman et al., 2014). The ultimate conclusion on the implementation of a policy is a political one. If the CBA balance is negative or if part of the policy conveys a negative rate of return, the politicians must settle on actualizing the policy, at any rate, dismissing the policy or concluding that the policy should initially be changed before a choice can be made. This implies the politicians, in the wake of considering the proof from the different sources accessible to them, must have the option to pick, in all heart, to ignore an investigation or CBA regardless of whether it has a negative or a positive result. At the point when a CBA is negative either altogether or to some extent, it is conceivable to utilize extra contentions to present a defense for not basing the choice on the result, or the other way around (Romijn et al., 2013). At long last, care must be taken not to utilize the CBA afterward to legitimize a choice that has already been made. If, for instance, the decision-making procedure is already far advanced and the politicians responsible have virtually pretty much conceded to a specific solution policy, a negative CBA would be unwanted, and the objectivity of the study could go under severe pressure. Many politicians argue that they opportunistically use CBA in political discussions. When the CBA doesn't uphold their assessment, they will scrutinize the study, and they underscore the significance of CBA when the outcomes defend their assessment even when they don't utilize CBA in shaping

their opinion at all (Mouter et al., 2017). Politicians & government officials contended that CBA is additionally used in bargaining processes behind the scenes. A positive CBA reinforces the situation of supporters of an undertaking policy in the bargaining processes, and the position of a venture's rivals is fortified by a negative CBA (Mouter et al., 2017).

CBA can play an essential role in the construction companies, contractors & developers regarding safety issues. Currently, in India, the situation is that most of the companies, developers & contractors don't even consider the safety factors to be taken on the construction sites as they think this adds unnecessary charges to the project cost (Rajiv et al., 2019). The usual tendency of the companies in India is that they care too much for the financial profits (Return on Investments) and less for social welfare (Rajiv et al., 2019). The companies can only be attracted to a policy implementation when they feel that they could return on the investment. Thus, CBA can help change their perception regarding safety investments; it can show that the benefits of safety measures can outweigh the cost they spend due to construction accidents. This can bring financial benefits for the companies and social benefits for all societies. This research aims to use CBA in such a way where results can be used in later stages to convince companies, developers & contractors about taking safety issues more seriously in India. How this can be used further is explained more in detail in chapter 6 in the discussion.

3.4.4 Types of CBA

There are two significant sorts of cost-benefit analyses ex-ante CBA & ex post-CBA. Ex ante CBA, which is merely standard CBA as the term is ordinarily utilized, is directed while an undertaking or strategy is viable before it is begun or executed. Ex ante CBA aids the choice about whether assets ought to be dispensed by the government to a particular task or strategy or not. Accordingly, its commitment to an open approach dynamic is immediate, prompt, and explicit (Boardman et al., 2014). Ex post-CBA is directed toward the finish of a venture. In this case, the entirety of the expenses is "sunk" as they have just been utilized around the project. The estimation of ex-post investigations is more extensive yet less prompt as they give data about the specific intercession and the "class" of such intercessions. They add to "learning" by government directors, lawmakers, politicians, and scholastics about whether particular tasks are advantageous (Boardman et al., 2014).

Some CBA contemplates performing throughout the term of a venture, that is, in medias res. Like ex-ante examinations, in medias res, investigations have the capability of straightforwardly affecting a choice—regardless of whether to proceed with the project. They likewise give information that can be utilized to foresee expenses and advantages in future ex-ante investigations (Boardman et al., 2014). Again, the fourth kind of CBA compares an ex-ante CBA and an ex-post (or in medias res) CBA of a similar task. This relative sort of CBA is generally helpful to strategy creators for finding out about the viability of CBA as a decision making and evaluative method. Sadly, there are just a couple of unengaged distributed instances of this sort of CBA. This sort of

CBA's scarceness isn't as impressive as it might show up because there is generally little interest for ex-post or in medias res CBAs. Regardless of whether one of these examinations is done, there may not be an ex-ante CBA to contrast it with (Boardman et al., 2014).

Ex-ante CBA could be beneficial when we talk about the Indian construction & development sector. The results of ex-ante CBA could be useful while a construction project is still under consideration. Ex-ante can be used by stakeholders in the construction field to assess if money should be invested in safety measures. The ex-post CBA can increase transparency & accountability by giving proof of the effectiveness of the investment made on safety measures concerning clear objectives of reducing the number of construction accidents, reducing the number of deaths, and reducing injuries. It could be a learning experience for the companies, developers, contractors, and other stakeholders involved in a construction project. Mainly politicians can use it very effectively in the Indian parliament to point to safety issues in the Indian construction & development sector.

4 Safety Policies & CBA Results

This chapter will first explain the safety policies that could be implemented with compulsion on all construction sites in India to reduce the number of accidents. These policies were selected based on the interviewee's responses on what safety measures they take/or should be mandatorily taken on construction sites to reduce the accidents. Table 4.1 gives information about these safety policies and which interviewees suggested those measures. Below the table, the safety policies are explained in detail, then the CBA for these policies, and finally, the financial analysis from the company's perspective.

***Table 4.1**: Suggestions by Interviewees*

Safety Policy	Suggested by Interviewee
Safety Training & Education	A, C, D, G, H
Safety Supervision	A, C, D, G, F, H
Provision of Personal Protective Equipment	A, C, D, F, G, H
Clean Site Conditions	A, C, D, F, H
First Aid Training	C, D, H

4.1 Safety Policies

4.1.1 Safety Training & Education

Safety training & education has been characterized as 'the orderly procurement and improvement of the information, abilities, and mentalities required by construction workers and employees to play out an undertaking or work satisfactorily or improve execution on the construction site' (Clarke & Flitcroft, 2013). This definition proposes that safety training & education includes exercises with the explicit objective of growing new information, working skills, and perspectives, which can be applied in the work environment. Even though adapting likewise centers around improving these mentioned factors, training has the particular objective of improved execution at business-related tasks (Clarke et al., 2013). Safety training & education isn't just a chance to learn new knowledge & skills, yet additionally plans workers to address difficulties and draw in with

changes that happen as some portion of their jobs (Thacker & Blanchard, 2003). Safety preparing alludes to formal off-the-work preparation. For example, guidance to individuals or teams may likewise remember for the-work training.

Concerning training, direct impacts of training & education incorporate improved health & safety information and abilities, improved critical thinking and expository skills, and upgraded risk mindfulness. Indeed, some research has shown that trained construction workers follow health & safety rules and guidelines more closely than those who have not been prepared (Vinodkumar & Bhasi, 2010). Change in worker conduct, regarding consistency with health & safety rules and strategies, has regularly been seen as a mark of safety training & education effectiveness (Ekens, 2001). Safety preparation has likewise been utilized as a method for hazard control on the construction site, as prepared construction workers are more averse to taking safety & health-related risks (Montorselli, Lombardini, Magagnotti, Marchi, Neri & Picchi, 2010). Even though training may accelerate to diminish hazard taking conduct among workers, it ought not to be utilized by companies as a substitute for formal hazard appraisal, the board, and control measures. Safety training and education effectiveness rely upon several variables, such as transfer of education, which is characterized as the degree to which training knowledge & skills created through preparing are effectively applied, summed up, and kept up after some time in the construction activities. Transfer of education & training will be affected by different elements, including the structure and conveyance of training & education, workers' qualities and inspiration, and the construction site atmosphere (Clarke et al., 2013). When training & education has been adequately structured and conveyed, knowledge education will be moved to the work environment, improving occupation performance (Clarke et al., 2013). Training adequacy might be decided by the degree to which learning results can be illustrated. Kraiger et al. (1993) proposed three learning outcomes: cognitive, ability-based, and emotional. Thus, the level of learning can be surveyed through the assessment of cognitive results (e.g., review of new data also, the capacity to apply information accurately), ability-based results (e.g., speed of execution and decreased mistake rates), and emotional results (e.g., inspiration, disposition quality and attitude towards health & safety).

Experimental investigations have discovered that safety training significantly affects a scope of health & safety-related results, including apparent safety information and both self and site supervisor evaluations of safety performance including the utilization of personal protective equipment, taking part in work practices to lessen hazard, and conveying health & safety-related knowledge (Neal & Griffin, 2006). Vinodkumar and Bhasi (2010) found safety training & education as the most effective safety management system in eight significant mishap danger process mechanical units in India. Safety training & education were found to anticipate health & safety information, safety inspiration, health & safety consistency, and safety support—the construction workers. Moreover, enhancements in health & safety inspiration have been found to bring about long haul consequences for workers' health & safety conduct and mishap involvement.

Likewise, the training not just upgrades workers' motivation to take part in a safe-conduct but also builds faith in their capacity to perceive and manage dangers. Leiter et al. (2009) discovered that workers who got good training & education on health & safety strategies felt more engaged in addressing the risks they experienced on construction sites. Finally, fulfillment with training will, in general, increment workers' security commitment and, more specifically, their authoritative commitment. Authoritative responsibility has been connected to workers' health & safety conduct and their ensuing mishap involvement.

4.1.2 Safety Supervision

Managing construction building site health & safety is a troublesome and multidimensional task. Numerous sources can influence site health & safety. Frequently, the obligation regarding building site safety is appointed by upper-level administration to the line-level or, on the other hand, site manager/foreman (Swuste, Frijters, & Guldenmund, 2012). Early work by Hinze & Gordon (1979) showed that the site supervisors' mentality towards safety motivation and the mental condition emphatically impact injury rates. Research during the London 2012 Olympics stadium construction & development ventures uncovered that site supervisor ability upgraded viable site safety practices and is a key to more extensive construction sector sway (Finneran, Hartley, Gibb, Cheyne, & Bust, 2012). The significance of the site supervisor for legitimate execution of health & safety programs on construction project locales has, for some time, been given consideration. Shohet et al. (1991) found that improved planning by the site foreman/supervisor prompts improved efficiency and safety at the building site, and Lingard et al. (2012) found that supervisors are bound to have a substantial effect upon safety, contrasted with top administrators and safety & health administrators.

One of the most widely recognized techniques for preparing site supervisors in the United States is the Occupational Safety and Health Administration (OSHA) 30-hour preparation. The OSHA 30-hour development outreach class is a calculated risk-based class expected for supervisors with administrative authority over working environment health & safety (OSHA, 2011). This effort course covers OSHA approaches, methods, and principles, just as construction & development health & safety standards (OSHA, 2013). The 30-hour outreach preparation goals incorporate extension and use of the OSHA development guidelines 29 CFR 1926, emphasizing the acknowledgment, evasion, decrease, and avoidance of working environment risks (OSHA, 2011). The Nevada Occupational Safety and Health Act (2009) requires all site supervisors to finish the OSHA 30-hour preparation inside 15 days of recruitment and recharge at regular intervals of 5 years (Hardison, Behm, Hallowell & Fonooni, 2013). In the USA, OSHA health & safety preparing has gotten a norm of safety preparing for the site supervisors & is utilized to characterize safety executives' ability.

Impacts of Safety Supervision

❖ Establishing Effective Communication

Health & safety communication between construction workers & site supervisors is of vital importance & has positive effects on health & safety performance in the companies (Torner & Pousette, 2009). Workers' safety execution on-site increases when the supervisor clarifies all working strategies & results of risky practices & when there is authoritative responsibility to improve work forms persistently and moderate dangers to sensible levels.

❖ Leader worker exchanges

An enormous amount of literature has indicated that exchange relations (interpersonal connections) between workers & site supervisors are imperatively critical to the safety execution in a company (Hardison et al., 2013). When a construction company endeavors to show that it esteems and thinks about its laborers, workers should see proactive administration backing to raise safety concerns. Supervisors in such cases endeavor to build up positive trade relationships among workers to improve work execution, work satisfaction & health & safety execution on-site (Michael, Guo, Wiedenbeckt, & Ray, 2006).

❖ Information about routine/non-routine construction activities

Large numbers of construction accidents happen when non-routine work assignments are being performed. In this manner, a site supervisor's administration in the execution pre-work arranging gatherings and work risk examinations is vital to forestalling genuine accidents because of strange and non-routine work (Hardison et al., 2013). This is usually finished before the construction work starts; work-related health & safety danger introductions are evaluated, and operational changes are planned far early (Hardison et al., 2013).

❖ Monitoring & responding to workers stress level

It is fundamentally significant that the supervisor assembles a positive environment for their workers. Group building abilities positively affect constructing a favorable climate for workers to work in and help make a readiness to think about new thoughts that may help build up an attitude of health & safety at work (Swuste et al., 2012).

❖ Safety promotions

The way site supervisors show the value of health & safety inside their company offers supervisors actual duty. It is significant for managers to depict their dedication to security through an active interest in safety arrangements, designating legitimate assets, and perceiving safe work conduct (Lingard, Cooke, & Blismas, 2009). When site supervisors take part in health & safety arrangements, workers consider safety to be an essential, authoritative need (Hardison et al., 2013).

4.1.3 Clean Site Conditions (Housekeeping on sites)

Housekeeping is characterized as the everyday cleaning and keeping clean of a building site (Lingard and Rowlinson, 1994). This is critical for counteracting mishaps and wounds on the project location (Lingard et al., 1994). Poor housekeeping has been found to have added to practically 1/4th of the accidents in the United Kingdom (Haslam, Hide, Gibb, Gyi, Pavitt, Atkinson & Duff, 2005). Chaotic construction sites and poor housekeeping practices can prompt numerous hazards, such as trip dangers, falling items, and sharp articles that can cause cuts to workers. From those acquainted with health & safety in a broad scope of different sectors, poor site conditions seen in the construction & development industry show up as a side effect of the business's poor safety & hazards management system. In this way, excellent site conditions are indicative of a positive health & safety culture. Site safety is significant for all partners, not just site workers. For a beginning, when there is a low safety culture on project location, there can be a few ramifications such as lost work hours and severe accidents. The expression "safety culture" is used to depict a culture in which health & safety is acknowledged to be of the highest need. Safety culture is the result of an individual or organizational values, mentalities, recognitions, abilities, and examples of conduct that decide the pledge to, and the style and capability of, an organization's health & safety management system (Cooper, 2000). Good housekeeping takes numerous safety issues; it improves confidence and builds efficiency since laborers usually value clean & perfect site conditions where activities can be finished unhindered.

Different variables add to the event of poor building site tidiness and cleanliness. Firstly is low material utilization and capacity framework. Ordering blunder, for example, overestimation, is a factor that influences the site condition. The material which is most certainly not promptly used for construction will have the requirement for capacity or distribution space. If this is not given, the materials are left spread around the building site, which is an instance of poor material handling (Shazwan, Quintin, Osman, & Suhaida, 2017). Recurrence of material being utilized likewise influences the stream segment that gives the material movement & placement during the construction activities. Henceforth, the administration must have an orderly methodology in controlling the in-transition and out-motion of development materials during the construction. Else, the building site may confront issues comparable to the stock/inventory. Other factors that affect the site housekeeping are the project's schedule & ineffective communication due to the staggered subcontracting framework. A too-close program will require the company to be wholly dedicated to finishing the project, thus stopping the company from having sufficient housekeeping time. Communication breakdown will impede housekeeping since the messages in guaranteeing the building site's neatness and cleanliness probably won't be conveyed to the concerned people.

Excellent housekeeping brings about a cleaner working environment, yet makes it more secure also. Excellent housekeeping lessens sicknesses and wounds and advances positive practices, propensities, and mentalities. Safety managers, safety engineers & safety supervisors are liable for surveying every work environment before work starts to distinguish the potential risks present and

decide approaches to dispose of the dangers. An effective housekeeping program is a significant component in working environmental health & safety frameworks. Cleaned-up working conditions are essential to all workers' health & safety and should be kept up consistently in both work and office zones. Legitimate housekeeping accommodates a proper arrangement of activities, instruments, gear, storerooms, supplies, and waste material. Excellent housekeeping is confirmed by floors liberated from oil and oil spillage; appropriately recognized ways; unhindered access and exits; perfect and efficient hardware and gear; all around settled hoses and lines; appropriately put away materials; surfaces liberated from gathered residue. Keeping up these conditions contributes altogether to bring down occurrence rates (OSHA, 2014). While OSHA guidelines necessitate that each working surface is freed from debris, including fluid and robust waste, toward the finish of each work shift or work, whichever happens first. To understand the advantage of a spotless work environment thoroughly, it is suggested that good housekeeping be kept up throughout the activity and workday.

4.1.4 Provision of Personal Protective Equipment

Personal Protective Equipment (PPE) is the gear required to provide security to workers from any danger in the working environment. The base for individual security for laborers or guests to a building site will be safety helmets, safety glasses, safety shoes & hand protection (Ulang, Salim, Baharum & Agus Salim, 2014). In light of the measurements that had been accumulated, it had been demonstrated that there is no assurance that the PPE would altogether avoid the accidents that would bring about injuries from occurring; however, would be capable of diminishing the opportunities for it to happen (Hashim & May, 2018). Different PPEs incorporate safety helmets, safety shoes, safety gloves & safety goggles. Each of these is explained in detail in the appendix & how they protect the workers.

❖ Awareness of using PPE

Preparing workers to use the PPE at construction sites is one of the fundamental procedures or prerequisites that the construction company & contractors need to get ready for workers before permitting them to start working. Besides, training ensures that the workers are very well prepared to complete the work at the building site with insignificant safety risks (Smith & Dejoy, 2014). Preparing would be robust when there are two different ways exertion, which is instructive and hands-with respect to approach whereby the laborers would need to attempt the PPE without anyone's help for the workers to increase a superior comprehension and mindfulness in regards to the PPE (Cooper, 2012). For example, the construction company & contractors would need to set up a test or watch the utilization of the PPE for a timespan before the laborers are being qualified in having the full mindfulness in regards to the entirety of the perspectives that are available in the PPE at the building sites (Cheng, Li, Fang & Xie, 2014). The familiarity with the PPE would likewise incorporate the determination of the appropriate and relevant PPE that would have the option to limit the security risks that are compromising the safety of the workers. The maintenance & observation of the PPE at the building site is significant too. This would be because the PPE

would need to be guaranteed concerning its quality and predictable capacity to limit the risks that the laborer is looking at the building site. The PPE should be continually checked by the laborers just as their site & safety supervisors to guarantee that it is in full working condition. These laborers should know about each one of the various techniques available to check and keep up the PPE in which it would be in acceptable condition and prepared for use by every one of the multiple workers at the building site.

❖ Effectiveness of Using PPE

The effectiveness of utilizing PPE at the building site relies upon the laborers' experience to use the PPE. Workers who are very much experienced using the PPE at the building site would comprehend what to do, utilize it, and maintain PPE elements (Hashim et al., 2018). Workers with experience would have a beneficial outcome at the building site. These laborers would have the option to regulate the PPE utilization at the building site by different laborers working on site. This would upgrade the adequacy of utilizing the PPE at the building site. The effectiveness of PPE at the building site would have the option to forestall and limit the pace of mishaps available at the building site. The significance would also rely upon the laborers' capacity to decide regarding the PPE fitting for their utilization. PPE that doesn't give a solid match would permit the dangerous material to interact with the worker of that PPE (Hashim et al., 2018). The workers would need to continually assess themselves concerning the fitting of the PPE to guarantee that they would have a lesser likelihood of uncovering themselves towards the risky materials at the building site (Adeyemi, Adejuyigbe, Ismaila & Adekoya, 2015). The worker information, attitude & conviction concerning the PPE utilization in the building site would likewise influence the PPE's adequacy at the individual level. Workers who are educated and have a positive belief about PPE would bring a sound working condition (Hashim et al., 2018). The workers would do their activity successfully and productively, which may be valuable for the business. This may accelerate the way toward finishing the project at the site, which may permit the company to get the money for completing the project because there would not be any postponements or extra expenses because of the mishaps that may occur.

4.1.5 First Aid Training

Fiske (1999) reported that the result of construction & development wounds depends not just on the seriousness of the injury yet also on the delivery of emergency treatment care/first aid treatment. Appropriately controlled early help can mean the distinction between life and death, fast versus delayed recovery, and brief versus lasting disability. The emergency treatment training arrangement has generally been prescribed about the degree of work environment health & safety dangers. Therefore, the more significant the hazard, the more prominent the requirement for additional workers prepared in emergency treatment. The past examination has likewise distinguished a relationship between customary first help preparing and a lower working environment. Individuals trained in medical aid have additionally communicated a more evident eagerness to assume individual liability for health & safety and a readiness to embrace safe-

conduct (Lingard, 2002). These discoveries recommend that emergency treatment preparation may have a positive preventive impact and the customary goal of giving workers the aptitudes to deal with the results of accidents once they have occurred. If this is the case, there could be an incentive to provide emergency treatment to all workers in a work environment instead of a predetermined number of assigned "first aiders." (Lingard, 2002).

Regardless of whether workers work in high-risk or low-risk conditions, they face an assortment of dangers. Shock, bleeding, poisonings, burns, temperature extremes, musculoskeletal injuries, bites and stings, medical emergencies, and distressed workers in confined spaces are just a sampling of the first aid emergencies encountered in construction places. These dangers are exacerbated when workers don't feel well. Their absence of focus can bring about excessive wounds on the off chance that your workers aren't set up to deal with these sorts of injuries on all movements. Their coworkers are left untreated until an emergency vehicle shows up. A casualty's condition may worsen, and wounds can become more serious, prompting more significant clinical expenses, lost efficiency, and costs workers' lives. It makes good construction practice to provide emergency treatment and proper preparation for every one of your workers. By making such a small investment in keeping your workers safe and all around prepared, the companies can gain enormous returns alongside a competitive advantage. Besides, it's the law. The Occupational Safety and Health Administration (OSHA) expects organizations to give emergency treatment training to workers without a close-by facility or clinic. While safety consistently starts with anticipation, not all construction accidents can be stopped. Essential medical aid preparation objective should be to give workers the vital devices and information to take care of injured workers until further help arrives (EHS Today, 2009).

These are the five significant safety policies for which the CBA & financial analysis will be performed. The CBA & financial analysis will not be performed separately for each safety policy but will be served as a package of these five policies. The reason for selecting them as a package is that it is known to be effective in reducing around 20-25% of the accidents. Respondents were asked how much the rate of accidents can be reduced by implementing these safety policies. They suggested that it could be around 20-25%, which is why in the research, 25% has been assumed as the effectiveness of the safety policies when applied as a package. This suggestion was mainly made by the safety engineer and safety managers I interviewed. Still, it is tough to analyze each personal policy's effectiveness when the individual policy is established. The total investment for safety costs will be divided among these safety policies.

4.2 Results of Cost-Benefit Analysis

A reference case is made with making some assumptions; these assumptions were made based on the interviews conducted. A CBA was performed using the information given in the reference case. A real-life construction project was selected, which is still in the planning, designing phase, and the construction for the same will begin in one year. This construction project belongs to Mr. F,

whom I had interviewed for this research. Details mentioned in this reference case regarding the construction project were also told by Mr. F. So, project costs, safety allocation, and the number of workers are from the real-world project.

❖ Details of Reference Case

- The construction project's total cost is INR 6 billion, out of which 0.6% is allocated for the safety measures. The project cost was revealed by the owner of the construction company I interviewed. The safety allocation is assumed based on the answers given by the safety engineers & safety managers during the interviews.
- The project will go on for five years. The project's duration was also revealed by the owner of the construction company I had interviewed.
- Around 850 workers will be working on the project for five years. The owner also revealed the number of workers that will be working on the project.
- Around 12% of the total workers are likely to meet with an accident while working on the project for over five years. This assumption is purely based on information collected during the interviews, where the respondents were asked about the frequency of accidents on the construction sites.
- On average, out of total accidents, it is assumed in the reference case that 14% of accidents will be reported as deaths & 86% in the injuries. Similarly, this assumption is based on information collected through interviews. The respondents were asked how many occasions the accidents result in deaths and injuries.

4.2.1 Societal Cost-Benefit Analysis

This SCBA is conducted purely to find its social impacts. This part will give tables with costs & benefits without discounting & with discounting over five years. Cost considered is the safety investment cost, and benefits are the decreased risk of death, decreased risk of severe injury, medical benefits & transaction benefits. All these factors are beneficial from the societal point of view. Reduced risk of death is the benefit when a worker's life is saved, a reduced risk of severe injury is the benefit when a worker is protected from getting injured; medical benefits to the society are that no worker will have to be admitted to the hospital. Calculations for all these factors, estimates for deaths & injuries per year, analyses for discounting factors are all shown in detail in the Appendix. This part will only give the tables derived after the calculations.

***Table 4.2**: Cost-Benefit Analysis Before Discounting for Social Perspective*

Description	Cost/Year (INR)	Benefit/year (INR)	Multiplying Factor	Total (INR)
Safety policy investment	-7,200,000	-	-	-7,200,000
Decreased risk on death	-	14,000,000	0.8	11,200,000
Decreased risk of severe injury	-	1,670,000	4.4	7,348,000
Medical benefits	-	12,000	5.2	62,400
Transactional benefits	-	25,000	12	300,000

How the benefits and multiplying factors are derived is explained below, and the detailed calculation is given in Appendix B.

- For the decreased risk of death, the multiplying factor is 0.8. With safety policies, the assumption has been made that four lives will be saved through the project. Now the project duration is five years, so each year, 4/5, 0.8 lives will be saved and which is why 0.8 has to be multiplied by the INR 14 million to get the VSL benefits. INR 14 million is the value of statistical life in the Indian labor market, and that is why it has to be multiplied by the multiplying factors.
- For a decreased risk of severe injury, the multiplying factor is 4.4. It has been assumed that with the implementation of safety policies, 22 workers can be saved from getting injured over five years, so each year 22/5, 4.4 workers will be protected from getting hurt. That is why 4.4 has to be multiplied by INR 1,670,000 to get the VSI benefits. INR 1,670,000 is the value of statistical injury in India, and that is why it has to be multiplied by the multiplying factor.
- For medical benefits, the multiplying factor is 5.2. The assumption has been made that with safety policies total of 26 accidents can be avoided. So, in those 26 instances, the victims won't have to be admitted to the hospital. Twenty-six accidents will be avoided throughout the project, so each year 26/5, 5.2 workers won't be admitted to hospitals. That is why 5.2 has to be multiplied by INR 12,000 to get the values of medical benefits. INR 12,000 is taken because this is the average expense that one has to bear when somebody is admitted to the hospital in case of an accident.
- For transactional benefits, the multiplying factor is 12. When the accidents are avoided, there won't be any additional compensation to workers and their families, other legal formalities. In such cases, one employee can be cut down from doing these activities, and so salary for one

hiring one such person can be saved. Now the salary is given every month and so for a year, so 12 is considered. That is why the 12 has to be multiplied by INR 25,000 to get the transactional benefits. INR 25,000 is assumed as that is the average salary of an employee doing the activities mentioned.

***Table 4.3**: Cost-Benefit After Discounting for Social Perspective*

Description	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Discount factor	0.957	0.916	0.876	0.839	0.802	
Safety policy investment	-6,890,400	-6,595,200	-6,307,200	-6,040,800	-5,774,400	-31,608,200
Decreased risk on death	10,718,400	10,259,200	9,811,200	9,396,800	8,982,400	49,168,000
Decreased risk of severe injury	7,032,036	6,730,768	6,436,848	6,164,972	5,893,096	32,257,720
Medical benefits	59,716.80	57,158.40	54,662.40	52,353.60	50,044.80	273,936
Transactional benefits	287,100	274,800	262,800	251,700	240,600	1,317,000
					NPV	**51,408,656**

This table shows the cost & all the benefits discounted over five years, five years as the project will run for five years. The calculation for the discount factor is given in Appendix B.
From table 4.3, we can see that the NPV for the SCBA is INR 51,408,656.
Table 4.4 gives the details of net benefit, net cost & the benefit to cost ratio for social perspective.

***Table 4.4**: B/C Ratio for SCBA*

Net Benefit	**83,016,656**
Net Cost	**31,608,200**
Benefit/Cost Ratio	**2.63**

4.2.2 Financial Analysis

Financial analysis is conducted entirely from the stakeholder's perspective—stakeholders such as construction companies, contractors & developers. For them, money is the most crucial thing, and social welfare is of least interest. Making a maximum return on investment is the prime aim while saving as much money as they could. In financial analysis, safety policy investment costs will be considered. Benefits such as avoidance of compensation in death & injury, medical benefits & transaction cost will be considered. These benefits are considered because these are the factors through which the companies can save money. Calculations for all these factors are again given in Appendix B. This part will only provide the tables derived after the calculations.

***Table 4.5**: Cost-Benefit Before Discounting for Financial Perspective*

Description	Cost/Year (INR)	Benefit/year (INR)	Multiplying Factor	Total (INR)
Safety policy investment	-7,200,000	-	-	-7,200,000
Compensation avoidance over death	-	180,000	0.8	144,000
Compensation avoidance over injury	-	50,000	4.4	220,000
Medical benefits	-	12,000	5.2	62,400
Transactional benefits (Employee)	-	25,000	12	300,000
Transactional benefits (Workers)	-	18,000	62.4	1,123,200

How the benefits and multiplying factors are derived is explained below, and the detailed calculation is given in Appendix B.

- For compensation over death, the multiplying factor is 0.8. With safety policies, the assumption has been made that four lives will be saved through the project. Now the project duration is

five years, so each year, 4/5, 0.8 lives will be saved and which is why 0.8 has to be multiplied by the INR 180,000 to get the compensation avoidance benefits over the death of workers. INR 180,000 is the employer's compensation to pay to the worker's family in the workers' death.

- For compensation over injury, the multiplying factor is 4.4. It has been assumed that with the implementation of safety policies, 22 workers can be saved from getting injured over five years, so each year 22/5, 4.4 workers will be protected from getting hurt. That is why 4.4 has to be multiplied by INR 50,000 to get the compensation avoidance benefits over a worker's injury. INR 50,000 is the employer's compensation to pay to the workers in case of the worker's injury.
- For medical benefits, the multiplying factor is 5.2. The assumption has been made that with safety policies total of 26 accidents can be avoided. So, in those 26 instances, the victims won't have to be admitted to the hospital. Twenty-six accidents will be avoided throughout the project, so each year 26/5, 5.2 workers won't be admitted to hospitals. That is why 5.2 has to be multiplied by INR 12,000 to get the values of medical benefits. INR 12,000 is taken because this is the average expense that one has to bear when somebody is admitted to the hospital in case of an accident.
- For transactional benefits (employee), the multiplying factor is 12. When the accidents are avoided, there won't be any additional compensation to workers and their families, other legal formalities. In such cases, one employee can be cut down from doing these activities, and so salary for one hiring one such person can be saved. Now the salary is given every month and so for a year, so 12 is considered. That is why the 12 has to be multiplied by INR 25,000 to get the transactional benefits. INR 25,000 is assumed as that is the average salary of an employee doing the activities mentioned.
- For transactional benefits (workers), the multiplying factor is 62.4. Based on the assumption, 26 accidents can be avoided, so in those 26 instances, the employer won't have to hire new workers. In total, the employer will avoid hiring new 26 workers over five years, so each year, 26/5, 5.2 new workers won't be hired. The worker's salary is paid every month, so per year, 5.2*12, 62.4, would be multiplied by INR 18,000. INR 18,000 is the average salary of a worker working on a construction site.

***Table 4.6**: Cost-Benefit After Discounting for Financial Perspective*

Description	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Discount factor	0.957	0.916	0.876	0.839	0.802	-
Safety policy investment	-6,890,400	-6,595,200	-6,307,200	-6,040,800	-5,774,400	-31,608,200
Compensation avoidance over death	137,808	131,094	126,144	120,816	115,488	631,135
Compensation avoidance over injury	210,540	201,520	192,720	184,580	176,440	965,800
Medical benefits	59,716.80	57,158.40	54,662.40	52,353.60	50,044.80	273,936
Transactional benefits (Employee)	287,100	274,800	262,800	251,700	240,600	1,317,000
Transactional benefit (Workers)	1,074,902	1,028,851	983,923	942,365	900,806	4,930,847
					NPV	**-23,489,267**

Table 4.6 shows the cost & all the benefits discounted over five years, five years as the project will run for five years. From the table, we can see that the NPV for the financial case is INR -23,488,256. NPV is negative, so it is not a sound investment from the stakeholder's point of view. Table 4.7 gives the details of net benefit, net cost & the benefit to cost ratio.

***Table 4.7**: B/C Ratio for Financial Analysis*

Net Benefit	**8,118,718**
Net Cost	**31,608,200**
Benefit/Cost Ratio	**0.25**

5 Sensitivity Analysis

This chapter gives different tables and tornado plots when different values of other factors have been changed to see how sensitive the results are concerning the nominal case. Factors value has been changed by -20% and +20%. I used 20% as I am quite uncertain about how to reduce and increase the costs and what values the results will change. The sensitivity analysis is performed to see how sensitive the NPV and B/C ratio are when other values are decreased & increased. The sensitivity analysis is performed for both the cases SCBA from the societal point of view and for financial analysis, which is essential from the employers' perspective. The sensitivity analysis is performed by changing the values of safety investment cost, VSL, VSI, the effectiveness of safety policies for SCBA and changing the values of safety investment cost, and effectiveness of safety policies for financial perspective. Below are tables and tornado plots for different scenarios, explaining how the NPV and B/C ratio changes with changes in one particular factor.

5.1 Sensitivity Analysis with Change in Safety Investment Cost (For Social Perspective)

In this case, the safety investment is changed by keeping all other factors as it is. Table 5.1 shows the NPV & B/C ratio values when safety cost is decreased by 20% and increased by 20%.

***Table 5.1**: Sensitivity Analysis for NPV & B/C Ratio with Change in Safety Investment Cost for Social Perspective*

Sensitivity Changes	Safety Investment (in INR million/year)	NPV (in INR million/year)	B/C Ratio
80% (20% Decrease)	5.76	57.73	3.28
100% (Nominal)	7.2	51.41	2.63
120% (20% Increase)	8.64	45.09	2.19

Table 5.1 shows the sensitivity analysis for NPV and B/C ratio when safety cost is changed. As seen in table 5.1, the NPV varies from INR 51.41 million to INR 57.73 million when the safety cost decreases by 20%. This shows an inversely proportional relationship between reduced safety cost & increased NPV. On the other hand, NPV comes down to INR 45.09 million from INR 51.41 million when the safety cost increases by 20%. Again, this shows an inversely proportional relationship between increased safety cost & reduced NPV. The table also indicates sensitivity

analysis for B/C ratio when safety cost is changed. As seen in the table 5.1, the B/C ratio increases from 2.63 to 3.28 when the safety cost is decreased by 20%, and the B/C ratio drops to 2.19 from 2.63 when the safety cost increases 20%.

5.2 Sensitivity Analysis with Change in Value of Statistical Life

In this case, the VSL is changed by keeping all other factors as it is. Table 5.2 shows the NPV & B/C ratio values when VSL is decreased by 20% and increased by 20%.

***Table 5.2**: Sensitivity Analysis for NPV & B/C Ratio with Change in VSL*

Sensitivity Changes	VSL (in a million/life saved)	NPV (in INR million/year)	B/C Ratio
80% (20% Decrease)	11.2	41.56	2.32
100% (Nominal)	14	51.41	2.63
120% (20% Increase)	16.8	61.24	2.94

Table 5.2 shows the sensitivity analysis for NPV and B/C ratio with changes in VSL. Table 5.2 shows NPV decreases from INR 51.41 million to INR 41.56 million when the VSL is reduced by 20%. On the other hand, NPV increases from INR 51.41 million to INR 61.24 million when the VSL increases by 20%. B/C ratio increases to 2.94 from 2.63 when VSL is increased by 20%, and the B/C ratio decreases to 2.32 from 2.63 with a decrease in VSL by 20%.

5.3 Sensitivity Analysis with Change in Value of Statistical Injury

In this case, the VSI is changed by keeping all other factors as it is. Table 5.3 shows the NPV & B/C ratio values when VSI has decreased by 20% and increased by 20%. Table 5.3 below shows the sensitivity analysis for NPV and B/C ratio with changes in VSI. Table 5.3 shows NPV decreases from INR 51.41 million to INR 44.96 million when the VSI is reduced by 20%. On the other hand, NPV increases from INR 51.41 million to INR 57.86 million when the VSI increases by 20%. B/C ratio increases to 2.83 from 2.63 when VSL is increased by 20%, and the B/C ratio decreases to 2.42 from 2.63 with a decrease in VSL by 20%.

***Table 5.3**: Sensitivity Analysis for NPV & B/C Ratio with Change in VSI*

Sensitivity Changes	VSI (in a million/Injury saved)	NPV (in INR million/year)	B/C Ratio
80% (20% Decrease)	1.34	44.96	2.42
100% (Nominal)	1.67	51.41	2.63
120% (20% Increase)	2.04	57.86	2.83

5.4 Sensitivity Analysis with Change in Effectiveness of Safety Policies (For Social Perspective)

In this case, the effectiveness of safety policies is changed by keeping all other factors. Table 5.4 shows the NPV & B/C ratio values have decreased by 20% and increased by 20%.

***Table 5.4**: Sensitivity Analysis for NPV & B/C Ratio with Change in the Effectiveness of Policies for Social Perspective*

Sensitivity Changes	Effectiveness of Policies	NPV (in INR million/year)	B/C Ratio
80% (20% Decrease)	20%	33.12	2.05
100% (Nominal)	25%	51.41	2.63
120% (20% Increase)	30%	71.10	3.25

Table 5.4 shows the sensitivity analysis for NPV and B/C ratio with changes in the effectiveness of safety policies. The table shows NPV decreases from INR 51.41 million to INR 33.12 million when the effectiveness of safety policies is reduced by 20%. On the other hand, NPV increases from INR 51.41 million to INR 71.1 million when the effectiveness of safety policies increases by 20%. B/C ratio increases to 3.25 from 2.63 when the effectiveness of safety policies is increased by 20%, and the B/C ratio decreases to 2.05 from 2.63 with a decrease in the effectiveness of safety policies by 20%.

5.5 Summary of Sensitivity Analysis for Social Perspective

From the above four cases, it can be said that the NPV & B/C ratio is more sensitive to change in the effectiveness of safety policies. Both NPV & B/C ratio values decrease with a decrease in safety policies' effectiveness and increase with an increase in the effectiveness of safety policies. NPV & B/C ratios are not too sensitive with changes in VSL & VSI. In case of changes in safety and investment cost, the results were inversely proportional to each other. With the increase in safety cost, both NPV & B/C ratio values decreased, and with a decrease in safety cost, both NPV & B/C ratio values increased.

***Figure 5.1**: Tornado Plot of Changes in NPV for Social Perspective*

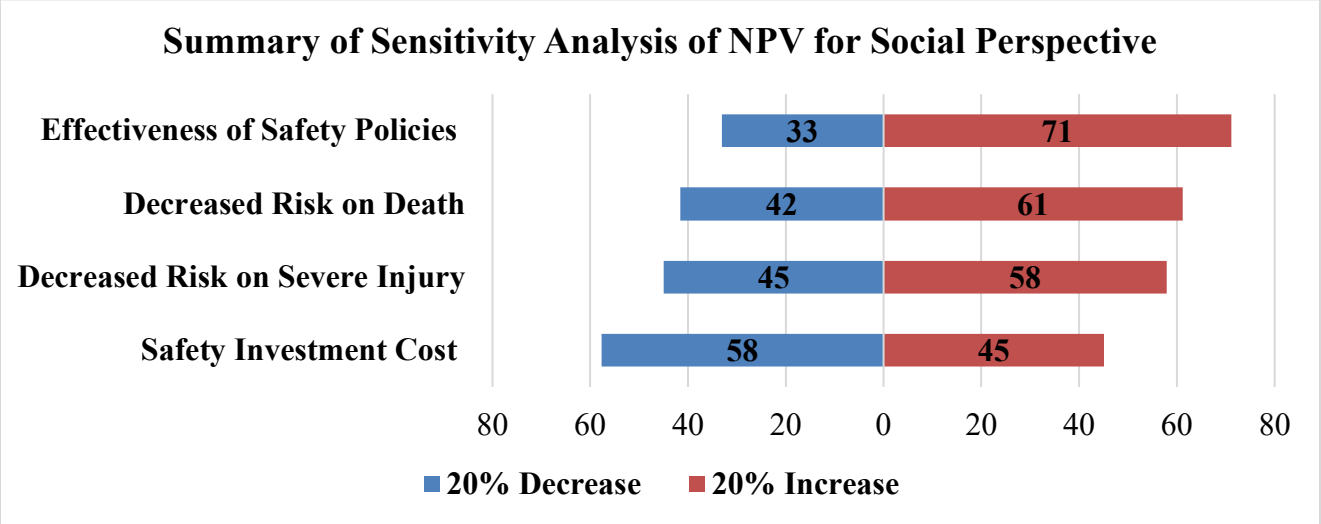
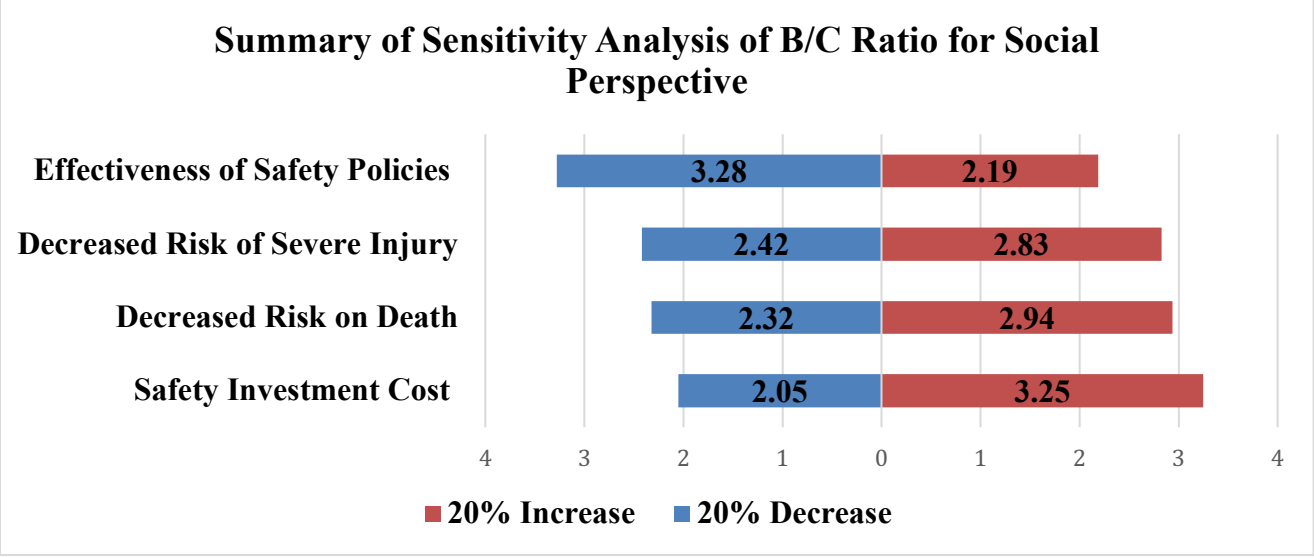


***Figure 5.2**: Tornado Plot of Changes in B/C Ratio for Social Perspective*



5.6 Sensitivity Analysis with Change in Safety Investment Cost (For Financial Perspective)

In this case, the safety investment is changed by keeping all other factors as it is. Table 5.5 shows the NPV & B/C ratio values when safety cost is decreased by 20% and increased by 20%.

***Table 5.5**: Sensitivity Analysis for NPV & B/C Ratio with Change in Safety Investment Cost for Financial Perspective*

Sensitivity Changes	Safety Investment (in INR million/year)	NPV (in INR million/year)	B/C Ratio
80% (20% Decrease)	5.76	-17.17	0.32
100% (Nominal)	7.2	-23.49	0.26
120% (20% Increase)	8.64	-29.81	0.21

Table 5.5 shows the sensitivity analysis for NPV and B/C Ratio when safety cost is changed. As seen in the table, the NPV varies from INR -23.49 million to INR -17.17 million when the safety cost decreases by 20%. This shows an inversely proportional relationship between reduced safety cost & increased NPV. On the other hand, NPV comes down to INR -29.81 million from INR -23.49 million when the safety cost increases by 20%. Again, this shows an inversely proportional relationship between increased safety cost & reduced NPV. The B/C ratio increases from 0.26 to 0.32 when the safety cost is decreased by 20%, and the B/C ratio drops to 0.21 from 0.26 when the safety cost increases by 20%.

5.7 Sensitivity Analysis with Change in Effectiveness of Safety Policies (For Financial Perspective)

In this case, the effectiveness of safety policies is changed by keeping all other factors as it is. Table 5.6 shows the NPV & B/C ratio values have decreased by 20% and increased by 20%.

Table 5.6 shows the sensitivity analysis for NPV and B/C ratio with changes in the effectiveness of safety policies. The table shows NPV decreases from INR -23.49 million to INR -24.83 million when the effectiveness of safety policies is reduced by 20%. On the other hand, NPV increases from INR -23.49 million to INR -21.91 million when the effectiveness of safety policies increases by 20%. B/C ratio increases to 0.26 from 0.31 when the effectiveness of safety policies is increased by 20%. The B/C ratio decreases to 0.21 from 0.26, with a decrease in the effectiveness of safety policies by 20%.

***Table 5.6**: Sensitivity Analysis for NPV & B/C Ratio with Change in* the *Effectiveness of Safety Policies for Financial Perspective*

Sensitivity Changes	Effectiveness of Safety Policies	NPV (in INR million/year)	B/C Ratio
80% (20% Decrease)	20%	-24.83	0.21
100% (Nominal)	25%	-23.49	0.26
120% (20% Increase)	30%	-21.91	0.31

5.8 Summary of Sensitivity Analysis for Financial Perspective

Sensitivity analysis for the financial perspective was only performed for safety investment cost and effectiveness of safety policies as the values of other factors was too small to make any significant impact, so they were not selected. Even with these two factors, the NPV & B/C ratios are not too sensitive with changes. In case of changes in safety and investment cost, the results were inversely proportional to each other. With the increase in safety cost, both NPV & B/C ratio values decreased, and with a decrease in safety cost, both NPV & B/C ratio values increased.

***Figure 5.3**: Tornado Plot of Changes in NPV for Financial Perspective*

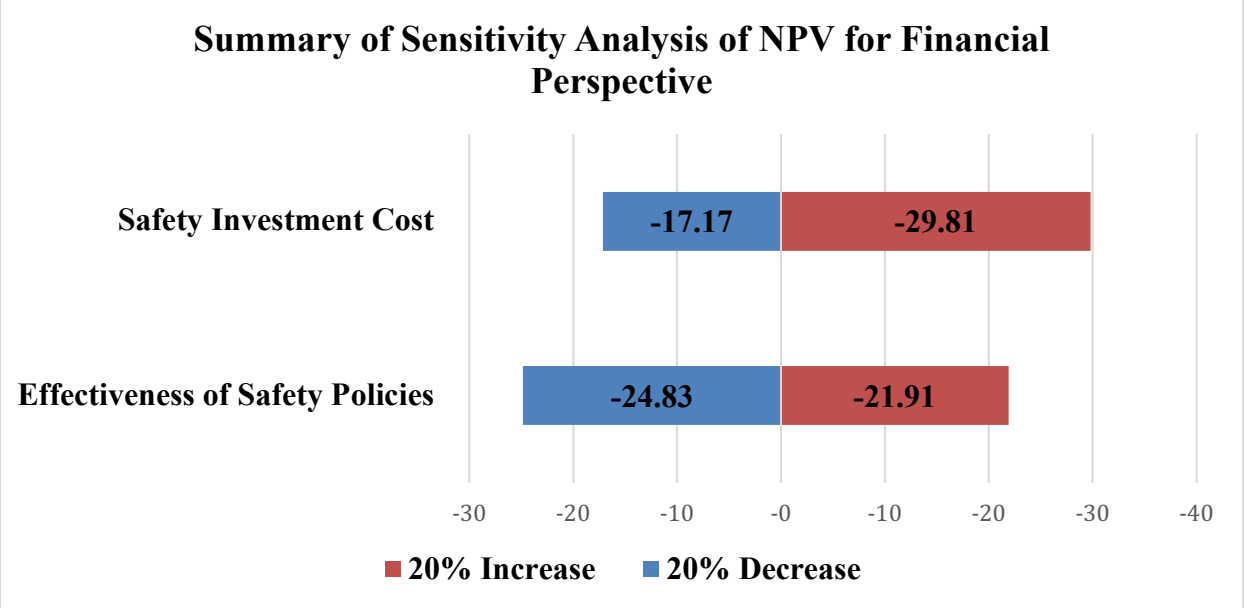
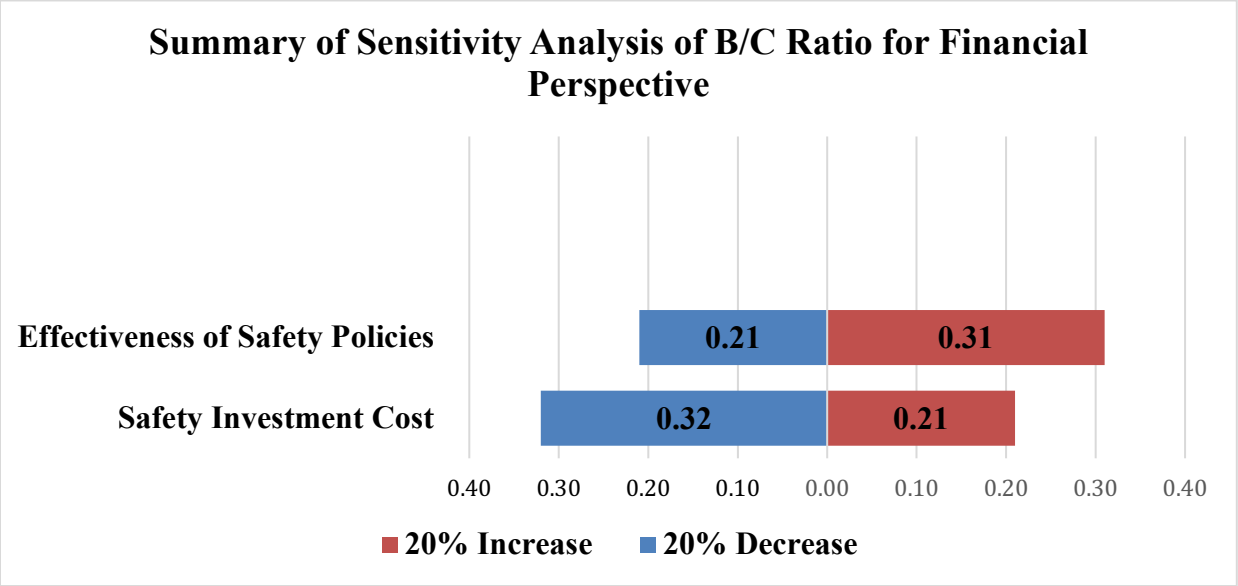


***Figure 5.4**: Tornado Plot of Changes in B/C Ratio for Financial Perspective*



6 Discussion

In the initial stages of the research, mainly two research gaps were found. First, no specific research was done to understand the impacts of safety measures in the Indian construction & development industry. Second, no one used the CBA method to analyze the financial and societal implications of safety policies in the Indian construction & development sector. So, this research focused on filling these research gaps with the main idea to identify the impacts of safety policies in financial and societal terms with CBA's help and then figure out how this can be useful in India.

To answer the first research question, it was necessary to know the Indian construction & development sector's scenario, why so many accidents occur, the major causes of these accidents, and the safety measures to reduce the accidents. The literature review gave information about the Indian construction & development sector's worst conditions and how many workers die every day. These safety measures were found based on the information collected from the interviews. Then based on that, five significant safety policies were found to be implemented to reduce the accidents. These safety policies were used as a package for CBA analysis. A reference case was made about a specific construction project. The reference case was selected to obtain a clear picture of a real-life problem from various angles & perspectives. Based on the reference case CBA from a societal perspective and financial analysis from the employer's perspective were performed. After performing these two separately, I got very extreme results in SCBA. The NPV was positive, and in financial analysis, the NPV was negative. From the societal perspective, safety policies should be implemented, but construction companies won't easily be ready to invest as they negatively return on their investment. CBA performed from a societal standpoint had an NPV of INR 51,408,656 & a B/C ratio of 2.63. The results were positive from the social welfare perspective. Financial analysis performed from the stakeholder's view had an NPV of INR -23,488,256 & B/C ratio as 0.25. This is an excellent investment from a societal point of view, not only because it has a positive NPV, but the lives of workers will be saved, which is the most significant benefit of implementing the safety policies. With safety policies, fewer workers will die, and fewer people from society will have to suffer like workers' family, friends, relatives & co-workers. On the other hand, the one who is supposed to invest is experiencing a negative return on investment, so we will be less happy to support it. In that case, politicians & government officials can play a crucial role as the investment is beneficial for society; by making some strict laws, they can make the companies invest in safety policies. In such cases, even if the companies don't want to invest in safety policies will have to do it as per the law.

To answer the second research question, it was necessary to know the role of CBA in decision-making. A literature review was referred for that purpose. The interviewees were also asked about the usability of results in India. Most of them said that government officials and politicians play a crucial role in further implementation. Governments can use the results and make strict rules regarding the safety policies implemented on construction sites. From the SCBA results, it is clear

that safety policies are very beneficial for society, and policymakers need to consider that fact. Policymakers in India are mainly politicians and government officials. Politicians can use the CBA results as political ammunition in discussions with politicians from other parties. Politicians can opportunistically use CBA results in political debates. Usually, politicians have a fixed plan, and if the CBA results do not support their opinions, they will criticize the results. If the CBA results are in their favor, they would emphasize the importance of the products. Responsible ministers for the Ministry of Labor & Employment, Ministry of Urban Development, can make the most of these CBA results. They could present these facts, results in Lok Sabha (lower house of the Indian bicameral parliament) & Rajya Sabha (upper house of the Indian bicameral parliament). Whenever any new law or act is to be enforced in India, it must be passed in both these houses with the 2/3rd majority. Considering India's construction industry and workers' worst situation, the responsible ministries need to take some strict actions against it. Stringent laws must be enforced regarding construction health & safety because most construction companies, contractors, developers, and all other stakeholders don't take health & safety seriously because there are no such laws that take strict action against them in case of violation. It is also effortless to close and divert such accident cases in India to grab no one's attention. Somewhere, the level of corruption also plays a vital role over here; people who have a lot of money, decisive people, can quickly get away from anything in India. This doesn't seem right, but unfortunately, that is the reality.

The government, if they want, can make stringent rules regarding construction health & safety. Responsible ministries can have their highly educated officials considering the cost-benefit point of view for safety measures. Eventually, with positive results, they can firmly put their issues in parliament houses where they are likely to get support from other politicians. Enforcing laws alone would not be sufficient; it should be appropriately implemented on each construction site, and inspecting that it is appropriately taking place at each construction site is essential. Once this starts taking place promptly, the construction industry will also take all such required safety measures, even if they don't want to still because of the laws they will have to. Also, responsible ministries can conduct seminars, meetings for all the stakeholders in the field and explain to them the benefits of investing more in the safety measures, which would benefit not only the society but also the stakeholders. Once they are convinced, they don't even need the laws, companies, contractors & developers would willingly invest in health & safety measures. Even if they invest 1% of their total project cost on safety measures, it could be very beneficial for the workers.

One of the exciting points in the research was the Value of Statistical Life used for the CBA. The value of statistical life in India is INR 14 million, which was also used to perform the cost-benefit analysis. VSL in India is significantly less as compared to that in other developed countries. For instance, the VSL in the Netherlands is Euro 2.6 million. After converting that into Indian currency, it comes to be around INR 228,800,000. So, if we compare, there is a massive difference between the VSL in India and the Netherlands. The Indian VSL is only 6% of the VSL in the Netherlands, which shows the Indian lives are not valued the same as Dutch. One of the reasons

for this imbalance could be that India's construction firms have a very low willingness to pay the workers for taking risks while performing the construction activities. Providing safety policies and a safe working atmosphere is considered relatively expensive by the construction lobby in India, and they also think that it affects their profit levels. When companies want to maintain their profit levels while providing appropriate safety measures to their workers, they reduce the workers' wages. Occupational health & safety is a significant area but mostly overlooked in India. There are specific rules & regulations formed by the government, but they are not well implemented. The government itself does not take any measures to make sure safety policies are taken seriously on every construction site in India, and the same was found through the interviews. VSL was used in CBA to identify these safety policies that are economically & socially efficient. The estimates of VSL can help in framing & evaluating various occupational health & safety policies by government & policymakers in India. However, such policies are made in political space, policies affecting life & health will probably incentivize policymakers' political power in India. Hence, VSL can be viewed as a political variable affected by those who have political force.

7 Conclusion & Recommendation

This thesis aims to find the safety policies and their societal & financial effectiveness to address the construction & development accidents problem in India. The use of these safety policies is vital as their implementation of construction projects can reduce accidents taking place at the construction sites. However, it is not easy as currently, most companies, contractors & developers in India don't even bother about providing these safety policies and safe & healthy work environment for their workers. This can be useful when all the stakeholders, especially the employer, understand the importance of providing these safety policies. The fact that proper safety policies are not implemented & healthy working conditions are not provided to the workers, India is one of the countries with the maximum number of construction accidents. The workers are not educated to understand the importance of their safety policies. Employers kind of take advantage of this thing and don't provide such systems to save money; consequently, many workers die or get injured.

This research study addressed this problem by structuring the solution around two research questions. The first research question was, *"What are the societal and financial impacts of adequate safety measures taken against unsafe safety practices on India's construction sites?"* This research question was answered in chapter 4, where safety policies were discussed, and SCBA and financial analysis were performed for the same. The safety policies were determined based on the interviews. The CBA results showed that implementing these safety measures/procedures is sound from a social welfare perspective as the benefits are higher than the costs. The NPV is positive for SCBA, so it is highly recommended that the safety policies be implemented on these construction sites from a societal welfare perspective. From the social welfare perspective, investing in safety policies is very important as it saves lives. So, we can call safety policies social welfare increasing as workers' lives are protected, which eventually means their family, friends & relatives won't have to suffer mentally and financially. This is a positive sign for attracting the politicians & government officials to understand the social benefits of safety policies on every construction project. Financial analysis shows negative results as costs are higher than benefits, so it is not a sound investment from the stakeholder's perspective. Employers primarily focus on investment where they have a good return. Investing in safety policies have negative returns for them, so they will be reluctant to invest in safety policies. This is one of the primary reasons that most construction companies, contractors & developers don't invest in safety policies.

The second research question was, *"In which way could CBA results be useful in making decisions regarding reducing risks at the Indian construction sites?"* This was addressed in chapter 6. CBA results could give a clear idea about the benefits & cost of safety policies. Along with the stakeholders involved in a construction project, politicians can also use CBA results. They can use CBA for their political ammunition and make strict laws regarding safety policies implementation. Once there are laws regarding occupational health & safety, and those are appropriately inspected,

even if construction companies, contractors & developers are unwilling to invest in safety measures, they will still have to do that as per the law. Once the politicians are convinced, they can use the CBA in forming their opinion regarding the safety policies for the construction sector in India. In India, politicians do have enough power to enforce a new law. Also, the media can use the study results because, in India, the media is a vital sector. Once they expose a specific problem or raise a certain issue pointing out to a particular industry, then reacts in a way as for companies, their reputation is critical.

The thesis was instrumental in addressing the Indian construction & development sector's significant issues and solving those problems with effective & mandatory safety policies on India's construction site. This thesis is just a small attempt to improve construction projects' safety conditions and help the workers; however, there are further barriers to the actual adoption & implementation of safety policies on sites. For now, we can only hope to bridge the gap for all those construction workers who should get access to safe & healthy lives by providing them with appropriate health & safety conditions.

7.1 Recommendations

This subchapter focuses on the recommendations for stakeholders involved in a construction & development venture in India. The idea of recommending them is to understand the importance & advantages of implementing safety policies on construction projects.

7.1.1 Recommendations for Contractors

❖ Reporting of Accidents

Thinking about past mishaps is essential for top officials who need to diminish future accidents & injuries in their organizations. Therefore, accident reporting should be steered through proper administration, explored, and afterward diverted back for corrective measures. After finishing the corrective measures, a follow-up program is expected to assess the disciplinary action's effectiveness.

❖ Safety Planning

If a definite work arrangement is completed, all materials & safety equipment that are fundamental to perform activities safely would be available when required. The extra effort needed to carry out any given assignment in a secure manner would be decreased & workers would pick safe strategies more regularly. Additionally, sub-contractual workers' broad utilization can cause requirements to be brought together in construction health & safety planning. The work of all the stakeholders is facilitated to stay away from dangerous conditions. Safety & health planning should be done fundamentally as a piece of undertaking planning with the goal that risk can be addressed before risky situations emerge and expensive interferences happen.

❖ Safety Training

Safety training must be custom fitted to handle the specific issues related to health & safety circumstances which the organization encounters. Preparing material should talk about the expenses of mishaps, the influence of good safety execution, and pressure the organization's safety goals, the pertinent laws and enactment, and legally binding associations with customers on health & safety matters. There is a developing requirement for new education and preparing techniques concentrating on top administration dependent on interior control, human components, safety executives & safety atmosphere instead of outside management, implementation, and specialized assessments. A formal preparation program causes workers to take different preventive exercises effectively. It additionally sets up an inspirational attitude towards health & safety & incorporates safety into productivity & quality objectives.

7.1.2 Recommendations for Management Practices

Both exploration and practical experience demonstrate that the top administration's job is critically significant for accomplishing the best health & safety results. Dangerous conditions and mishaps are generally signs that something isn't right in the management system framework itself. The following measures by the management could be useful in reducing construction accidents & improving safety performance.

- Acknowledge moral duty regarding improving health & safety and wiping out and unsafe & harmful working techniques or conditions.
- Communicate & show a genuine worry for health & safety.
- Use a self-investigation program.
- Dispense whatever a number of the expenses of accidents as possible to the construction venture on which those accidents happen.
- Relegate the costs of safety measure programs to an organizational health & safety account.
- Use a functioning surveillance program to gather and disperse data about the accident rates in each construction project.
- Assess field supervisors/safety supervisors for promotion & pay increment after considering the on-location accident records.
- Discuss health & safety similarly as about the expense & schedule of the project.
- Embrace a cost-revealing framework that indicates the cost of accidents in the week after week or month to month reports.
- Give safety training to recently employed workers, focusing on safe work strategies and occupation hazards.
- Utilize incentives with alerts.

7.1.3 Recommendation for Owner

As found in the results with the implementation of safety policies, a lot can change for owners. With fewer accidents, the productivity at the construction sites can be maintained; projects will not be delayed; compensation costs can be saved in death and injuries. So, owners should invest a tiny percentage of the total project cost for safety implementation. Owners of the construction companies can play a significant job in decreasing the expenses and rate of accidents. Customarily, owners have regularly viewed themselves as in a less vulnerable legitimate position if they don't include themselves in a contractual worker's security program.

❖ Proposed contractors' prequalification and safety performance evaluation

Owner of construction companies can prequalify & assess the contractors & subcontractors health & safety execution dependent on the accompanying factors mentioned below,

- Who in the organization gets and surveys accident reports and how frequently.
- How frequently safety meetings are organized for field supervisor or safety supervisor/safety engineers.
- Frequency of health & safety inspection on a project.
- Accident expense framework estimation utilized.
- Past health & safety execution.
- The critical administrative individual is responsible for health & safety.
- Health & safety program of the organization.
- Safety documentation.
- Subcontractors' approach.
- The executives, management, work exercises, preparing, the inspiration for safety, and communication.
- Plant safety equipment and maintenance.
- Provision of Personal Protective Equipment

❖ Safe Owner Practices

The construction company owner has a lawful obligation to give directions and orientation to the contractors & subcontractor. The following strategies can be utilized by the owner to improve the contractual worker's safety execution.

- Utilize a work license framework for possibly unsafe exercises to direct the work dangers.
- Stress health & safety during the pre-bid stage.
- Consolidate specific safety necessities in specifications.
- Conduct occasional inspections & maintenance of health & safety records.
- Think about health & safety as a model in granting the contracts to the contractors.
- Appoint in-house health & safety staff with appropriate ability.
- Discuss health & safety at work gatherings.

- Expect contractual workers to delegate security to on-location faculty.
- Permit a safety edge to be considered in severe offering for granting contracts.
- Prize safe contractual workers for good execution.

7.1.4 Recommendations for Designer & Consultant

Designers & consultants can play a substantial role in diminishing the rate of accidents & fatalities; designers should acknowledge this duty with a sincere promise to give in each plan a more secure workplace for the construction workers. The design of numerous conventional construction projects happens with little respect for the issues to be settled during the construction & development process. Designers must be mindful of the different methods by which their structure choices sway the workers' on-location safety conditions. Specifications should be sufficient & ultimately portray the establishment system and norms. Safe materials should be utilized as regularly as could reasonably be expected. The designer's comprehension of the reasons for site mishaps will help to concentrate on construction details, which might be possibly dangerous. Since a considerable number of fatalities & injuries result from falling from a height, it is significant that designers try to decrease the requirement of construction workers to work at height. Instances of improving the design for the safety of workers are as follows,

- Design higher parapet walls on all rooftop edges of a building. A parapet wall is a boundary that is an expansion of the wall at the edge of a rooftop, patio, balcony, walkway, or other structure.
- Gather the rooftop & floor infiltrations, so the number of openings can be kept to a minimum.
- Try to avoid overhead electrical cables at the work site by migrating them (potentially underground).
- Try to avoid more in-depth excavation work.

7.1.5 Recommendations for Workers & Site Supervisors

New construction workers must be appropriately orientated to their activity condition since they usually are most vulnerable against workplace accidents due to unfamiliarity with expected risks and issues of a development venture that is new to them. Measurements show that laborers who have been hands-on one month or less represent 15% of all construction mishaps (Kjellen and Sklet, 1995). Some portion of the obligation lies with supervisors & site safety engineers. They should direct a garbage removal program week after week or day by day, secure specific access and safe streets at work, and post cautioning and hazardous signs. Workers, thus, should comply with these strategies and adhere to the site directions/guidelines. Casualties of deadly accidents, for most of the time, work without the control of a foreman. Recommendation for Industry
Subsequently, various recommendations can be advanced to give some direction to progress in the construction & development industry are as follows:

- To improve construction health & safety systems and better general execution of the development industry, it is suggested that contractual workers spend more on expenses of mishap anticipation to guarantee a more secure workplace. In practical terms, this implies spending more on medical aid facilities, the arrangement of PPE, safety advancement, safety training & education, and safety staff.
- To expand advantages of safety measures and better execution, it is suggested that officials in the company give more exertion towards thorough usage of health & safety measures to make their workplace more secure. In handy terms, this implies attempting to encourage a unique feeling of distinguishing proof with the laborers and focusing on eliminating the accidents.
- To build creation without trading off the health & safety measures, maybe, laborers must be taught that health & safety issues are the duty of each one. Likewise, laborers should be sufficiently prepared to raise awareness, so risks and potential human mistakes can be distinguished early and limited.
- It is suggested that contractual workers, construction companies & developers utilize the CBA model to assess the expense of mishap, which will encourage the dynamic decision-making process in the administration of construction & development health & safety. The utilization of CBA could, without a doubt, improve the health & safety systems on building locales.
- It is suggested that the created cost-benefit investigative results can likewise be utilized by designers/architects to empower them with a more secure configuration, and estimators to assign them costs for qualified health & safety measures to forestall mishaps construction destinations. This can add to making a working group design out health & safety issues from the beginning phases of the construction activities.

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7.1.7 Recommendation for Policy Makers

Policymakers are mainly politicians and government officials in India. When we talk about the construction & development industry, the Ministry of Urban Development is responsible. This ministry should make some strict rules regarding safe activities in the construction sector. When the safety of construction workers is concerned, the Ministry of Employment & Labor is responsible. They should create strict laws regarding the protection of the workers. As found in the results, implementing safety policies can be very beneficial and can save many lives. It was found that only on a single project, four workers' lives can be saved, so implementing safety policies through India could save many lives. The policymakers should consider that if employers even spend 0.5%-1% of their total project cost on safety issues, a lot can be changed.

7.1.8 Recommendation for Future

As found in chapter 5, the NPV & B/C ratio values were sensitive against the changes made ineffectiveness of safety policies, so maybe future studies could improve the effectiveness of safety policies, which can eventually benefit both the society and stakeholders from the construction industry. Politicians, government officials, stakeholders involved in construction projects, especially the owners, contractors can use CBA to analyze the benefits & costs of safety policies.

7.2 Personal Reflection

While working on my thesis, I have come across four NGOs in India. Sharing the results with them will help as they have a close connection with the government's people. They keep organizing seminars where they call people from government bodies such as people from the Ministry of Labor & Employment, Ministry of Urban Development; they have people from the construction lobby, leaders of union workers, social activists, etc. In such seminars, they explain how the construction workers suffer, how they don't get any social benefits, how the accidents are growing on construction sites day by day due to which the workers and their families have to suffer. Their main aim in such seminars is to give all the guests a picture of how construction workers in India are suffering, and support from those people is critical to provide these workers with better lives. I have already talked to all the four NGOs regarding my work, and they are pleased with the kind

of work I am doing. And they also feel that this could be helpful for them, and that is why they all have asked me to give them my final report which they can use for the betterment of workers. I have already got an opportunity to present my work in a February 2021 seminar, which will be conducted by one of these NGO's. With my results, they can convince more and more people from the construction industry to invest more in safety measures & politicians & government officials to make some strict rules & regulations. Even people from the government can realize the benefits of providing safety measures and can do something that companies, contractors, and developers strictly follow all the safety norms.

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Appendix A: Interview Transcripts

A.1 Interview with Candidate A

Q.1 What do you do at your NGO?

We are working for the dignified livelihood and social security of the construction workers. When we say social security, what are some of the problems construction workers face? These are the daily wage workers; no one provides them with the medical benefits, pensions, or other types of services workers in the organized sector usually get. Construction workers, agricultural laborers, street vendors, etc., come under daily wage categories, where there is no social security being provided. So our NGO, which started more than three-decade ago, started working in this direction of how to provide social security to construction workers. We were also at the forefront of forming a law, and that is how The Building & Other Construction Workers Act 1996 was created. We work for the welfare of construction workers and domestic workers.

Q.2 Do you also focus on the safety issues of the construction workers?

It is not a significant area of focus for our organization. Still, as far as the construction industry is concerned in India, Safety has been a very neglected part of the industry. Like providing PPE, safety training & education are ignored. Even the data of accidents are not adequately reported or maintained; the reason is that the construction sector consists of builders, developers, contractors, and their lobby is powerful. The whole idea is somehow not to give benefits to construction workers. Most of the time, the safety inspectors, labor inspectors are bribed, and they never report the construction sites' accidents. This is very unfortunate, but that is the case in India.

Q.3 So does your NGO take any safety measures to ensure that least construction workers are met with an accident?

No, we don't take any safety measures because we are not doing any construction activities independently. We are an NGO, so we do not do any construction activities. We are working for the social security of construction workers from the legal aspects. We mainly focus on how economic justice can be given to them. But as far as any construction accident is concerned, if we get to know that any death has taken place, or some casualties have occurred, that way we come to know. Then we try to approach the government so that the workers can get compensation and all those things. But ultimately, wherever we find that safety rules and regulations are not being followed, we try to bring it to the notice of the concerned governing body. You know, but in most cases, especially when there are big construction sites that are going on, we are not even allowed to enter so that we can't even check for safety. There is supposed to be a safety officer, there is reason to be a labor inspector, but these people are heavily bribed to report all these accidents. Even if they see the rules and regulations are not being followed, they will still not do anything. That is the unfortunate part.

Q.4 So far, what have you done for the welfare of construction workers?

From the welfare point of view, what we do is we make sure there is building & other construction workers welfare board is there in every state as per law. Aa per Indian law, whenever any structure is being constructed, it costs more than INR 1 million most of the buildings. They are supposed to give 1% to the state government, and then the state government gives it to these welfare boards. These boards have representatives of governments, employers, and employees. So these boards get funding through the projects, and then the workers who are registered with them will get the benefits in case of any mishap. So usually, construction workers are not directly dependent on the government but these boards. So we make sure that these boards are providing benefits to the workers or not. Because most of the time, corruption occurs, and the money that should be reached to workers doesn't go to them. During the lockdown, all the sites were closed, and so the construction workers were not getting any money, so we requested these boards and the government if they could provide some money to the workers.

Q.5 Do you get any support from the government?

No, we don't get any support from the government. We don't get any financial support. We work with the construction workers and take up their issues and matters with the government and the boards. SO basically, we are representing the workers. Often, the workers don't get paid by the builder, so on such instances, on behalf of the workers, we approach the builder. That is how we help them to negotiate, and the construction workers are paid their dues.

Q.6 Have there been instances where workers have come to you with inappropriate safety at the construction sites?

Yes, it has happened in the past. Many times it has happened. In most cases, the issues are with the big construction sites, and on big construction sites, everything is barricaded and fenced for security reasons, so even we are not allowed to enter the site. So, we find it difficult to solve these issues. In some cases, we have contacted the court and have gained permission to enter the sites, and then we try to solve the problem. In 2010, a massive event of commonwealth games took place in Delhi, India, and so many construction activities were going on to prepare the event. During that time, the safety rules and guidelines were floated left, right, and center. In that case, we approached the Delhi High Court and formed a committee to ensure safety on construction sites. Despite the court’s order, many big builders did not even allow the committee appointed by the court to the site. It is tough to get access to these sites, but once we get access, we highlight safety and occupational health issues. It includes things related to the living conditions of workers, their sanitary hygiene, all such matters. Because the builder is supposed to provide some stuff to workers as per the laws. Like builders are supposed to give PPE, Clean drinking water, proper living conditions, all those are checked. This is the responsibility of the labor inspector, but in reality, nothing is done by them.

Q.7 So, in what parts of India your NGO is operating?

We majorly work in Delhi and Jharkhand directly, but we also give the secretariat for a national campaign committee for construction laborers. It is called NCCL, National Campaign Committee for Construction labor. So, we provide that secretariat facility. Because of that, many organizations are our partners in all parts of India, working for the construction workers' welfare. We are in regular touch with all of them. That is how we came to know about the organization in Gujarat, which works for workers' welfare and takes necessary measures related to safety. That is how I was able to share their details with you. I don't know if you have already talked to Mr. VVV; he is the NGO's head. It would be best if you spoke to him because he is the one who is working for safety-related construction issues for a very long time. He will give you a lot of detailed insights because he works specifically on safety issues. So, he has selected data on construction accidents for Ahmedabad city in Gujarat. Similarly, we are not able to get the data in other parts of India.

Q.8 Do you know any other organizations that can help me with my research?

As far as organizations are concerned, there are many organizations, but we go and ask them for accident data, no one is willing to share the data. There are organizations such as the labor institute, Directorate of Industrial Health & Safety in the Delhi government, and similarly, it is there in every state government. Then there are labor departments in various state governments. In India, the more significant challenge is that labor is concurrently subjected, which means both central and state governments can make rules and regulations. Because of that, there is a lot of overlap, and ultimately, the data that is supposed to be available with them is not there, nor they try to collect and compile it. Finally, I have one request for you once you finish your draft; you share it with us because it will benefit us.

Q. 9 Do you think my results of the thesis can be helpful to you?

If the results are positive and in favor of construction workers, they can be accommodating. As I told you already, you share your work with us once it is ready, we can surely use it. See, we closely work with the government, we have connections with a lot of higher government officials so your work can be easily conveyed to them, and through them, it can be taken to the parliament as well. We can also share your work with the highly skilled people working in the related area and can ask for their take on your work; if we get a green signal from them, it will make your job even more useful and applicable, so don't you worry, share it with us once it is ready. We will take care of the rest.

Q.10 What do you think needs to be done to stop the accidents in India?

Measures like safety & health training should be given, PPE should be provided, safety engineers or safety supervisors should be there on every site to ensure safe working. I also mentioned earlier there should be clean site conditions on every project. Having all these measures could be helpful. Safety supervisors should be there to monitor the worker's activities. Most of the workers are not educated, so training regarding the importance of safe working is necessary.

A.2 Interview with Candidate B

Q.1 How do you collect the records of the construction accidents?

There is a law called Right to Information (RTI), which was enforced in 2005 in India. So, in whichever city we are working, we file RTI at the police station, and from there, only we collect the data. Whenever a worker dies because of a construction accident so that the worker is taken to civil hospital (government hospital), the complaint is registered. In many cases, the worker is taken to a private hospital as there is no police involvement. When any accident case is taken to the civil hospital, it is mandatory to register that case at the police station. So, builders & contractors, to avoid police cases they admit the workers to private hospitals. In those cases, we don't get the records of accidents. So, we mostly get data of death workers only, and mostly the cases where workers are majorly injured with a permanent disability are not registered with us.

Q.2 What, according to you, is the average % of death in India?

It is difficult to estimate because there is not data, records of almost a high number of accidents. Still, we have been working for the last 20 years in this field, and from our analysis, we found that around 10%-15% of the construction accidents result in death. You see, this is a very high number, and we are trying our best to bring that number down.

Q.3 How do you get to know that an accident has taken place?

We have three sources: First is the Newspapers, second is we have our union spread across different states so our volunteers, if they found out about any accidents ten they report it to the head office, which is in Gujarat and in the regions where we are not operating we have a connection with other NGOs like us so in some instances they help us, and that is how we get to know about an accident. The third source is RTI, which we file at the local police stations in every city we are operating in, and an avg, we file around 50-60 RTI every year in every town, districts & zone wise.

Q.4 How does this RTI work?

We first file RTI at the Deputy Commissioner of Police's (DCP) office, and from there, our request is forwarded to other police stations, and then we get our data. There is a District Superintendent of Police (DSP) on a district level, so we file an RTI at his office, and then whatever blocks come under that office, they send our requests to those police stations, and then they provide us the required information. So that's how we cover almost around 1000 police stations.

Q.5 So what kind of information do you get from the Police?

We ask them to provide details like the date of the accident, name of the victim, place of accident, cause of the accident if it’s a death or injury, is FIR registered against anyone, etc. to which they provide whatever information they have. So, we take all this information and make our report, which we present in our seminars where we have people from different sections related to construction & development in India.

Q.6 Does your NGO do anything to prevent accidents?

We usually file RTI at the start of the year, so by March, we typically have all the data of accidents, then we make a report of those accidents and necessary information. Once that is done, we arrange seminars, have implementing authorities like building & other construction workers, Director Industrial Safety & Health (DISH), and invite all the stakeholders, such as the state's contract association, all developers. We also ask the police, fire safety department, and workers. Our main aim at such seminars is to make the authorities; stakeholders realize that what they are spending on workers' health & safety is not just an expenditure but an investment for society. In our possible way, we try to force government authorities to ban or file a case on the contractor, employer on whose site the accidents take place. There should be a prosecution for the detailed investigation of the accident is all that we do.

Q.7 What else do you do?

We also share our work/report with the newspaper; we do press conferences so that this data should reach maximum people. In our view, doing this makes an impact as more awareness is spread among workers, contractors, builders, and all other stakeholders. Our ultimate goal is that there should be no deaths because of a construction accident in India.

Q.8 How do you think my work will be used in India?

As I told you over the phone also, you share your work with us, and we will present that in one of our seminars in front of all the stakeholders from different divisions. I will tell you what we have realized over the years that when our work is reached to maximum people, only we see some changes taking place like some builders taking safety issues seriously, local governing bodies making strict safety rules, and severe punishment if anyone is found violating it. In your case, reaching maximum people's work would be the key, especially to the government authorities. Not all the employers will be convinced to put in assets for safety, which will bring maximum benefits for society and not for them. These are the things in the later stages. First, you complete your work form strong results; then, we can surely make it work together. I would also like to add one thing that previously, one student had done a Ph.D. in safety-related issues. Even though he had used it with us in later stages, some professors from the Indian Institutes of Technology (IIT) also have close connections. We like to work with you guys who are taking this issue seriously and want to make things change because usually, maximum people who are not related to this field will ignore it thinking how this affects them. Anyways good luck to you and share your work once it's done and when you come back to India, let us know we will meet you personally.

A.3 Interview with Candidate C

Q.1 What measures do you take to ensure safe working conditions on-site?

There are a lot of safety measures. The main actions we take are providing safety training & education to the workers, providing them PPE kits, and providing proper scaffolding, safety nets, and guard rails. Provision of scaffolding, safety nets & guardrails is the most important as most accidents occur because of falling from a height. Also, many emphases are given on safety training & education; we do that every quarter. We also provide first aid training & training to use some of the risky equipment on site.

Q.2 How much do you usually spend on safety?

Our company spends around 0.3% on the safety measures; this sounds a deficient number, but this 0.3% is of the total project cost, and even you know our company projects are so prominent in terms of size and project cost. It might change some time to 0.4% or 0.5%, but the current project I am working on is spending around 0.3%.

Q.3 How do you decide what actions you need to implement?

It's purely based on the experience in the past. In the initial days, say 2-3 decades back, anyone would hardly take any safety measures. As the accidents started increasing slowly, people at our company started realizing the need for safety. But to date, most of the companies in India don't even know the safety policies. So, as I said, based on the accidents and analyzing them, we decided what we have to do. Those guidelines were formed a few years back, and we are following that to date.

Q.4 How many accidents are likely to occur on a construction project & how many results in death?

There is no fixed number. It depends on the workers how they work and how severe your firm is about safety issues. I think around 10% of workers are likely to meet with an accident again. This is just an assumption from my personal experience, but it can't be fixed and might change from place to place and one project to another and companies to companies. Out of which 10% -12% results in death.

Q.5 After you take such safety measures, what difference do you see before and after the number of accidents?

The number of accidents is reduced. I can't tell you the actual numbers, but we can see a decrease of around 20% in the number of accidents when we compare past & present. For instance, we provide safety training & education four times a year, so workers understand the importance of safe working conditions. They realize that their employers are making efforts to improve their safety. See, it's not possible to completely get the number to zero. Still, to some extent, it is helpful, and with rapid industrialization in the future, it might come down to a more significant percentage.

Q.6 If some accidents occur at construction sites, how does that affect the company's other factors? Such as productivity, scheduling of the project, etc.

When an accident occurs on a site, the first thing that is done is giving him first aid and rushing him to the nearest hospital. In this process, the co-workers have to do the required items, the responsible site engineer; the site supervisor also tries to control the situation. When something like this happens, a lot of time is consumed in taking the required measures, so many working hours are lost during that particular day. Also, it is a normal thing that motivation among other workers is also lowered in such situations, which affects their productivity, and a decrease in productivity eventually results in delays. So, we at our company try to avoid as many accidents as we can.

Q.7 How do you compensate/help the workers injured or died due to accidents?

This is something between the worker, the worker's family & the employer. The management team usually deals with this kind of stuff. I am a technical person, so I don't have any idea about this. Not only me but also the other safety engineers, civil engineers don't know about these things. It is entirely confidential between the employer and the worker. As far as I know, as per the government norms, the amount is between INR 150,000 to INR 200,000 in case of death & INR 40,000 to INR 60,000 in case of injuries, but these are not necessarily followed. A lot of employers try to style it for a lesser amount.

Q.8 What rules or guidelines do you follow regarding the health & safety of the construction workers?

Whenever our company hires any civil engineer, electrical engineer, civil supervisor, etc., we provide them training regarding safety before starting their work. Then wearing safety shoes, a safety helmet is mandatory for anyone going to the site; even if it is an owner or director of the project, they will have to wear safety shoes and safety helmet. For workers' safety helmets, safety shoes are mandatory in all the cases, but safety gloves & safety goggles are obligatory depending upon the activities theory. Safety supervisor, safety engineers, have to make sure that every worker is wearing these safety kits. When any worker is found violating these guidelines, the engineers and contractors can take necessary actions.

Q.9 Are these rules set by the government, or does your company have its own rules & regulation regarding safety?

The government does not have any strict rules & regulations regarding safety at the construction sites in India. Sure they have some guidelines for compensation in death & injuries, but even those are not followed properly. In some of the cases, companies set up their own rules & regulations regarding safety. Still, mostly as there is no government intervention regarding safety issues on construction sites, many companies ignore it without realizing the same consequences.

Q.10 What, according to you, are the most critical factors can reduce the number of accidents & injuries on construction sites?

In my opinion, the most crucial factor is the safety training & education, where the workers will be given an idea about the risky situation they face while working on sites and knowledge to how they can avoid those situations. Many accidents occur because of workers' irresponsible acts, so they need to perform a particular activity in a trained way. Wearing a full PPE kit is another important aspect as it might reduce the impacts of accidents in any case if the accident takes place. Workers should be supervised while working, so even if someone is doing something wrong, the supervisor or safety engineer can correct them and avoid the mishap. In some cases providing first aid training can also help reduce the small injury from becoming a severe one.

Q.11 How do you think the hazards can be eliminated or substituted on construction sites?

I don't think we can eliminate it. Plus, the hazards depend on how workers behave on site. If they are adequately trained and know what to do, eventually, there will be no risks. Threats like working at height, using risky equipment cannot be stopped, and to be honest, these are not even hazards when workers work without proper safety gears; PPE, in that case, it is a problem. In all, risks can only be reduced with appropriate training & provision of PPE; these two are the most critical factors. In case, despite giving these provisions, the workers are still making any mistake, in that case, safety supervisors like us are there who can make sure nothing happens.

Q.12 How do you distinguish between the engineering safety controls & administrative safety controls? What are the responsibilities of both?

I am not sure, but I think what we call engineering controls at our company are measures like providing safety nets, scaffoldings, keeping ladders wherever required, giving access with lifts & provision of PPE. Administrative safety controls would consist of safety training & education, safety motivation & hiring safety supervision. Engineering controls can help workers while working on-site, whereas the administrative authorities prepare workers before working on sites.

Q.13 How do you think my results will be useful?

You need to know people from the government or social activists. These are the people who care for society more than most of the other employers, so if you come up with positive results, they can surely make use of it. The problem is that your work should reach them, even if they don't trust your results, they can have their highly qualified people look into your results if they are beneficial. If you have contact with bit politicians by any chance, your work will get easier.

A.4 Interview with Candidate D

Q.1 What measures do you take to ensure safe working conditions on-site?
We take the safety & health of our workers very seriously. We ensure that they are provided with all kinds of training & education, safety kit provisions, first aid training & a healthy work atmosphere on site. We also make sure other things such as safety nets, scaffolding, guardrails are provided wherever necessary. As for safety managers, we train our safety engineers, safety supervisors on what is expected from them, and contribute to making the site accident free.

Q.2 How much do you usually spend on safety?
It is not a fixed amount, which is not the case for only our company but almost all the construction companies in India. It is usually decided based upon the size and cost of the project because depending upon the height; you will hire workers to work, and then only you can choose how much you would spend on safety measures. Our company usually spent around 0.4% - 0.6% of the total project cost on safety. This is common for most of the companies that invest in security. The maximum any company would spend on safety would be 1%-1.2%. I don't think anyone would spend more than that because some projects in India are massive in project cost that even 1% would make a considerable amount.

Q.3 How do you decide what actions you need to implement?
We have a safety manual of our company, prepared by the senior safety employees based on their experience of what was needed to ensure safe working conditions. Our company is pretty old and reputed in Maharashtra, so our senior employees had formed a company's safety culture and followed since then. We make minor changes as we come across any new experience while working on sites, but otherwise, pretty much whatever is in the safety manual we follow.

Q.4 How many accidents are likely to occur on a construction project & how many results in death?
This isn't easy to answer because there is not a fixed percentage. Usually, our projects are enormous, so they last for 4-7 years, and almost around 1000-1200 workers work on us every project. It is difficult to say, but I think from what I have seen in general, it should not be more than 15%. Out of total accidents, maybe around 8%-10% are likely to die because some of the sites' accidents are brutal.

Q.5 After you take such safety measures, what difference do you see before and after the number of accidents?
It is quite evident that the number of accidents is reduced when we take safety measures. Still, in our company, the number of casualties was never too much. We took safety seriously a long time ago when other construction companies in India did not know much about the safety concepts. Yes, it is effective having proper safety measures on sites, and if I have to say it in a number, then

I would say at least in our sites all over India, the accidents have been reduced to 30% to be precise. Still, some accidents occur, but we learn from every experience and ensure that the same thing should not repeat.

Q.6 If some accidents occur at construction sites, how does that affect the company's other factors? Such as productivity, scheduling of the project, etc.

When an accident occurs, almost everyone on site is quite disturbing, like a safety engineer, safety supervisor, co-workers, etc. I will give you an example if an accident takes place in a building. The responsible engineers have to leave their work in hand and do the necessary things like first aid, taking the worker to the hospital immediately, so in that case, call the ambulance. If the engineers are not there, the co-workers will do the first necessary things, so eventually, even workers in that building will have to leave their work in hand and do the essential items required. Usually, quite a time is lost in all that procedure. In the worst-case scenario, if the worker is dead, it would affect the workers emotionally, jeopardizing their work on-site, and eventually affecting the company's scheduling. See, even if you are a civil engineer so you know we have a deadline for every activity which should be completed within the given period. So to conclude your question, yes, accidents do affect the productivity and scheduling of the project.

Q.7 How do you compensate/help the workers injured or died due to accidents?

The most we can do is give them money, which is unfortunate, to be honest. I mean somebody dies, and then you count that in terms of money, but that is the only case anyone would do at least an employer. So, we usually follow the government's norms that in case of death, INR 180,000-INR 200,000 should be given to the worker's family and in case of injury, it would be less say around INR 50,000. In some cases, the company tries to negotiate with the workers to be given less or more. Employers often give them less money knowing that helpless people would take anything they will provide them with and knowing that there is nothing they can do even if the employer offers less compensation.

Q.8 What rules or guidelines do you follow regarding the health & safety of the construction workers?

As I told you, we provide the required training, provide the necessary safety kit, and the rest of the guidelines we follow in our company safety manual. Some of the rules & guidelines are like everyone should be wearing safety shoes and a safety helmet full-time while working on-site. If someone is found without either of these or both, then no matter if workers, engineers, supervisors, or managers are punished like some amount is charged or their one-day salary is cut something like that. One more thing that is provided in our guidelines is that there should be cleaned toilets to be used by workers, so maintaining clean hygiene is also essential.

Q.9 Are these rules set by the government, or does your company have its own rules & regulation regarding safety?

In India, the government has not set any rules & regulations regarding safety on construction issues. In other developed countries, I think the government enforces strict laws regarding occupational safety, and they also make sure to inspect it correctly from time to time. Even if the government enforces such rules in India, they will not check it properly, so nothing much will change. So, we have our own rules & regulations when it comes to occupational safety.

Q.10 What, according to you, are the most critical factors that can reduce the number of accidents & injuries on construction sites?

In my view, the two most important things are safety training & education, provision of PPE, constant safety supervision are the most critical factors that would reduce the number of accidents. Apart from these sites should always be clean, there should be pepper guarding systems such as safety nets, scaffolding, etc. Safety supervision, which is the work I do, is also an essential factor that can reduce the number of accidents. First aid training should also be provided. I mean, that's what we do at our company, at least.

Q.11 How do you think my thesis will be used in India?

There are very few companies that would willingly be interested in investing in safety measures to get in touch with them and try to analyze how they started investing in it and then can use that approach with other companies. But unless there are strict laws in our country which are appropriately monitored and violators are punished, then things can change, so sharing your work with a politician or skilled government officials who are educated enough to understand your work could be helpful. If you want, you can also share your work with us, and we can see what we can do. We usually have students interning with us, so maybe some might be interested in further research with your thesis.

A.5 Interview with Candidate E

Q.1 How do you know about construction accidents in India?
Our News Paper closely works with some of the NGOs in India. These NGOs work for the welfare of construction workers. So, we get some data from them, and we try on our own.

Q.2 How do you collect the data of construction accidents?
As I said earlier, we work with NGOs, so sometimes we get help from them. We get some information through filling the Right to Information (RTI). RTI is a way by which we can demand data of accidents from the police station, and whatever construction accidents have been registered with them, they provide the information.

Q.3 Why do you collect it from the police station? I mean, I find that strange why would someone collect accident data from a police station?
In India, as per law, whenever any accident case is registered in a government hospital, that case is registered with the area police station where the hospital is situated. This one of the significant reasons in almost 75% of the case, no FIR (First Information Report) is not registered. Because companies don't take the workers to government hospitals, the issue is not registered, so it becomes necessary to collect accidents.

Q.4 What, according to you, are the cause of these accidents?
Lack of awareness among workers ranging from contractors refusing to enforce safety equipment on workers at construction sites and lack of government site inspection. You would be surprised to know that there is only one safety inspector allotted per 506 construction territories. Even civil engineers, who are the key persons to oversee construction, are not trained into safety."

Q.5 Do you see our government taking any initiatives?
To be honest, not at all. You know the situation in our country. Politicians are busy doing politics for their benefits in such cases. The last thing they will do is think about the real problems. If the politicians take some initiative, things definitely can get better; they can enforce laws regarding a particular item.

Q.6 I have already told you about my thesis work. Do you think the results can be used in India?
It isn't easy. I mean, it is tough for companies to invest in anything if they don't see a return on investment, and investing in safety policies brings them very little or no benefits at all, so safety is ignored by most of the construction companies in India. But if you come up with results that are positive from the worker's point of view, some social activists, NGO surely would make use of it. Even some politicians & government officials can use it. I mean definitely, politicians would try to make it work for their benefit, but workers will eventually also benefit. If you want, you can share your work with me; I can see if I could write something about it in our News Paper.

A.6 Interview with Candidate F

Q.1 How long have you been involved in the business? Tell me something about the company?
We started the company in 1984, in Beed district in the Indian state of Maharashtra. It was operated only in one district in the initial days, but then we started expanding in India's other communities. As of today, we work in 8-9 districts out of a total of 36 districts in Maharashtra. We operate in all construction types, such as housing, infrastructure, retail, inventory & hospitality.

Q.2 What do you do to ensure safety on your construction sites?
Personally, my brother and I are not civil engineers or architects. We are not technical people. For every project, we have safety engineers who look after the safety issues on our projects. Depending upon the size of the project, the number of safety engineers and safety supervisors varies. In most cases, we try to have a sufficient number of safety engineers and supervisors. For every two buildings on a site, there will be one safety engineer or safety supervisor.

Q.3 What kind of safety measures do you take on your construction projects?
As I mentioned before also, we have a separate safety engineer or safety supervisor. We don't give safety training or first aid training to workers. We do provide PPE's like safety helmet, safety shoes. We also make sure the site is cleaned from time to time; I mean, you visit any of our sites, and you would find it very clean because we clear the waste from time to time.

Q.4 What about the construction accidents at your projects? How often accidents take place on your sites?
Honestly, the frequency of accidents is not much. I mean, accidents do occur, but almost most of them don't result in severe injuries. Even if any accident occurs, we make sure the worker is immediately taken to the nearby hospital/clinic and provided the necessary treatment. We also take care of all the medical expenses in such cases and also offer any compensation if necessary.

Q.5 Do you have a fixed amount that you spent on the safety measures?
We don't have such a fixed amount; it depends on the project's size and valuation. Depending on how big the project is, how many workers will be working, we decide how much we have to spend on PPEs, and how much to hire safety engineers.

Q.6 Could you also tell me how many accidents (%wise) take place on your construction projects?
We never kept a record and sat and analyzed it, but as far as I remember, around 8-10% of the workers are likely to meet with an accident during the duration of the construction projects.

Q.7 How willing are you to spend more on safety measures to reduce these accidents?

I don't see our company spending much on the safety measures; currently, whatever we are spending on safety issues is sufficient. We are also getting satisfactory results with the same. Besides, our technical safety team has also never asked us to do something like this. As I said earlier, my brother and I are not technical people, so purely technical things are entirely dependent on our technical team. They mostly make such decisions they consult with us, but we usually go their way. They have been working with us for a long time, and we are delighted with their performances.

Q.8 What if I told you that investing more in safety measures can be profitable to you? Would you invest more in safety?

How is that possible? For us, we think of return on investment while investing in every project. We don't invest in a project where we feel that we won't return on investment or return on investment is too low. But as you are saying, if we think that we are getting more in return than investing, we will definitely invest in it. But as you are saying, investing in safety can be more profitable for us, I don't understand that; I don't think it will bring any return to our company.

Q.9 Could you tell me any upcoming project that your firm is working on? I mean, if you could tell me the project cost, duration of the project, the estimated number of workers, etc.?

I can't tell you the project's name, but yes, we have some upcoming projects. The biggest one is in the initial phases of planning and will be on-site in 1 year. The project's estimated cost is 600 crore (INR 6 billion), and around 850-880 workers will be working on this project.

A.7 Interview with Candidate G

Q.1 What do you think is the central issue?

Accidents are taking place, that is a big issue, but 70% of them are nowhere recorded. There is no record of these accidents with any agencies related to India's safety & health; also, the Government of India does not have the data. As the data is not published, many people are unaware of this problem, so everything is going light. That is why we at our NGO try to overcome this problem. You leave about the minor accident even if the significant accidents are not recorded. About 80-85% of the workers working in India's construction field are illiterate, uneducated & migrants, so the casualties will usually not be reported to the authorities.

Q.2 What you do at your NGO?

We provide our support to unions for construction workers worldwide, especially in the Indian states of Tamil Nadu, Gujarat, Maharashtra, etc. So, in any case, where accidents are dead or injured, we make sure that their families get compensation because, in some cases, the companies won't even give compensation, so we have to come in for the negotiation. Also, we have a connection with social activists and newspapers, thinking that the companies don't mess with us and give compensation.

Q.3 What do you think so may construction accidents take place?

Significant reasons are companies' inefficiency in investing in safety measures, lack of rules, government regulation, and workers' illiteracy. Companies should at least invest in safety kit, safety supervision & should train their workers because most of the workers are illiterate. Now, if you see all these three issues are slightly interconnected. Companies know that workers are not educated enough to understand the importance of safety, so they don't even ask for it, so they take advantage of that. There are no laws about safety implementation, so that makes employers' position strong in not providing any safety measures. Plus, in India, you know things can be managed efficiently, so even if once in a blue moon some government inspector comes from the government to inspect the site can be easily bribed and turned into the company's favor. So basically, there is no fear in employers as there are no strict rules and knowing that workers will not do anything, so they play around like this. You are a civil engineer yourself; you also have worked in the industry; you must know how things work. Apart from this, basic things like safety helmet, safety belt, safety nets are also missing. That is the reason falling from height is a significant issue of accidents.

Q.4 how do you think my thesis can be used?

I would say your thesis is a good subject. The main reason that companies & contractors are not investing in safety measures is that they know if somebody dies or gets injured, it can be settled for a little compensation as human life is very cheap in India. Workers are also organized, not educated, so in cases of accidents, they will be paid a total sum like INR 100,000 to INR 200,000.

See, to be honest, I think cost-benefit would not make any use from the employer's point of view to invest in safety measures because there is no return. Unfortunately, there is not much pressure on the construction industry. In some other sectors, if safety issues come up and then, there is media attention. Hence, the industry responds in a particular way, and of course, one such way is investing in safety as no human life should be lost like this. So, if you could in any way provide your work to media people and if they feel that it's excellent research and indeed benefit from the worker's point of view, surely it can help you further. I would also be pleased to share your work with us; we can surely use it, so please do share your thesis with us once it is completed.

A.8 Interview with Candidate H

Q.1 What measures do you take to ensure safe working conditions on-site?

The first and foremost important factor we focus on is safety training and education. For our company, that is the most important thing; it is not only for workers but also for all the company employees. Apart from that, we provide all kinds of safety equipment to workers and employees. We provide all engineering controls like providing scaffolding, safety nets, lifts, ladders wherever required, etc.

Q.2 How much does your company usually spend on safety?

It varies from project to project depending upon workers that will be employed. This kind of project also plays an important role. I can tell you the exact numbers, but it is around 1% of the total project cost, which is generous to provide all the required safety equipment, training for all the workers at different times in a year, first aid all such things are covered in safety investment cost.

Q.3 How do you decide what actions you need to implement?

We have a separate safety department that even before the projects start to decide what kind of safety measures we need to implement for this particular project. Depending on the type of project, it is determined how much resources we need. Our company had established a separate safety department a few years back. Since then, getting different experiences to ensure safety on sites, our department has learned a lot about what to do and what not.

Q.4 How many accidents are likely to occur on a construction project & how many results in death?

See, no one can tell you the exact number because it is impossible to predict the actual number precisely. I can only tell you a probable range, which is 8%-10% in general. Our company is usually less around 7%, but again these changes from project to project because, in a few tasks, work is a bit different and more dangerous than some other projects. As far as my experience is considered, it would not go beyond 20% if that is the case, then the responsible company needs to consider some serious issues. I will give you an example if 100 accidents are taking place, around 7-8 workers are likely to die.

Q.5 After you take such safety measures, what difference do you see before and after the number of accidents?

When you take safety issues seriously and properly implement safety measures, the accident can be reduced. It is impossible to bring it down to zero but reducing it by 20% is still possible. Suppose I have to tell them about the accident that has taken place on our projects. We see a declining trend in the accidents because every year, we add something new to our safety policies, and we learn from our mistakes, making sure that it won't be repeated.

Q.6 If some accidents occur at construction sites, how does that affect the company's other factors? Such as productivity, scheduling of the project, etc.

When anyone meets with an accident, anyone gives him a first-aid and takes that work to the hospital. In that process, a lot of time is gone, plus also other workers leave their employment and get into this, so yes, there is a loss of working hours, which is quite understandable as providing treatment in case of an accident is the first thing that should be done. This is wrong to compare these two things, but when we think from a business point of view, productivity is affected, and time is lost, which is the reason for the project's delay. This delay can cost a considerable amount to the employer as all the activities are related to the civil field. Even if one activity is delayed, it will wait for further all activities.

Q.7 How do you compensate/help the workers injured or died due to accidents?

I can't tell you much about this as this is not a part of the safety manager's job. There is a different department in our company to handle such issues, so it is purely between them and the victim or the victim's family. I think the compensation would be around INR 250,000. I am sorry I know only this much, so I can't tell you in detail about this.

Q.8 What, according to you, are the most critical factors which can reduce the number of accidents & injuries on construction sites?

Proper training & education is a must or is the first thing you would do on the site. When workers are trained enough, they can understand what activity involves dangers and can be more preventive while doing that work. Safety supervisors, safety engineers, and safety managers like us play an essential role. We keep monitoring that everything is performed safely. In some cases giving proper first aid can also make a difference. And last but not least, the provision of safety kits.

Q.9 How do you think my results can be used in India?

You will have to try hard because convincing people to invest is a tough job. I can only say that reaching more and more people only helps you somehow, so maybe try doing that. In some instances, government officials and politicians can do something with the results.

Appendix B: Calculations & Explanation

❖ Money Spent on Safety Policies

As mentioned in the reference case, 0.6% of the total project cost will be spent on safety policies. It was assumed to be 0.6% because of the information received through interviews. In the interviews, I asked some interviewees (CCC, DDD, III) how much their companies & other construction companies in India spent on safety measures. They said in huge companies; it might range between 0.3% to 1%, which is why it is assumed to be 0.6% in this research.

= 0.6% of INR 6 billion

= 6/100 * INR 6 billion

= INR 36 million

So in a big project like this, which is being carried out by a big company in India, they would spend INR 36 million on safety. This amount would be spent on measures like providing them safety training & education, providing them PPE, hiring people to monitor security, other engineering safety measures such as giving scaffolding, safety nets, safety guard rails, etc.

❖ Estimated Number of Accidents

During the interviews, the interviewees were asked about the % of workers likely to meet with accidents throughout the project's construction work. Based on their experience working in this field and the statistics they had for their companies and other companies, they said the rate could vary anywhere between 11% to 16%. For this research, I decided to assume the rate of accidents around 12% throughout the project. So as per the assumption

= 12/100 * 850

= 102

This means out of 850 workers, 102 workers are likely to meet with an accident over five years until the construction is completed.

❖ Probable Number of Deaths & Injuries

During the interviews, interviewees were also asked about the deaths & injuries among the accidents. They were asked on an average how many accidents resulted in the deaths of workers & in how many cases the workers were injured. They said that it is not fixed, but they said the deaths could result in 12% - 16% of the total accidents and rest into injuries from their statistics.

For this research, it was assumed that out of 102 accidents, 14% would result in workers' deaths & 86% into injuries.

= 14% of 102

= 14/100 * 102

= 14.28 = 14

= 102 - 14

= 88

This indicates 14 workers can lose their lives & 88 workers might get injured during the project's construction.

❖ Reduction in Number of Accidents (Effectiveness of Safety Policies)

In the interviews, interviewees were asked about the efficiency of the safety measures. They were asked to what extent these safety policies can reduce the accidents on the project. According to them, with the implementation of all safety policies, accidents can be reduced to 20%-30%. For this research, it was assumed that safety policies could reduce accidents by 25%.

= 25% * 14

= 25/100 * 14

= 3.5 = 4

Four deaths could be avoided over five years with the implementation of safety measures, which means 0.8 life per year would be saved.

= 25% * 88

= 25/100 * 88

= 22

Twenty-two workers could be saved from getting injured throughout the five-year duration of the project, so per year, 4.4 workers could be saved from getting hurt.

❖ Value of Statistical Life

The value of statistical life is INR 14 million in India. This was assumed based on the work done by Majumder et al. (2018) & Madheswaran et al. (2018). They found the value of statistical life, considering the Indian labor market. Benefits over VSL will be regarded when implementing safety policies to reduce the number of deaths by four throughout the project duration. Still, the benefits and costs will be discounted each year, so we have to consider 0.8, which is the number of workers saved each year.

= 0.8 live will be saved

So, benefit over VSL = 0.8 * 14,000,000

= 11,200,000

Benefits over the Value of Statistical Life is INR 11,200,000/Year.

❖ Value of Statistical Injury

The value of statistical injury is INR 1,670,000 in India. This was assumed based on the work done by Majumder et al. (2018) & Madheswaran et al. (2018). They found the value of the statistical injury, considering the Indian labor market. Benefits over VSI will be regarded as when implementing safety policies will reduce the injuries by 22 throughout the project duration, but the benefits and costs will be discounted each year, so we have to consider 4.4, which is the number of workers saved from getting injured each year.

= 4.4 workers won't be injured/year

So, benefits over VSI = 4.4 * 1,670,000

= 7,348,000

Benefits over Value of Statistical Injury is INR 7,348,000/Year.

❖ Medical Benefits

These are the costs that construction companies, contractors & developers will be saving with each accident avoided, so eventually this will be profitable for them. In India, there is no compulsion on insurance, so the government does not pay for the medical expenses. When any worker is injured and is taken to the hospital, its consulting charges are paid. The average consulting costs in India for such accident cases are INR 12,000, so that is how the company will be saving those in 26 instances as a total of 26 accidents would be reduced over five years with the implementation of safety policies so per year, 5.2 workers won't be admitted to the hospital.

= 5.2 * 12000

= 62,400

So, the medical benefits for them would be INR 62,400/Year.

❖ Transactional Benefits (Employee)

These are the costs paid to the employees to handle the administration work like compensation & hiring new people in case of workers die. When a fewer number of workers are killed or injured, there will be less work, so at least one such employee can do some other work, and eventually, the salary given to that one employee will be saved. On average, this person would earn around INR 25,000 per month, so for the CBA, it will be calculated for a whole year. The per year salary saved for that one employee will be the benefit.

= 12 * 25000

= 300,000

= So, the transactional benefits would be INR 300,000/Year.

❖ Transactional Benefits (Workers)

These are the costs that construction companies, contractors & developers will be saving with each accident avoided, so eventually this will be profitable for them. When workers are injured, they can't work for some time, and in such cases, the company has to hire new workers as the construction can not be stopped, and new workers are needed so that the project schedules are not affected. The average monthly wage for a worker is INR 18,000, which will be saved by the company in 26 instances as 26 accidents would be avoided throughout the duration, which means per year, 5.2 accidents would be avoided. Those 5.2 workers will have to be paid per month.

= 5.2 * 12* 18000

= 1,123,200

So, the benefits over the avoidance of hiring are INR 1,123,200/year.

❖ Benefits Over Death Compensation

When any worker dies while working on the construction sites, the company has to compensate INR 180,000; this is decided by India's government. In most cases, after a worker dies, a negotiation occurs between the worker's company and family, and then a compensation amount is

decided. It is tough to know the compensation in that case, so for this research, the compensation amount in case of death is considered the same as decided by the government. As four deaths would be avoided, the company won't have to pay money in those 4 cases, which would benefit the company. Per year 0.8, worker death would be avoided.

= 0.8 * 180,000

= 144,000

So, benefits over avoided death compensation are INR 144,000/Year.

❖ Benefits Over Injury Compensation

When any worker gets injured while working on the site, the company has to compensate INR 50,000; again, this is the same amount decided by the government. In most cases, after a worker is injured, a negotiation occurs between the company and worker, and then a compensation amount is decided. It is tough to know the compensation in that case, so for this research, the compensation amount in case of injury is considered the same as decided by the government. As 22 workers would be saved from getting injured, the company won't have to pay money in those 22 cases for 5 years, and so per year, it would be 4.4, which would benefit the company.

= 4.4 * 50,000

= 220,000

So, benefits over avoided injury compensation are INR 220,000/Year.

❖ Discount Rate

The discount rate is considered to be 4.5% for this case. This is based on the study conducted by Majumder et al. (2018) & Madheswaran et al. (2018). According to both of them, India's discount rate is usually between 2.5% - 5%. For this research, the discount rate is taken at 4.5%, which is similar to the discount rate used for conducting a CBA for a dam project India a few years back.
The formula to calculate the discount factor is 1/(1+i)^n,
Where,
i= discount rate
n= year in which benefits are discounted

For year 1,

Discount factor = 1/(1+4.5%)^1

= 1/(1+0.045)^1

= 0.957

Discount Factor for Year 1 = 0.957

For Year 2,

Discount factor = 1/(1+4.5%)^2

= 1/(1+0.045)^2

= 0.916

Discount Factor for Year 2 = 0.916

For Year 3,

Discount factor = 1/(1+4.5%)^3

= 1/(1+0.045)^3

= 0.876

Discount Factor for Year 3 = 0.876

For Year 4,

Discount factor = 1/(1+4.5%)^4

= 1/(1+0.045)^4

= 0.839

Discount Factor for Year 4 = 0.839

For Year 5,

Discount factor = 1/(1+4.5%)^5

= 1/(1+0.045)^5

= 0.802

Discount Factor for Year 5 = 0.802

Appendix C: Sensitivity Analysis Calculation

C.1 Calculation & Explanation for Factors Used in Sensitivity Analysis from a Societal Perspective

❖ Safety Cost Investment

The nominal (original/actual) safety investment cost was 7,200,000/year. Two assumptions were made if the safety cost decreases by 20% & increases by 20%.

- If safety cost decreases by 20% per year,

= 0.8 * 7,200,000

= 5,760,000

So, when the safety cost is decreased by 20%, the company will invest INR 5,760,00/Year.

- If safety cost increases by 20% per year

= 1.2 * 7,200,000

= 8,640,000

So, when the safety cost is increased by 20%, the company will invest INR 8,640,000/Year.

❖ Value of Statistical Life

The nominal (actual/original) VSL was INR 14,000,000. Two assumptions were made if the VSL decreases by 20% & increases by 20%.

- If VSL decreases by 20% per year,

= 0.8 * 14,000,000

= 11,200,000

So, when VSL is decreased by 20%, it will be INR 11,200,000/Life.

- If VSL increases by 20% per year,

= 1.2 * 14,000,000

= 16,800,000

So, when VSL is decreased by 20%, it will be INR 16,800,000/Life.

❖ Value of Statistical Injury

The nominal (original/actual) VSI was INR 1,670,000. Two assumptions were made if the VSI decreases by 20% & increases by 20%.

- If VSI decreases by 20% per year,

= 0.8 * 1,670,000

= 1,336,000

So, when VSL is decreased by 20%, it will be INR 1,336,000/Injury.

- If VSI increases by 20% per year,

= 1.2 * 1,670,000

= 2,004,000

So, when VSL is decreased by 20%, it will be INR 2,004,000/Injury.

❖ Reduction in Number of Accidents (Effectiveness of Safety Policies)

The nominal (original/actual) effectiveness of safety policies was 25%, which means the deaths & injuries will be reduced by 25%. Two assumptions were made if the effectiveness of safety policies decreases by 20% & increases by 20%.

- If the effectiveness of safety policies decreases by 20%,

= 0.8 * 25%

= 20%

When the effectiveness of safety policies is decreased by 20%, then as per new effectiveness, 20% of the deaths & injuries will be reduced.

20% * 14

= 20/100 * 14

= 2.8 = 3

Three deaths could be avoided over five years with the implementation of safety measures, which means per year, 0.6 life would be saved.

= 20% * 88

= 20/100 * 88

= 17.6 = 18

Eighteen workers could be saved from getting injured throughout the project's five-year duration, so per year, 3.6 workers could be saved from getting hurt.

- If the effectiveness of safety policies increases by 20%,

= 1.2 * 25%

= 30%

So, when the effectiveness of safety policies is increased by 20%, then as per new effectiveness, 30% of the deaths & injuries will be reduced.

= 30% * 14

= 30/100 * 14

= 4.2 = 5

Five deaths could be avoided over five years with the implementation of safety measures, which means one life would be saved per year.

= 30% * 88

= 30/100 * 88

= 26.4 = 27

Twenty-seven workers could be saved from getting injured throughout the project's five-year duration, so per year, 5.4 workers could be saved from getting hurt.

C.2 Calculation & Explanation for Factors Used in Sensitivity Analysis from Employers Financial Perspective

❖ Safety Cost Investment

The nominal (original/actual) safety investment cost was 7,200,000/year. Two assumptions were made if the safety cost decreases by 20% & increases by 20%.

- If safety cost decreases by 20% per year,

= 0.8 * 7,200,000

= 5,760,000

So, when the safety cost is decreased by 20%, the company will invest INR 5,760,00/Year.

- If safety cost increases by 20% per year

= 1.2 * 7,200,000

= 8,640,000

So, when the safety cost is increased by 20%, the company will invest INR 8,640,000/Year.

❖ Compensation in Case of Death

The nominal (original/actual) compensation expense in case of death was 180,000/year. Two assumptions were made if the compensation expense decreases by 20% & increases by 20%.

- If compensation cost decreases by 20% per year,

= 0.8 * 180,000

= 144,000

So, when the compensation cost for death decreases by 20%, the company will pay INR 144,000/Death.

- If compensation cost increases by 20% per year

= 1.2 * 180,000

= 216,000

So, when the compensation cost for death increases by 20%, the company will pay INR 216,000/Year.

❖ Compensation in Case of Injury

The nominal (original/actual) compensation expense in case of injury was 50,000/year. Two assumptions were made if the compensation expense decreases by 20% & increases by 20%.

- If compensation cost decreases by 20% per year,

= 0.8 * 50,000

= 40,000

When the compensation cost for injury is decreased by 20%, the company will pay INR 40,000/Injury.

- If compensation cost increases by 20% per year

= 1.2 * 50,000

= 60,000

So, when the compensation cost for injury increases by 20%, the company will pay INR 60,000/Year.

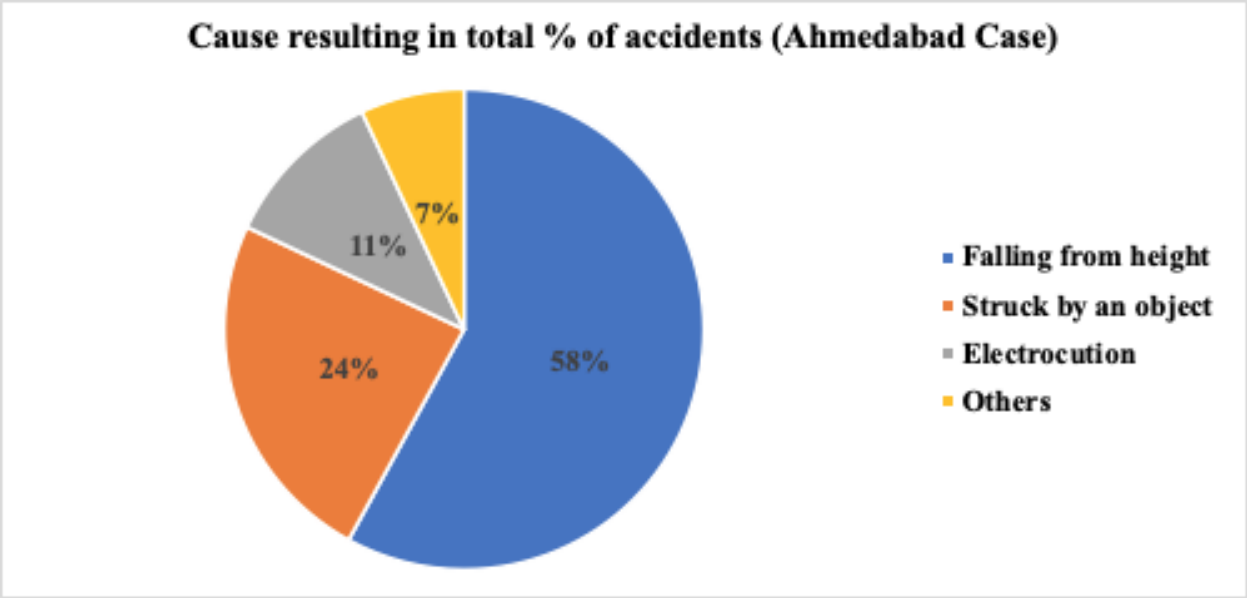
Appendix D: Accident Causes & Preventive Measures

This Appendix chapter will present a sample data of accidents, significant causes of accidents, and prevention to reduce those causes. Later it will explain in detail the causes of the sample accidents and preventive measures for them. The data was collected from an NGO operating in India. The information was not used for the actual analysis; it gave insight into the number of accidents in a city, their causes, and an overall idea about how accidents are recorded, collected & published in Indian cities. The data was collected from 2008-2018 for Ahmedabad city in the Indian state of Gujarat. Table A1 shows the number of total accidents per year, the number of deaths & the number of workers injured. Figure A1 gives the causes of accidents for the following sample data.

***Table D 1**: Data of Accidents for Ahmedabad City (2008-2018)*

Year	Death	Injury	Total
2008	90	92	182
2009	92	68	160
2010	109	84	193
2011	100	79	179
2012	120	12	132
2013	89	15	104
2014	69	11	80
2015	62	18	80
2016	55	4	59
2017	67	25	92
2018	137	7	144
Total	990	415	1405

***Figure D 1**: Causes of Accidents in %*



D.1 Reliability of Data

In India, the records of construction accidents are not recorded and hence are not readily available. Only 20-25% of the time, accidents are reported (Rajiv et al., 2019). The NGO collected this data from the police station. In India, when any accident case is registered in a government hospital, it eventually becomes a police case, and the FIR (First Information Report) is written with them. So this NGO collected the data from the police, and according to the NGO, only 20% of the construction accidents are registered within the Police Station. In most cases, companies don't take the workers to government hospitals as a police case will be recorded, and it would damage the reputation of the company. As only in a few instances, the accidents are reported, so there is a lack of records of construction accidents. This data was only used to find the causes so that accordingly, prevention measures could be taken. It is also difficult to see a particular pattern from the data. The number of injuries in some years against the number of deaths is minimal. It is not because the data is wrong, but because only in those small cases, the accident was reported. But if we see the number of deaths for a decade, it is almost 1000 when only 20-25% of the accidents are registered, and this is only for one city (district) in India. Similarly, 738 other districts are there in India except for the small towns. So from this, we can imagine the accidents that take place on construction projects in India.

D.2 Accident Causes & Prevention

In this part, we will discuss the three major causes of accidents as per the data I received from the NGO. The three major causes of accidents are falling from height, electrocution & struck by an object, which is explained below, along with the preventive measures that can reduce these causes of construction accidents.

D.2.1 Falling From Height

Most noteworthy mishaps happen because of working at height. Accidents happen while performing an activity at peak due to ill-advised utilization of stepping stools, inappropriate scaffolding & carelessness on the safety rules (OSHA, 2015). Installation of imperfect stepping stools or inadequate facilities of stepping stools should not be allowed on the site. While working at the height, mishaps happen because of the breakdown of scaffoldings, falling from scaffoldings or fall of material, or scaffolding objects. Inappropriate safety harness, absence of certainty while working at height can cause mishaps. Along with the workers working at height, the bystanders could also be in danger due to carelessness (Chheda et al., 2017). Scaffolding is considered as one of the riskiest occupations in construction because of the height associated with it. The significant purpose behind risk in scaffolds is its inappropriate erection. Falls from a height are the most widely recognized scaffold risk. Wounds related to scaffolds increase the possibility of being hit with falling items or waste. Power is another significant hazard in platform related functions as electrical lines are generally raised, making the worker use a scaffold inclined to contact those electric lines (Benny & Jaishree, 2017). Stepping stool mishaps or stepping stool falls among the most concerning safety issues in construction & development sites. Falling from a height of more than one meter is more hazardous. Ladder mishaps happen more when the worker ascends the ladder/stepping stool with his apparatus on the other hand. The ground on which the stepping stool is set ought to be unbending, and the stepping stool falls flat at the point when it is set on a precarious item like concrete block, bricks, and so on.

D.2.2 Prevention for Falling From Height

This part will focus on different measures to reduce the danger of falling from height while working on construction sites. Mostly the preventions have been selected as per the OSHA guidelines for construction work.

❖ Conduct a Fall Risk Assessment

Comprehending what can promptly add to a fall can help in addressing the hazard. Working close to unguarded edges, lacking safe access, or walking on slippery, dangerous, or uneven surfaces are typical examples. A fall risk evaluation significantly distinguishes and assesses these physical fall risks (OSHA, 2011). The following factors should be considered in the assessment process

- Figure out which explicit site activities, exercises, or regions open workers to fall risks
- Decide the sort of work performed

- Decide whether workers will be exposed to any of the accompanying
  1. Unprotected sides and edges
  2. Leading edges
  3. Floor gaps
  4. Wall openings and lifting zones
  5. Slippery surfaces
  6. Ramps, runways, and different walkways
  7. Portable stepping stools and flights of stairs
  8. Working with gears at height
  9. Obstructions (materials)
  10. Working overhead and related work
  11. Roof work
  12. Aerial lifts
  13. Scaffolds
- Decide whether laborers require horizontal as well as vertical movement while working
- Decide the number of laborers presented to a fall risk
- Decide the kind of walking/working surface
- Decide the separation to floor level

The individual leading the fall risk evaluation ought to have relevant experience and significant involvement with requests to perceive and assess all fall risks. Besides, this individual should likewise have on-site practical information and comprehension of fall assurance necessities and other related fall security techniques. A safety engineer would be the right person to carry out such an assessment. An able individual is somebody fit for finding existing and predictable risks in the environmental factors or working conditions that are dangerous or risky to workers and has the authority to take brief restorative measures to dispose of them (OSHA, 2011). Including site supervisors in the fall hazard evaluation is basic. They can give important data about where and when fall prevention is fundamental and thoughts to forestall fall risks, perhaps or better. Getting their information will likewise urge workers to take possession. If the fall risk evaluation demonstrates the requirement for fall prevention, the subsequent stage is to decide whether the fall hazards can be disposed of through designing controls or potentially alternate work techniques.

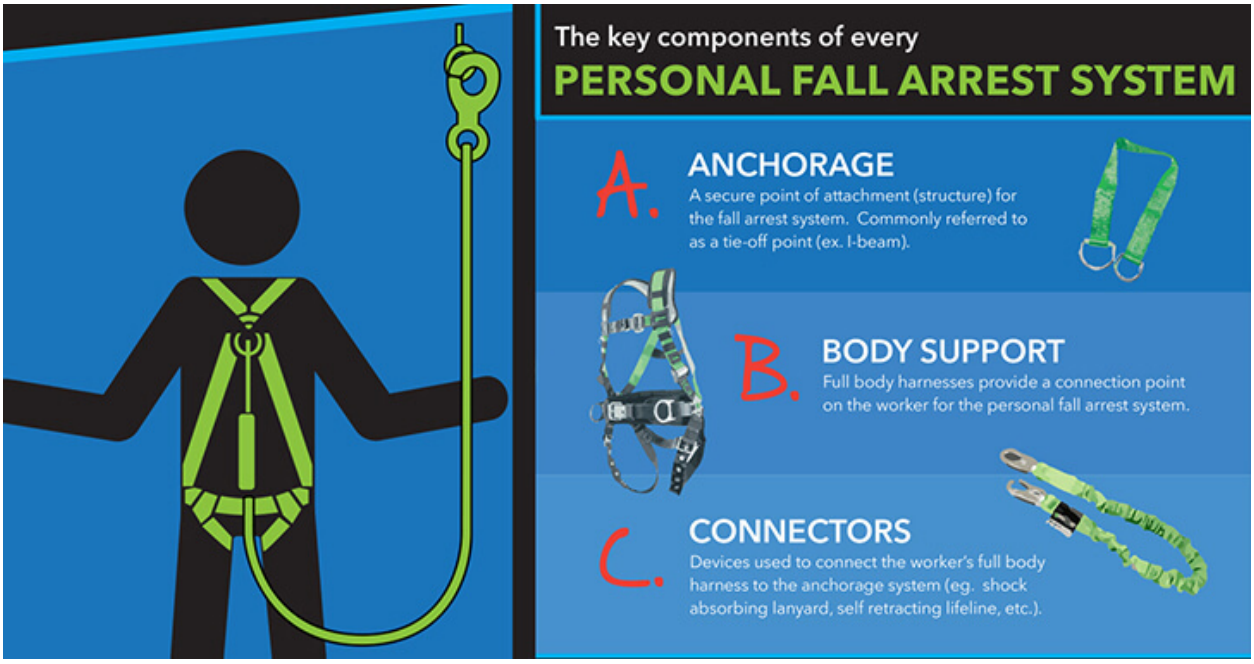
❖ Provision of Fall Prevention Systems and Methods

A fall prevention system alludes to equipment & gear intended to control fall hazards. All fall-prevention systems either prevent falls from happening or securely capture a fall. The typical fall prevention system consists of the following. OSHA has recommended these fall prevention systems for safe practices on construction sites. Additionally, I am a civil engineer; I have worked for a year on construction sites, so as per my training, I know the necessary measures to be provided to prevent a fall from height.

- Personal Fall Arrest System

It comprises a stay, connectors, and a full-body harness that cooperate to prevent one from falling and to limit the arrest power. It also includes anchorage, body support, connectors & rescue or descent. Be that as it may, the individual fall-capture system is successful just on the off chance that workers know how the entirety of the segments works together to capture the fall. A personal fall arrest system is one alternative assurance that OSHA requires laborers on building locales presented to vertical drops of 6 feet or more (OSHA, 2011). Photo D1 shows the typical all arrest system.

***Photo D 1**: Personal Fall Arrest System*



- Guardrail System

Guardrail systems are vertical obstructions consisting of top rails, mid-rails, and halfway vertical members. Guardrail systems can likewise be joined with toe-sheets, which are boundaries that stop workers from falling to lower levels. As per OSHA norms, the typical height of guardrail on the construction site should be 1.2 meters. Photo D2 below shows a standard barrier on a construction site.

***Photo D 2**: Typical Guardrail on Construction Site*

- Safety Nets

Safety net systems consist of work nets, boards, and interfacing parts. They are ordinarily utilized to prevent individuals who work 25 feet above the ground (OSHA, 2011). By introducing safety nets under an elevated level work area, there is less probability that the workers will be harmed on the off chance that they fall. Safety nets installed under a significant level of work territory lessen the distance that workers can lose. They reduce the fall's effect and give a 'delicate landing' to reduce an individual's probability of being harmed. As per OSHA, companies & contractors should also consider the following points.

- Try not to utilize short nets. Examine nets in any event once every week for wear, harm, or decay of segments, such as network connection points.
- Expel materials, instruments, also different things at the earliest opportunity from the net and in any event before the following work shift starts
- All mesh intersections must be made sure about to keep the openings from augmenting.
- Use a safety net (or area of the net) with a fringe rope having a base breaking quality of 5,000 pounds.

Photo D3 below shows how a safety net should be used on a construction site, covering all the openings, so workers' chances of falling are reduced. Still, someone falls, safety nets can easily protect the workers from getting injured.

***Photo D 3**: Safety Nets on a Construction Site*

- Proper Scaffolding

The most well-known method of giving a stage to work at height is scaffolding. As per the guidelines of OSHA (2011). Potential risks related with the scaffolding works are:

Fall of a person: Workers working on a scaffolding platform may fall & get seriously injured at a height.

Fall of Material: Material/tools or other things might slip & fall from workers' hands while working on a platform & workers working below them can get injured. This is mostly the case when workers are plastering or painting the external walls.

OSHA provides measures to avoid these issues:

- Guard rails should be fitted to the scaffolding & should be made sure to forestall their outward movement.
- The scaffolding should be sufficiently able to bear the heaps of laborers and materials.
- The ground level should be checked for immovability and if essential baseplates should be utilized for appropriate support.
- Workers should not be permitted to work under the scaffoldings if it is necessary to complete work; at that point, safety nets should be given to capturing the fall of materials and devices.

- Scaffolding should be secured by connecting it to the permanent building structure at specific points to avoid scaffolding movements.
- Scaffolding should not be over stacked with overabundance labor or materials.
- Working of cranes, vehicles & substantial hardware/equipment close to the scaffolding should not be permitted without oversight.

***Photo D 4**: Wrong Practice in the absence of Scaffolding*

Non-availability of access to higher elevation, compel workers to use wrong practices

***Photo D 5**: Right Practice with Scaffolding*

Wide and secured platform while working at height along with proper PPEs ensures safe working condition

D.2.3 Electrocution

Electric shock is deadly; it intends to slaughter with power—electric shock results when a human is presented to a fatal electrical vitality measure. Electrocution occurs when a worker/employee is exposed to a deadly electrical vitality (OSHA, 2011). An electrical danger can be characterized as a genuine working environment risk that opens laborers to burns, shock, fire, explosion, & arc blast.

Types of Electrocution Hazard in Construction

❖ Contact With Electric Lines

Overhead and covered electrical cables are particularly dangerous as they convey incredibly high voltage. Fatalities are conceivable as an electric shock is the principle chance; however, burns and falls from rises are also risks that laborers are presented to while working in high voltage electrical cables (OSHA, 2011). Laborers may not understand that cranes are all accounts, not the only equipment that arrives at overhead electrical wires. Chipping away at a stepping stool or in a man-basket suspended under or close to electrical cables likewise represents a danger of electric shock. The covering on an overhead electrical line is basically for climate security; accordingly, laborers

need to realize that on the off chance that they contact an electrical cable, secured or exposed, there are possible chances of death.

❖ Contact With Energized Sources

The significant risks in regards to contact with energized sources are electrical shocks & burns. Electrical shock happens when the body ends up being connected with the electric circuit, either when an individual interacts with the two wires of an electrical circuit, one wire of an enabled course and the ground, or a metallic part that becomes empowered by contact with an electrical transport. An electrical shock's effects rely upon different factors, such as the pathway through the body, the proportion of current, the exposure's timing, and whether the skin is wet or dry. Water is an unbelievable electric force channel, allowing momentum to stream even more adequately in wet conditions and through wet skin (OSHA, 2011).

D.2.4 Protection from Electrocution

OSHA (2011) suggests three ways in which electrocution dangers can be avoided on construction sites. These three measures are explained below.

❖ Ensure Overhead Electric Safety

Overhead electrical wires must be de-energized and grounded by the organization or manager of the electric cables, or other cautious evaluations must be given before work is started, for instance, PPE kits, ensuring gloves, hoods, sleeves, tangling, covers, line hose, and mechanical guarded head defenders. Defensive measures, such as protecting or securing the wires, must be proposed to avoid contact with the electric power lines. Companies should prepare laborers in regards to control line dangers and about the free defensive measures. Laborers should be thoroughly educated about what activities may have electrical hazards and how they will manage the risks. Likewise, laborers should be reminded that they must consistently pose inquiries if they have any questions about keeping up safe working conditions (OSHA, 2011).

❖ Ensure Power Tools are Maintained in Safe Condition

The companies & contractors, and most importantly, electrical engineers need to ensure that all power apparatuses are maintained in a safe condition to:

- Ground power supply systems, electrical circuits, and electrical equipment
- Frequently inspect electrical systems to ensure the path to ground is continuous
- Ensure workers understand to inspect electrical equipment before use
- Ensure ground prongs are not removed from tools or extension cords

❖ Ensure Appropriate Guarding

The companies should take care of the following things,

- Guarding incorporates finding or encasing electrical equipment/gears to ensure workers don't coincidentally get exposed to its parts.
- Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where they are accessible only to authorized people qualified to work with/on the equipment.

D.2.5 Struck by an Object

As per the data collected, this is the third major cause of the accidents. Struck-by wounds are delivered by persuasive contact or sway between the harmed individual and an object or piece of hardware equipment/gear. It is imperative to call attention to that in construction & development, struck-by risks can look like trapped in or – between risks (Bhole, 2016). Struck by an object is mainly divided into two categories, as explained below.

❖ Struck-by Flying Item

Flying item risk exists when something has been tossed, heaved, or is being moved across space. It can incorporate occurrences when a bit of material isolates from an apparatus, machine, or other hardware, striking a laborer, bringing about wounds or casualty (Smita, 2016). Additionally, a danger exists if an item is launched out under power by an apparatus or hardware typically intended for that reason, for example, a nail from a nailer: The nail is impelled from the gun forcibly, it is released. This power can be either pneumatic or powder-impelled (OSHA, 2011). Powder-impelled instruments are especially dangerous due to the ability behind the clasp. These latches are intended to insert through the wood, cement, and steel, and they can unquestionably go through workers. Utilizing compressed air can likewise cause flying article risks. Compressed air is typically used to control instruments and clean surfaces.

❖ Struck-by Swinging Items

At the point when materials are precisely lifted, they have the potential to swing and strike laborers. As the heap is raised, the materials may swing, divert & turn. This action can get laborers by surprise & the swinging burden could hit them (Bhole, 2016). Breezy conditions are particularly risky because the heap will swing more. They are based upon where the laborer is standing and the power behind the stack, the laborer may fall to another level in the wake of being struck and continue even more apparent wounds (Smita et al., 2016). Notwithstanding swinging, the heap can slip from their apparatuses (Riggings) and strike laborers. Loads must be fixed appropriately to forestall slippage. At the point when the injury has alluded to objects which are not free, they are joined at a few moments or are being held by the laborer. This incorporates occurrences where a pivot-like movement withdraws, making a swinging movement where the laborer is struck-by a hammering or swinging motion.

D.2.6 Prevention from Struck by an Object

Bhole et al., 2016 suggested some preventive actions to avoid getting hit by an object

- Inspecting equipment connections, checking pressure gauges, using proper lubrication, and replacing defective gears
- Use appropriate personal protective equipment (PPE)
- Use right toe boards, identifying and barricading the areas below work zones, and requiring PPE if someone wants to enter that area
- Providing training to new workers in the drill rig and other activities and where to stand safely.
- Protect workers from entering the site by barricading the swing radius of cranes and excavators.
- Protect workers on the ground by instructing equipment (Crane & excavators) operators to be aware of workers working around the equipment.
- Workers on the ground should stay alert and be mindful of equipment moving nearby.

D.3 Personal Protective Equipment

Apart from all these measures, providing PPE is one of the essential safety policies which can play a crucial role in avoiding accidents. The PPE's effectiveness is already explained in chapter 4; here, we will only discuss the different PPE provided to workers. PPEs such as safety helmets, safety shoes, safety gloves & safety goggles. The uses of all these have been explained based on a report of OSHA (2004) on the importance of PPE on construction sites.

D.3.1 Safety Helmets

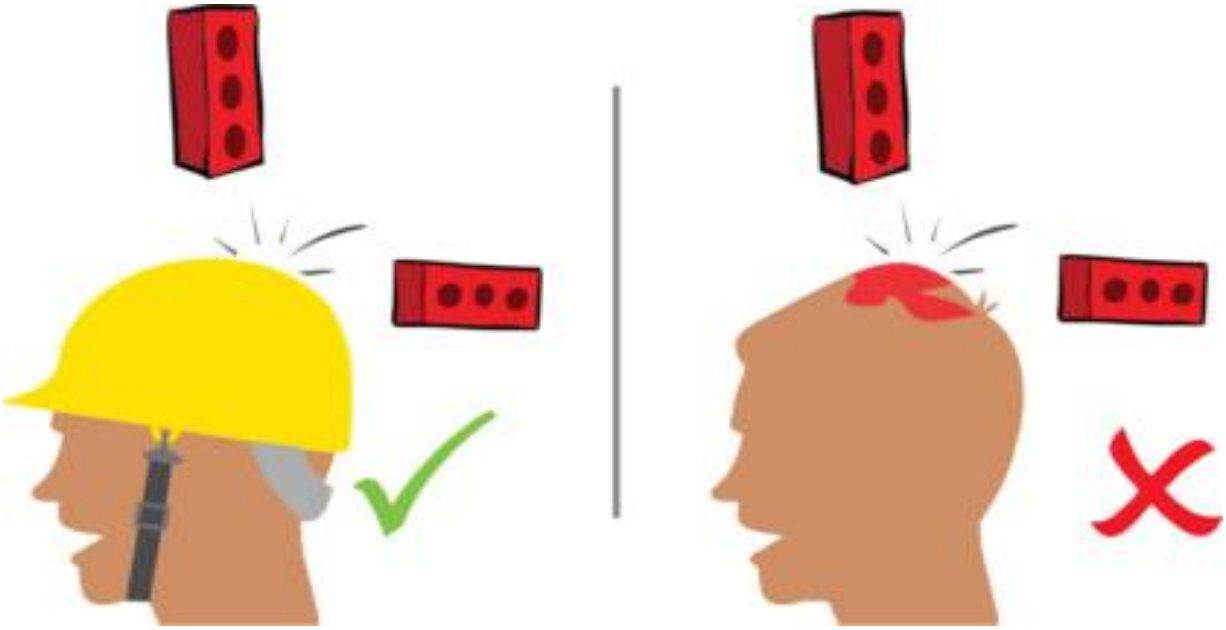
Safety helmets are used to protect workers, employees from the injury happening because of falling or flying objects, striking against some fixed items, saving the head from getting severely injured in case of a fall (OSHA, 2004). Safety helmets mainly help in the following situations:

❖ Protection From Falling Objects

- Falling items, overhead loads & sharp object projections are usually found on multiple construction sites.
- A little device or nut/bolt falling from some height can cause genuine wounds or even demise on the off chance that it strikes an unprotected head, so wearing a safety helmet can avoid this to a certain extent.
- Head wounds frequently happen when moving and working in a twisted position, or while emerging from such a situation. Having a safety helmet will avoid this no matter what place or where the workers work on a construction site.

Photo D6 shows how wearing a safety helmet could be helpful for head protection.

***Photo D 6**: Safety Helmet for Protection from Falling Objects*



❖ Protection in Hard Hat Areas

- Safety helmets ensure the head adequately against a large portion of hazards & should be worn at whatever point the worker is working on-site and especially when in a zone where overhead work is going on.
- These zones are known as "hard hat areas" & should be set apart with safety signs at passages and other appropriate spots (ILO & OSHA, 2004).
- The standard applies to all: Managers, supervisors, engineers, workers & visitors on a construction site.

Photo D7 below shows how it should be mandatory to wear a safety helmet while working near cranes or other equipment types.

***Photo D 7**: Safety Helmet in Hard Hat Areas*

It is mandatory to wear a safety helmet for every person visiting on-site. It includes workers, engineers, managers, directors, owners & visitors, etc. Different colors have been given to safety helmets to be worn by particular individuals.

Photo D8 shows different types of helmets to be used at construction sites.

***Photo D 8**: Types of Safety Helmets*

D.3.2 Safety Goggles

Clear or colored goggles, a screen, a face shield, or other reasonable gadgets should be provided to workers when liable to be presented to eye or face injury from airborne residue or flying particles, hazardous substances, destructive warmth, light or other radiation, and specifically during welding, fire cutting, rock penetrating, solid blending, steel cutting & bending at construction sites (OSHA, 2004). Eye protection should be comfortable, suitable & accessible to urge laborers to wear it. Many eye wounds can happen because of flying material, residue, or radiation when the accompanying activities are being completed at the site:

- Breaking, cutting, boring, dressing or laying of stone, concrete blocks, bricks & steel with hand or force devices
- Welding and cutting of metals (On construction sites, this could be in the form of aluminum formwork used for concreting of slabs, columns, beams).
- Chipping and dressing painted or eroded surfaces
- Removing off or cutting out rivets & bolts

Wearing safety goggles is not mandatory for all workers but mandatory for the workers involved in activities such as cutting of metals, drilling of metals, etc. Photo D9 & photo D10 shows workers wearing safety goggles while performing specific tasks.

***Photo D 9**: Use of Safety Goggles while Drilling Activity*

***Photo D 10**: Use of Safety Goggles while Cutting Activity*

D.3.3 Safety Shoes

Wearing safety shoes while working on the site is very important. It can be helpful in the following situations (OSHA, 2004):

- Sharp objects such as nails, parts of metals lying on the floors can penetrate the workers through the sole if the workers are not wearing safety shoes.
- Feet can sometimes be crushed due to falling of materials or other objects on the feet, which can be prevented if the workers wear protective footwear.

The type of safety shoes or boots to be utilized will also depend on the kind of work being carried out, but all safety footwear should have an impenetrable sole. Photo D11 shows different types of shoes that should be provided to the workers.

***Photo D 11**: Different Kinds of Safety Shoes*

The photo D12 below shows the worker is not wearing safety shoes, which is entirely wrong & unacceptable. Workers need to understand that it is essential that they wear safety shoes while on the site, even for simple tasks. As shown in the photo, the column formwork parts are quite heavy and could easily cause broken bones of the feet if those fell on feet.

***Photo D 12**: Worker Working Without Safety Shoes*

Photo D13 below shows a lady working on the construction site, which is not wearing any safety footwear, entirely unsuitable for working on a construction site.

***Photo D 13**: Worker Working Without Safety Shoes*

D.3.4 Safety Gloves

Hands are very vulnerable to accidental injury on the construction sites. To a great extent, they are preventable by better manual dealing techniques & gear/equipment & by wearing right hands such as safety gloves (OSHA, 2004). According to OSHA (2004), hazardous handwork conditions on the construction sites can include the following things

- Activities including contact with sharp or rough surfaces
- Placements of rebars/steel for slabs, beams, columns
- Cutting & bending of rebars/steel
- While conducting plastering of walls
- While lifting bricks, stones, or concrete blocks for wall construction
- Contact with or sprinkles from hot, destructive, or harmful substances, for example, bitumen and tars
- Working with vibratory machines (at the time of concreting), for example, pneumatic drills where some cushioning of the vibrations is alluring

Gloves are among the least expensive and most clear PPE things, yet they can significantly improve construction health & safety. However, numerous workers in India are not provided with gloves, so they need to work with their bare hands. As seen in the photo D14, those are the gloves with a thin plastic coating which should generally be used for activities such as the lifting of

materials like bricks, stones, concrete blocks, cement bags, etc. and laying of bricks stones, concrete blocks, etc.

***Photo D 14**: Safety Gloves for Lifting of Materials*

Gloves, as shown in photo D15, should be used while working with steel. Activities like steel fixing, steel placements for slabs, columns and beams, cutting of steel, and steel binding with binding wires should be performed by wearing proper hand protection. These are the thick gloves, primarily to be used while working with metal parts. It can avoid sharp cuts or hand getting infected from the corroded steel.

***Photo D 15**: Safety Gloves for Dealing with Steel*

Appendix E: Costs of Safety Policies

Table E1 gives approximate costs for the implementation of some of the safety policies in India. Costs for safety measures like providing safety nets, guardrails, and scaffolding are not considered in the table as they are per square feet in India. It is impossible to assume how much the area is on the site, which requires these measures. However, we can say that the remaining amount, around INR 6 million, can be spent on those measures.

***Table E 1**: Approximate Costs of Safety Policies in India*

Safety Item	Description	Nos	Quantity/Year	Repeatations	Rate (INR)	Total (INR)
Safety Shoes	Safety shoes for workers	850	2	5	462	39,27,000
	Safety shoes for staff	80	2	5	875	7,00,000
	Gum boot	250	1	5	350	4,37,500
Safety Helmets		1050	2	5	115	12,07,500
Reflective Jackets		1050	2	5	110	11,55,000
Full body harness		150	1	5	1195	8,96,250
Safety Goggles		250	2	5	50	1,25,000
Hand gloves	Cotton gloves	200	6	5	24	1,44,000
	Rubber gloves	200	12	5	32	3,84,000
	Lether gloves	450	6	5	45	6,07,500
Safety training & education		1	4	5	30,000	6,00,000
Safety motivation program		1	6	5	5000	1,50,000
Safety supervision		15	12	5	22,000	1,98,00,000
First aid training		1	4	5	2000	40,000
First aid box		1	50	5	500	1,25,000
TOTAL						**3,02,98,750**