

CLASSIFICATION OF FACTORS AFFECTING LABOUR PRODUCTIVITY IN HILLY AREAS

A

THESIS

Submitted in partial fulfillment of the requirements for the award the degree

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Under the supervision

of

Dr. Saurabh Rawat

(Assistant Professor)

by

Hardik Chauhan (182602)

to



JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

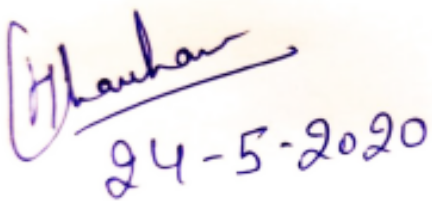
WAKNAGHAT, SOLAN – 173234

HIMACHAL PRADESH, INDIA

May – 2020

STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled “**Classification of Factors Affecting Labour Productivity in Hilly Areas**” submitted for partial fulfillment of the requirements for the degree of Master of Technology in Civil Engineering with specialization in Construction Management at **Jaypee University of Information Technology, Wagnaghat**, is an authentic record of my work carried out under the supervision of **Dr. Saurabh Rawat**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.



Handwritten signature of Hardik Chauhan and date 24-5-2020.

Signature of Student

Hardik Chauhan

182602

Department of Civil Engineering

Jaypee University of Information Technology, Wagnaghat, India

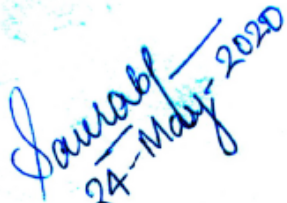
May - 2020

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **“Classification of The Factors Affecting Labour Productivity in Hilly Areas”** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in Construction Management submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat**, is an authentic record of work carried out by **Hardik Chauhan, 182602** during a period from July, 2019 to May, 2020 under the supervision of **Dr. Saurabh Rawat** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: May 24th, 2020



Signature of Supervisor

Dr. Saurabh Rawat
Assistant Professor
Department of Civil Engineering
JUIT, Waknaghat



Signature of HOD

Dr. Prof. Ashok Kumar Gupta
Professor and Head
Department of Civil Engineering
JUIT, Waknaghat

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ABSTRACT

Construction Industry is considered as the back bone of the developing countries which not only improves its infrastructure but also gives boost to its economy by providing jobs to millions of peoples. But construction industry faces many problems these days. One such great problems is of poor labour productivity faced by construction industry. Several developed countries are now focussing on these issues to find the factors that have negative impacts on labour productivity but no such study was carried out in hilly areas. This study tries to overcome this gap and thus the hilly region of the great Himalayas were considered for this study. Questionnaire survey were conducted in Shimla city of Himachal Pradesh, India on construction personals with considerable experience in construction works of hilly areas. A total of 51 factors were selected from the recommendations of past research works and these factors were divided into six groups, namely, (1) Work and Payment factors, (2) Labour issues, (3) Poor project management, (4) Poor site management, (5) Labour Welfare, (6) External and Unforeseen factors. Classified of the factors were done as critical, moderate and mild impacting on construction labour productivity on the basis of severity index. Factor analysis such as relative importance index, frequency index was done to understand the relationships among the factors. It was observed as Fairness of pay, Performance incentives, Weather conditions and Payment delays were the top severe factors in hilly areas affecting labour productivity. Recommendations to remove the effects of these factors were also given in the end of this study. Considering the outcomes of this study in the construction projects of hilly areas project cost can be reduced considerably.

Keywords: Construction Labour Productivity, Relative Importance Index, Frequency Index, Severity Index, Questionnaire Survey.

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LIST OF ACRONYMS & ABBREVIATIONS

Acronym	Description
Ft.	Feet
<i>F.I.</i>	Frequency Index
<i>I.I.</i>	Importance Index
<i>R.I.I.</i>	Relative Importance Index
<i>S.I.</i>	Severity Index

CHAPTER 1

INTRODUCTION

1.1 General

Construction Industry is considered as the back bone of the developing countries which not only improves infrastructure of the country but also gives boost to its economy by providing jobs to millions of peoples. Advanced technology is introduced every day in this field, but still the productivity is not what is expected. It is a well-known fact that construction industry is labour intensive, where only labour costs around 30% to 50% of the total cost of the project [1]. Innovation in the material, equipment, tools and machinery can be seen but very less focus is given to the labour class which ultimately will use these innovations. Thus, it is requirement of the hour to understand the cause behind this gap. Developed countries as well as developing countries are now focusing to identify and remediate the problems regarding this concern issue of poor labour productivity. Researches are being carried out to identify these factors which adversely affects the labour productivity in construction projects in various countries. But very few studies talk about the factors affecting labour productivity in hilly regions. Separate study is required for understanding issues related to productivity in hilly areas as climatic and environmental conditions of these areas are very different and harsh with respect to other areas.

In this study an attempt is made to study the factors affecting the labour productivity in hilly areas. This study is conducted in Shimla city of Himachal Pradesh. Shimla is known as “Hills Queen” as it is located on the south western ranges of the grate Himalaya with highest peak in city with the altitude of 8050 ft. A questionnaire survey was conducted on personals working in construction industry having knowledge and experience of construction work in hilly areas. The analysis of this survey gave us the main factors that adversely affects the productivity and causes loses and delays in construction projects. The remedies on how to deal with those factors, are also discussed so that this study can help in proper project management.

1.2 Problem Statement

Productivity loss is considered as one of the severe and greatest problem in construction industry nowadays. Project's total cost consists of mainly; material cost, equipment cost and labour cost. Equipment cost and labour cost are governed by market price and are also taken into consideration by both the parties in prior estimation. And even if market prices vary, there is not much difference in their costs. Whereas, labour cost labour is most unpracticable and most variable cost among other costs. The main reason behind this variability and unpredictable nature of labour cost is due to poor labour productivity. These loses due to poor labour productivity is not even considered in construction contracts. Poor labour productivity results into delays and can cause huge loss to the project. If productivity increases, it can benefit and can reduces the project's cost by reducing the time taken and cost of labour. These factors make the labour cost one of the major risks in construction industry. This makes it very important to find, understand and resolve the factors that effects the labour productivity.

To solve the problem of poor labour productivity we firstly have to find the effects of several factors on the labour productivity. In this direction many developed as well as developing countries are continuously working. Many researches are published and many more researchers are still studying the effects of different factors in different-different locations of the world. D.Jiukun studied these factors in U.S. in 2009 [2], R.A.Rivas conducted his study in Chile in 2011 [3], A.M.Jarkas conducted similar study in Qatar in 2012 [4]. Similar study was conducted by A.V.Thomas in southern part of India [5], but there are no such study was conducted in hilly areas so far. In the present study, an attempt is made to fill this research gap. For this reason, Shimla city was selected which lies in the hilly areas of the great Himalayan Ranges.

1.3 Purpose and Significance of this study

The study of factor affecting labour productivity in hilly areas is highly significant for construction works in such regions. To understand to purpose and significance of this study, firstly we have to understand the problems related to hilly areas. Hilly regions require separate study because we cannot directly apply the research findings of other places on hilly areas directly. A study by A.Kumar [6] was conducted in hilly areas, in which he describes that hilly areas have

difficult terrain, adverse climatic conditions, steep gradient, rich flora and are more prone to natural hazards. Which makes hilly areas more critical and important to study. Heavy rainfall, snow fall, floods and hailstorm make climatic conditions of hilly areas very challenging. Such climatic condition results in landslides and road blockage which delays the construction works, causes demotivation among labourers. Not only climatic conditions but geographical conditions of hilly areas are also very harsh. Difficult terrain, ridge, valley, steep gradient, hard rocky strata, unavailability of roads, distant markets, small drains or streams, rich flora and poor transportation facility makes construction in hilly areas very tedious task. Thus, the purpose of this study is to conduct a study for such difficult terrains to better understand the factors affecting labour productivity in these regions.

To conduct such a study in hilly areas, experience and knowledge of personals who have worked in hilly regions was required. A questionnaire survey was conducted on such construction personals to gather their expertise. By analyzing the survey forms, all the factors were classified in different categories. Recommendations are given for top critical factors on how to remediate those critical factors and increase the labour productivity. The significance of this study can be analyzed by the fact that by understanding and adopting the recommendations given by this study, the organization and companies working in construction industry in hilly areas will be benefited. Increasing the labour productivity will reduce the project completion time and results in low labour cost and increased profits for such companies.

1.4 Definition of Productivity

The word productivity was first mentioned in 1766 by Quesnay in an article [7]. After that different philosophers and different organizations have given their definition of productivity according to their use and understandings. Definition of productivity changes with respect to one industry to another. Not only in different industry, it also differs in different fields of same industry. One of the relatable definitions with respect to construction industry is given by G.Mahesh [8] “average direct labour hours required to install a unit of material”. A general definition which can be used in variety of industries and their different fields was given by Arditi and Mochtar [9] which introduced productivity as the ratio of total output to the total input both expressed in Dollars. But

in any project, there are numbers and numbers of input as well as outputs. In this regard there emerges two measures of construction productivity.

1.4.1 Total Factor Productivity: One in which all the inputs and outputs are taken known as Total Factor Productivity shown in Equation (1) [10].

$$TFP = \frac{\textit{Pound value of output}}{\textit{Pound value of input}} \quad (1)$$

There are mainly two drawbacks of total factor productivity. At first, to get the desired output, it is very difficult to continuously measure and accurately determine each and every input resource. Other drawback is the fact that it is impractical to judge the combined effect of different factors on the resultant output.

1.4.2 Partial Factor Productivity: Second measure relates output to single or defined set of inputs known as Partial Factor Productivity [10]. This enables us to compare the performance of individual inputs such as Labour productivity, Capital Productivity and Equipment or Plant Productivity as shown in Equation (2).

$$\textit{Labour Productivity} = \frac{\textit{Output Quantity}}{\textit{Labour Hours}} \quad (2)$$

Partial factor productivity has many advantages over total factor productivity. One can easily focus on a single selected factor of input. It makes the measurement and monitoring process very easy and manageable. Which results into very reliable as well as accurate data collection for evaluation purpose. As we can measure single input factors separately, it makes partial factor productivity a very handy tool to be used in very complex nature fields such as construction industry.

As we have mentioned earlier, construction industry is labour intensive that is the reason much of project's capital is spent over labour costs. This makes the study of labour productivity very crucial. The American Association of cost Engineering have given the definition for labour productivity as "relative measure of labor efficiency, either good or bad, when compared to an established base or norm" [11].

1.5 Significance of Labour Productivity

In construction industry, productivity is of great significance and labour productivity accounts for a great part in production input. It is very difficult to measure and anticipate different internal as well as external factors which are never constant. This factor is the main reason behind the continuous variation and affects labour productivity. This continuous variation leads to reduction in productivity which ultimately affects the schedule of the planned work and causes delays. These delays have consequences and results in huge capital loss in construction projects. On the other side if productivity is increased less manpower is required to perform the same task, which reduces the need of extra workers and reduces the labour costs resulting in profits of the construction company.

The other significance of labour productivity is that it helps as a tool to measure performance of workers. By measuring the performance of workers, we can give incentives to those workers who are showing good productivity. This will work as motivational factor to other workers as well and ultimately improve overall productivity of the team. This tool not only measure the individual performance but we can monitor and measure the overall productivity on the daily basis. By doing this, one can calculate the difference in productivity by comparing with past records and can easily analyze the effects of different factors that occurred between those time span. By doing so, we can improve the productivity by introducing only those factors who have shown positive effects on productivity in comparative study. This will not only increase the profit of company but will also make them to compete with today's challenging and competitive construction market.

1.6 Research Structure

This research study is divided into five chapters and an appendix. The short description of each chapter and appendix is given here.

Chapter 1 Introduction: This chapter provides the knowledge about the topic, discusses the problem, provides the purpose and scope of this study, defines the productivity and its significance in construction industry.

Chapter 2 Literature Review: This chapter can be considered as the back bone of this study. It provides the knowledge gathered by past researchers on the topic of labour productivity in construction industry published in different reputed journals papers, books and text articles. From the study of these research articles it provides a number of different factors that affects labour productivity.

Chapter 3 Research Methodology: Discussion of the methodology used for this research study is enlisted in this chapter. Selection of factors for this study, formation of questionnaire survey form, survey data collection and the methodology used in survey analyses is thoroughly explained in this chapter.

Chapter 4 Results and Discussions: From the analyses of the survey conducted, all the results of different factors were represented in tabular form in an overall manner as well as in their respective category. The probable cause of high or low ranking of the factors are also discussed in this chapter.

Chapter 5 Recommendations and Conclusions: On the basis of top factors given by the analysis of questionnaire survey forms, different recommendations are given for all the severe factors. This chapter also concludes this entire study and provides meaningful information.

Appendix: In this section questionnaire survey form is attached in both the language i.e. English as well as Hindi.

CHAPTER 2

LITERATURE REVIEW

2.1 General

Review of literature is considered as the foundation of any research study. Stronger the foundation, more ambitious goals we can achieve. Similarly, if literature review of the research study is thorough and systematic, it will define the aim of research very clearly and makes the research very reliable. In this chapter a brief summary of various prestigious journal's research work is discussed on the topic of factors affecting labour productivity in construction projects. Literature review is followed by the quick summery of this discussion. Research gaps and objectives defined by this literature review is also discussed in this chapter.

2.2 Review of Literature

There are significant studies of factors affecting labour productivity by different researchers. In 2003, Liberda M. et al. [12] conducted a study on 20 construction industry experts with an average experience of 27 years in concerned field in Alberta province of Canada. They collected a total of 49 factors and divided them into three main categories as Human, External and Management. From the interview it was observed that in human category; “worker experience and skills, motivation, attitude and moral” are the top three factors. In External category; “congested work area, change in drawings and specifications, adverse weather condition”, whereas, in Management category; “lack of detailed planning, inadequate supervision, non-availability of material” are the top three factors. It was observed from the overall ranked list that top ranked factors are from management category followed by human and then external category.

Another study in Turkey conducted by Kazaz et al. [13] in 2008 with 37 total factors divided into 4 groups was analysed using relative importance index method and found that organizational factor group was the top group and quality of site management was most influencing factor.

A study was conducted in US by Dai J. [2] et al. in 2009 on factors affecting construction labour productivity. In their study they conducted questionnaire survey over nine construction sites throughout United States of America and over 1996 craftworkers were contacted. They included 27 frequency factors and 56 agreement factors in their questionnaire survey form. In the analysis of survey data, it was observed that the groups with negative impact on construction labour productivity are as follows in descending order: construction equipment, materials, tools and consumables, engineering drawing management, direction and coordination, project management, training, craft worker qualification, superintendent competency, and foreman competency". The author also performed regression analyses which shows that "construction equipment, project management, and craft worker's qualification" are the categories with the highest possibility of labour productivity improvement in labourers viewpoint. The author suggested the communication bridge between job site management and craft workers as the key point to resolve the problem of shortage of labourers.

A study in Indonesia by Soekiman et al. [14] in 2011 with 113 total factors divided in 15 groups were analysed using relative importance index method and was seen that lag of material was the most effective factor in supervision group.

A similar study was conducted by Jarkas A.M. et al. [7] in Kuwait in 2012. They conducted questionnaire survey on 157 construction firms. Their questionnaire survey form comprises of 45 total factors. They divided these 45 factors in 4 major groups consisting of human/labour, technological, management and external factors. They used the Relative Importance Index method of the analysis of the survey data. In their analysis results it can be seen that top three factors in in management group are "lack of labour supervision, proportion of work subcontracted and lack of incentive scheme". In technological group, "clarity of technical specifications, the extent of variation/change orders during execution and coordination level among design disciplines" were top three. In human/labour group, "motivations of labor, skill of labor, physical fatigue" were top three factors. Where as in external group, "high/low temperature, high humidity and sandstorm" are the top three factors. It can also be seen that the average RII for overall factors was highest for technological group followed by human/labour, management and in the end external group.

A study conducted in Lithuania by Gudiene N. et al. in 2013 [15] with 71 factors in 7 groups was analysed using relative importance index method and it was seen that competence of project manager was the top factor in Project related factor group.

In another study carried out by Thomas A.V. et al. [5] in the year 2013, factors affecting construction labour productivity was analyzed. This research work was one of the first labour productivity study carried out in India. A structured questionnaire survey was conducted over 185 construction personals which includes project managers, engineers, site supervisor and laborers. This questionnaire contains 44 factors which were divided into ten main categories, which are; “Tools and equipment issues; poor labour motivations; improper supervision; poor material planning; poor site management; improper drawing management; project management incompetency; craftsmen issues; lack of meetings; lack of communication. The survey data was analyzed by Importance Index, Frequency Index and Severity Index and were ranked accordingly. Top three factors according to importance index are “unavailability of material on time at the workshop, delayed material delivery by the supplier, unavailability if drawings on time at the worksite”, according to frequency index; “Strikes called by political parties or hartals, unavailability of material on time at the workplace, harsh weather condition”. Whereas on the basis of severity index “unavailability of material on time at the workshop, delayed material delivery by the supplier, strikes called by political parties or hartals” were the top three factors. The author also performed factor analysis and it was observed that tool and equipment issues, poor labour motivation, improper supervision were the top three groups with 9.4%, 7.8%, 7.7% of variance explained and 4, 3.3, 3.3 as eigen value respectively.

In Palestine, Mahamid I. et al. [16] done the same study in 2013 with 31 factors divided in 5 categories and used Importance Index method to analyse and found that Rework was the top factor and weather changes was the least important factors and top-rated group was Managerial factors. In Egypt, El Gohary and Aziz [17] carried such study in 2014 and total 30 factors were selected and divided into three groups, relative importance index method was used and “Labor experience and skills” was ranked as topmost factor and ‘management factor’ group was determined as top group. Jarkas A.M. et al. [4] conducted another study in 2014 in Qatar with 38 factors, used relative importance index method for analyses and “Lack of financial incentive scheme” was the top ranked factor.

Gupta M. et al. [18] in 2018 conducted their study on workforce productivity in India but they only focused their factors to worker's welfare and site amenities. In this study author carried out their study on 151 persons by questionnaire survey. Total of 38 factors related to workers welfare and site amenities were selected and were divided into eight main groups namely: "health and medical provisions, site services, labor camp facilities, hygiene and sanitation, leave and benefits, social welfare and employment policies, remuneration and accommodation facilities". For this study five different sites were selected for better data collection. For ranking of factors Relative Importance Index method of analysis was used. On data analysis it was observed that factors like "no health coverage/insurance policies for labourers in case of any accident or disease; inadequate lighting arrangements for construction activities at site; no power supply at labour camps; high chances of epidemic at labour camps; lack of educational facilities/primary schools for children of the labourers near the site; no pension schemes for permanent construction workers; low daily wages of labourers; no arrangement of accommodation by the employer/ contractor" are the top factor in their respective categories as mentioned above. Whereas in overall manner "hazardous jobs without proper safety arrangements; unavailability of safe drinking water at labor camps; inadequate lighting arrangements for construction activities at site" are the top three factors. The author performed ANOVA p-value test was performed to check the difference in the perceptions of engineers and supervisor. Reliability and suitability of data was analysed by different tests using SPSS software.

One of the recent studies conducted in 2019, a research work was published by Karthik D. et al. [19] in which they focused their productivity study only to masonry laborers in Southern part of India. They also conducted questionnaire survey on 120 construction persons with relevant experience in this field. A total of 38 factors were included in questionnaire survey form, which were collected from past studies. These 38 factors were divided into five categories namely; management team, material and equipment, unforeseen and unfamiliar factors, work force, working conditions. Relative importance index method for analysis was used. In work force group; "lack of skills and experience of workers, physical performance and fatigue, poor relation among workers" were top three factors. "Poor or no supervision method, poor relation between labour and superintendent, bad leadership skill" were top three factors in management team group. In working condition group; "poor work planning, unrealistic scheduling, accidents", in material and equipment

group; “poor condition of equipment and tool, material shortages, equipment and tool shortage” where as in unforeseen and unfamiliar factors group; “weather conditions, stringent inspection, rework” were the top three factors. Average relative importance index was highest for work force group followed by management team, working condition, unforeseen and unfamiliar, material and equipment group was also observed.

One of the recent studies in 2020 by Dixit S. et al. [20] was conducted in India, in which author conducted questionnaire survey on construction personals. Factors were divided into four main groups: “management, technological, labour and external”. In this study ranking was done on the basis of relative importance indexing score of factors, some other statistical tests were also conducted. It was observed that the factors; planning and scheduling with 0.69, availability of material with 0.68 and storage areas for material with .67 of RII score were the top three factors that affects labour productivity.

2.3 Research Gap and Summary of Literature Review

Finding a research gap in literature review requires very thorough study. On the basis of these literature reviews, one thing was observed that there was no such study was found that talks about the study of factors affecting labour productivity in hilly areas. In this literature many things were observed and are discussed in following points:

- Use of Relative Importance Index (RII) technique was observed in this literature review as it is proved to be suitable for respondent satisfaction rating.
- To gather the responses from the respondents, likert scale of 1-5 is generally adopted in these literature review.
- All the factors are divided into groups in these research papers to make the study easy and are mainly grouped in 5-10 groups.
- Total number of factors considered for preparation of questioner is in the range of 24 – 57, only few others papers having number of factors as high as 71 and 113 were observed.
- Survey was conducted construction personals, mostly project managers, site engineers, supervisors and craft workers in the range of 100-180 respondents.

2.4 Aims and Objectives Defined

On the basis of review of literature, many observations were made as listed in summary of literature. Review of these literature have given us a research gap on which this current study is based. Thus, from the review of literature the aim of present study is to classify the factors affecting labour productivity in construction industry working in hilly areas. To achieve this aim this, study is divided into various objectives. On the completion of all the below mentioned objectives we will achieve our aim of current study.

- Identify and gather various factors that have unfavourable impact on labour productivity in hilly areas on the field of construction industry.
- Calculate and analyse the data gathered from questionnaire survey using Relative Important Index, Frequency Index and Severity Index method on all such factors.
- To classify all such factors on the basis of Severity Index score that affects labour productivity.
- To improve labour productivity by giving recommendations for all the severe factors, collected on the classification.

CHAPTER 3

METHODOLOGY

3.1 General

This chapter discusses the methodology adopted for this research work. In this section we will discuss about the selection of all the factors, grouping of these factors, preparation of questionnaire survey form, selection of survey personals, data collection, analysis of data, methods used in analysis of data, relative importance index, frequency index and severity index. This chapter thoroughly explains each and every step taken for the completion of this research study and also explains the analysis methods used in this study.

3.2 Factor Bank

As we have discussed in literature review that many such labour productivity studies already exist in different research journals and books. These studies were conducted in different parts of world by different authors. Taking the help of those research works, factors that negatively affects labour productivity were taken from them. A factor bank was prepared in a spreadsheet software containing 348 such factors. Factors by different researchers from different studies were arranged according to the rank given to them were entered in different columns.

3.3 Selection of Factors

After the factor bank was created, the factors ranking top as well as most common in the factor bank, containing factors from different study, was selected for this research work. Each factor was little modified so as to clearly explains the meaning and how it impacts labour productivity, so that it could easily be understand by respondents. As there are no such study conducted in hilly areas earlier thus, some factors were suggested by the construction industry experts who participated for pilot survey, were also added. Factors selected for this research work are given in Table 3.1 in alphabetic order without any priorities, ranking or grouping.

Table 3.1: List of factors selected for this study.

S. No	Factors	S. No.	Factors
1	Absence of canteen facilities	27	Misunderstanding among laborers
2	Absenteeism	28	Nature and size project
3	Accidents during construction	29	No health coverage or insurance policies.
4	Age	30	No provision of annual holidays
5	Alcoholism	31	Noise, dust, radiation
6	Availability of labour	32	Payment delays
7	Change in government laws	33	Performance incentives
8	Change orders from higher authorities	34	Personal problems
9	Complex designs in the drawings.	35	Poor access within construction job site
10	Concurrent operations	36	Poor site conditions
11	Design Changes	37	Project objective is not well defined
12	Differing site conditions from the plan	38	Quality of material and tool
13	Fairness of pay	39	Rework
14	Improper sanitation and housekeeping	40	Shortage of water and/or power supply.
15	Inadequate construction method	41	Size of Crew
16	Inadequate transportation facilities	42	Slow repair of machine or tool
17	Increase in the price of materials	43	Supervision delays
18	Insufficient lighting	44	Team spirit
19	Job security	45	Training sessions
20	Labour union rules and influences	46	Unavailability of material and tool
21	Lack of experience / skill	47	Unavailability or defected PPEs
22	Lack of medical facilities at site	48	Violations of safety laws
23	Lack of suitable rest area offered	49	Weather conditions
24	Material storage location	50	Work stopped due to strikes
25	Migrant labour	51	Working overtime
26	Misunderstanding / disputes between higher authorities		

3.4 Factor Grouping

For better understanding of all 51 selected factors that have negative impact on labour productivity, they have to be divided into groups. While going through the list of these factors very thoroughly, factors were divided into six groups which are: 1) labour welfare; 2) labour issues; 3) poor project management; 4) poor site management; 5) work and payment factors 6) external and unforeseen factors. These groups are briefly discussed below.

3.4.1 Labour Welfare: Factors related to labour welfare management, that are for the convenience and betterment of labourers such as medical facilities, insurance policies, annual holidays transportation facilities etc. are categorised in this group. There are eight such factors in this group and are shown in Table 3.2. Providing such facilities to the workers gives moral boost to them.

Table 3.2: Factors in Labour Welfare group

Sr. No.	Labour Welfare Factors
1	Absence of canteen facilities
2	Improper sanitation and housekeeping
3	Inadequate transportation facilities for workers
4	Lack of medical facilities
5	Lack of suitable rest area offered
6	No insurance policies or health coverage for labourers
7	No facility of annual holidays
8	Unavailability or defected Personal Protective Equipment

3.4.2 Labour Issues: Some problems are related to the worker itself thus, in this group such problems that are related to the workers are enlisted in this group. Factors such as age factor of worker, experience or skills, personal problems misunderstandings among them etc. are listed in this group. Table 3.3 shows the factors listed in this group and there are eight such factors related to labour issues.

Table 3.3: Factors in Labour Issues group

Sr. No.	Labour Issues Factor
1	Absenteeism
2	Age
3	Alcoholism
4	Lack of experience / skill
5	Migrant labour
6	Misunderstanding among laborers
7	Personal problems
8	Team spirit

3.4.3 Poor Project Management: Factors related to poor project management also reduces the labour productivity as they are one of the main reasons of demotivation among workers. Factors such as supervision delays, design changes, disputes in higher authorities, rework etc. are the reason of time delays in construction project causing demotivation for workers resulting in poor labour productivity. They are shown in Table 3.4 and contains eleven such factors.

Table 3.4: Factors in Poor Project Management Group

Sr. No.	Poor Project Management
1	Change orders from higher authorities
2	Complex designs in the provided drawings
3	Concurrent operations
4	Design Changes
5	Disputes between higher authorities
6	Inadequate construction method
7	Project objective is not well defined
8	Rework
9	Supervision delays
10	Training sessions
11	Violations of safety laws

3.4.4 Poor Site Management: Factors related to site management like material storage location, insufficient lighting, poor access, shortage of water/electricity etc. are enlisted in this group. There are ten such factors and are shown in Table 3.5.

Table 3.5: Factors in Poor Site Management group

Sr. No.	Poor Site Management
1	Differing site conditions from the plan
2	Insufficient lighting
3	Material storage location
4	Poor access within construction job site
5	Poor site conditions
6	Quality of material and tool
7	Shortage of water and/or power supply
8	Size of Crew
9	Slow repair of machine or tool
10	Unavailability of material and tool

3.4.5 Work and Payment Factors: Factors related to the work like working overtime, job security etc. and their payment such as fairness of pay, performance incentives, payment delays etc. are entered in this group. There are six such factors and are enlisted in Table 3.6 as shown below. These factors are very crucial for improvement of labour productivity as money is the driving force for workers to do their job.

Table 3.6: Factors in Work and Payment Factors Group

Sr. No.	Work and Payment Factors
1	Fairness of pay
2	Job security
3	Nature and size project
4	Payment delays
5	Performance incentives
6	Working overtime

3.4.6 External and Unforeseen Factor: Factors that cannot be pre-determined are enlisted in this group. This group contain factors like accidents, weather conditions, change in government laws, strikes, increase in material prices etc. These are such factors that are not govern by project management thus are known as unforeseen factors. There are eight such factors and are shown in Table 3.7 as shown below.

Table 3.7: Factors in External and Unforeseen Factor group

Sr. No.	External and unforeseen factors
1	Accidents during construction
2	Availability of labour
3	Change in government laws
4	Increase in the price of materials
5	Labour union rules and influences
6	Noise, dust, radiation
7	Weather conditions
8	Work stopped due to strikes

3.5 Preparing Questionnaire Survey Form

For this research work questionnaire survey method was adopted. This method is best suited in collecting data on such factors that requires identification by rating [19]. The survey form consists of two parts. General information of the respondent is collected by the first part of survey form that includes name, contact number, sex, educational qualification, name of the company working in, age of the company, designation/role, experience in construction field. However, name and contact number were optional to enter so as to keep the identity of respondent confidential. A questionnaire survey form is also attached in the appendix for reference.

Second part consists of 51 factors that adversely affect the construction labour productivity. Likert scale was used to fill the response with five response scale for importance section and three response scale for frequency section. Response scale and their meaning for importance and frequency is shown in Table 3.8. For reference this table is also provided in the questionnaire survey form for batter understanding of likert scale.

Table 3.8: Likert Scale for importance and frequency

Score	Importance	Frequency
1	Not applicable	Rare
2	Does not affect it	Moderate
3	Very slight affect	Very frequent
4	Affects it	
5	Directly affects it	

According to one's experience they have to tick in the box provided in front of every factor from one to five for importance and one to three for frequency. A sample survey was conducted to validate the correctness and understanding of questionnaire survey form. A blank space was also provided to enter any suggestion from the respondents. The suggestions were considered and incorporated in the questionnaire form. This final questionnaire form was created in English and translated in Hindi for better understanding of the factors by labour class.

3.6 Questionnaire Survey

“Department of Civil Engineering at Jaypee University of Information and Technology, Wahnaghat, Sloan”, organized workshop on behalf of Himachal Pradesh Public Work Department in which Junior Engineers, Executive Engineers, Technical Assistants, from Shimla and Solan district participated and they were introduced to “Mix Design: Methodology for concrete and bitumen”. Himachal Pradesh District Disaster Management Authority also conducted a training for construction laborers and masons from surrounding areas to teach them hazard resistance construction techniques. These questionnaire survey forms were distributed in workshop labs to all such experienced construction experts with a brief introduction of topic and questionnaire survey. Any doubt in filling form were cleared personally. Also, these survey forms were distributed in local private construction contractors and to their employees.

This survey was conducted on direct workers (masons and labourers), middle level employees (Junior Engineers, Technical Assistants, and Site Supervisors) as well as top level administrations (Company Owners, Managers and Senior Engineers). Total number and different type of participants for this research work is shown in Figure 1.

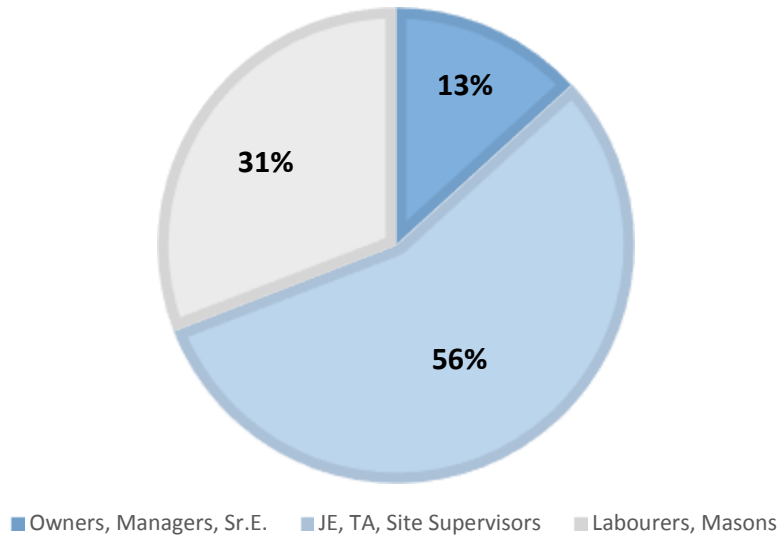


Fig 3.1. Participants of survey

3.7 Analysis of Survey Data

For analyses purpose and classification of factors that negatively influencing labour productivity, data analyses methods such as Relative Importance Index, Frequency Index and Severity Index is adopted. All the questionnaire survey forms were collected and this survey data is entered in spreadsheet software for analyses and calculation of relative importance index, frequency index and severity index. These indices are discussed and calculated as follows.

3.7.1 Relative Importance Index: It is a method to identify the importance of any factor by calculating mean value given by different respondents. With the help of likert scale, respondents give importance to a factor from one to five scale. Higher the number given in scale by respondents, higher the importance or effect of that factor. As large number of respondents giving high points to a factor it will increase the weightage to that factor. To understand the relative importance factor clearly the formula used in its calculation is given in Equation (3).

$$\text{Relative Importance Index} = \frac{(5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1)}{5(n_5 + n_4 + n_3 + n_2 + n_1)} \quad (3)$$

Notations n_5, n_4, n_3, n_2 and n_1 in Equation (3) are the total number of respondents who marked on 5, 4, 3, 2 and 1 score respectively on importance scale.

3.7.2 Frequency Index: As we have seen that relative importance index does tell about the importance and impact of that factor on productivity of labourers. But there are some factors which are of less impact but occurs very frequent which make them very critical to be considered and vice-versa. To overcome this problem Frequency Index was incorporated with the survey and is calculates as shown in Equation (4).

$$\text{Frequency index} = \frac{(3n_3 + 2n_2 + 1n_1)}{5(n_3 + n_2 + n_1)} \quad (4)$$

In Equation (4), notations n_3 , n_2 and n_1 are the total number of respondents who marked on 3, 2 and 1 score respectively on FI scale.

3.7.3 Severity Index: To classify all factors, we have to integrate both Relative and Frequency indices together. Multiplication of relative importance index and frequency index known as Severity Index gives as a list of all the factors which incorporates relative importance and their frequency. In this way we can classify all the factors according to the severity index score, which takes care the effect of their importance as well as their frequency. Severity index is given in Equation (5)

$$\text{Severity Index} = \text{Relative Importance Index} \times \text{Frequency Index} \quad (5)$$

3.8 Classification of factors

It was observed in literature review that in all the research work in the field of identification of factor influencing labour productivity all the researchers used ranking strategy on the basis of RII score. It was also observed that for certain factors the relative importance index score was very close to each other but still due to minor differences they are ranked apart. This is one of the major drawbacks of ranking method. There is always chances of minor errors in data, these errors can come from many ways. These errors could lead to increase or decrease RII score of a factor and results in ranking that factor higher or lower with respect to other factors.

To remove this drawback, instead of ranking all these factors we can classify all such factors in different classes. This classification will have the same basis as other studies to classify on the basis of severity index score which incorporated both relative importance index and frequency

index. The range of severity index score obtained from the analysis will be divided into three classes. The factors with in top range are classified as factors with severe effects, followed by moderate effect and low effects. In this way classification of factors will solve the problem of slight difference in indices scores.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 General

This chapter discusses the outcomes of this study. After the analyses the results of relative importance index, frequency index and severity index and their corresponding scores for each factor are given in tabular form. Each group are discussed separately and then overall, taking each factor from all the groups combined are also discussed. Classification of all the factors are also done on the basis of severity index score. This chapter also discusses the probable reasons behind the very critical factors.

4.2 Results and Discussions

All the factors were divided in six main groups. Data collected from questionnaire survey forms were analyzed using relative importance index, frequency index and severity index as discussed in methodology used. The reason behind the classification done on the basis of severity index score is that the it incorporates the effect from both relative importance index and frequency index. The data for severity index could lies in the percentage range of 0% to 100% thus this range is divided into three parts. The factors from 0% to 33% are classified as factors of mild effect, factors from 34% to 66% in moderate effect range were as data greater than 66% are classified as factors with severe effect. It was also taken into care that factors lying at the transition range of 33% and 66%, with 1% of variation are placed at higher class, so as to neglect any errors that may have caused minor percentage reduction. The results of relative importance index, frequency index and severity index from these analyses are discussed according to their groups as below which also shows the classification made on the basis of severity index. After the discussions made according to their respective groups, an overall discussion is also done taking all the factors combined irrespective of their groups. Only severity index is taken into account for overall classification of factors. At the end of this chapter a brief ranking off all the six groups is done on the basis of average severity index value of the group.

4.2.1 Work and Payment Factors: Relative importance index, frequency index and severity index were calculated as per equation 3, 4 and 5 respectively and are shown in Table 4. Classification of the factors are done on the basis of severity index. “Fairness of pay; performance incentives and payment delays” are the factors classified as factors with “Severe” effect as their severity index is greater than 66%. All of these factors are payment related factors and it is much predictable that in such harsh environment of hilly areas, if workers do not get legitimate amount for their work, it will definitely be going to affect their productivity negatively. Which is the reason this factor is at the top with severity index of 74%. Absence of ‘Performance incentive’ is one of the main reason due to which there is very less motivation among the workers to improve their performance. Whereas due to delays in payments, workers lose their interests in their work causing reduction in productivity.

Table 4.1: Analyses result for Work and Payment factors

No.	Work and Payment Factors	Importance					RII	Frequency			FI	SI (%)	Class
		5	4	3	2	1	(%)	3	2	1	(%)		
1	Fairness of pay	86	24	15	8	3	86.76	87	38	11	85.29	74.01	Severe
2	Performance incentives	72	41	17	4	2	86.03	79	41	16	82.11	70.64	Severe
3	Payment delays	75	33	15	10	3	84.56	64	54	18	77.94	65.91	Severe
4	Job security	68	21	24	16	7	78.68	41	57	38	67.40	53.03	Moderate
5	Working overtime	57	40	21	13	5	79.26	39	48	49	64.22	50.90	Moderate
6	Nature and size project	6	12	19	41	58	40.44	14	50	72	52.45	21.21	Mild

It can also be observed from the table all the factors from ‘severe’ class have relative importance index greater than 80% which shows their importance for labour productivity. Factor such as “Job security; working overtime” are classified as factors with ‘moderate’ effect on labour productivity. These factors do have relative importance close to 80% but sue to less frequency index, they have low severity index thus, classified as moderate affecting factors. Whereas on the other hand factor ‘Nature and size of project’ is the only factor with ‘mild’ effect on labour productivity, as worker are paid for the work they perform, irrespective of nature and size of project. Which is the reason this factor has relative importance index of 40%, frequency index of 53% and severity index of 21% only.

4.2.2 Labour Issues: On the basis of questionnaire survey analyses it is quite evident that factors related to labour issues cannot be taken lightly. Their impact on labour productivity are worth consideration. As we can see from Table 4.2 that in labour issues group ‘personal problems’ is the most critical factor influencing labour productivity with severity index of 62% and RII of 80%, but due to 76% of frequency index it is classified as ‘moderate’ factor. Personal problems mostly include their family related issues or health issues. ‘Lack of experience / skill’ is the second most critical factor in this group with SI of 57%, RII close to 80% and FI of 72%.

Table 4.2: Analyses result for factors related to Labour Issues

No.	Labour Issues	Importance					RII (%)	Frequency			FI (%)	SI (%)	Class
		5	4	3	2	1		3	2	1			
1	Personal problems	53	41	33	7	2	80.00	63	52	21	76.96	61.57	Moderate
2	Lack of experience / skill	63	28	29	12	4	79.71	55	46	35	71.57	57.04	Moderate
3	Age	39	33	25	22	17	68.09	42	45	49	64.95	44.22	Moderate
4	Migrant labour	37	36	30	18	15	69.12	32	56	48	62.75	43.37	Moderate
5	Team spirit	21	27	36	31	21	59.41	34	65	37	65.93	39.17	Moderate
6	Misunderstanding in laborers	28	31	28	23	26	61.76	30	54	52	61.27	37.85	Moderate
7	Absenteeism	13	24	42	32	25	55.29	37	55	44	64.95	35.91	Moderate
8	Alcoholism	16	25	42	31	22	57.35	36	42	58	61.27	35.14	Moderate

Age of labourers is also considered as ‘moderately’ affecting factor. Labourers whether they are local or migrants from other location does also affects labour productivity. Working as a team is also another factor influencing productivity. Misunderstanding may also cause reduction in labourers efficiency of doing work as it reduces the team spirit and causes demotivation. Another factor which also reduces productivity is absenteeism of workers, due to non-availability of workers, it affects the work progress and dependency of work gets affected. last factor in this group is alcoholism, which affects the concentration of worker and may cause the health problems among them. From this table it is very clear that all factors from this group have moderate effect on labour productivity, it is also very clear that all factors have relative importance index greater than 55% and frequency index greater than 61%, which means we cannot ignore these factors and have to consider them seriously.

4.2.3 Poor Project Management: One of the main reasons of poor labour productivity is caused by bad project management. From Table 4.3 it can be seen that factors in this group such as ‘concurrent operations’ is the highest rated factor with RII of 71% and SI of 47% which means that multiple jobs are performed simultaneously. Factors like supervision delay, rework, violation of safety laws, change in orders from higher authorities and training sessions are the factors causing ‘moderate’ affect in labour productivity with relative importance index in the range of 50% to 58% and severity index in the range of 33% to 38% are factors to be considered as important.

Table 4.3: Analyses result for Poor Project Management factors

No.	Poor Project Management	Importance					RII	Frequency			FI	SI (%)	Class
		5	4	3	2	1	(%)	3	2	1	(%)		
1	Concurrent operations	42	32	30	22	10	70.88	41	52	43	66.18	46.91	Moderate
2	Supervision delays	15	23	22	39	37	51.18	58	46	32	73.04	37.38	Moderate
3	Rework	21	25	32	35	23	57.94	38	41	57	62.01	35.93	Moderate
4	Violations of safety laws	11	17	25	45	38	47.94	43	62	31	69.61	33.37	Moderate
5	Change orders higher authorities	14	18	25	43	36	49.85	39	59	38	66.91	33.36	Moderate
6	Training sessions	14	29	38	26	29	56.03	30	45	61	59.07	33.10	Moderate
7	Inadequate construction method	8	18	28	40	42	46.76	30	42	64	58.33	27.28	Mild
8	Design Changes	11	19	28	46	32	49.85	21	46	71	54.59	27.21	Mild
9	Disputes b/w higher authorities	9	16	26	36	49	45.29	26	39	71	55.64	25.20	Mild
10	Complex designs and drawings	12	16	21	45	42	46.91	18	37	81	51.23	24.03	Mild
11	Project objective not well defined	4	11	18	42	61	38.68	11	43	82	49.26	19.05	Mild

On the other hand, factors such as inadequate construction method; design changes; disputes between higher authorities; complex design and drawings and project objective not well defined are such factors which have relative importance index less than 50%, and frequency index less than 60% and severity index also less than 28%. Thus, these factors are classified as factors with ‘mild’ effect on labour productivity. There was a total of eleven factors in ‘poor project management’ group, from which six factors are of ‘moderate’ class and rest five of eleven factors lies in ‘mild’ class.

4.2.4 Poor Site Management: Factors corresponding to this group also affects labour productivity. From the Table 4.4 it can be seen that there are total ten factors out of which six factors falls under ‘moderate’ class whereas remaining four factors are classified as ‘mild’. Thus, factors of poor site management group are worth consideration. With relative importance index nearly 70%, severity index of 45% and frequency index of 65%, factor ‘quality of material or tool’ is the highest rated factor in this group. Other factors such as; unavailability of material or tool; slow repair of machine or tool; poor access within job site; poor site conditions; size of crew are the factors having moderate effect on labour productivity. These factors have severity index in the range of 35% to 43% and relative importance factor in the range of 51% to 67% and frequency index in the range of 62% to 71%.

Table 4.4: Analyses result for Poor Site Management factors

No.	Poor Site Management	Importance					RII (%)	Frequency			FI (%)	SI (%)	Class
		5	4	3	2	1		3	2	1			
1	Quality of material or tool	46	26	22	28	14	69.12	41	45	50	64.46	44.55	Moderate
2	Unavailability of material or tool	39	24	23	31	19	64.85	40	51	45	65.44	42.44	Moderate
3	Slow repair of machine or tool	34	36	27	21	18	66.91	34	49	53	62.01	41.49	Moderate
4	Poor access within job site	17	25	34	29	31	55.29	31	72	33	66.18	36.59	Moderate
5	Poor site conditions	11	20	31	49	25	51.62	43	65	28	70.34	36.31	Moderate
6	Size of Crew	12	22	41	33	28	53.68	38	58	40	66.18	35.52	Moderate
7	Shortage of water/power supply	12	26	32	30	36	52.35	33	41	62	59.56	31.18	Mild
8	Material storage location	14	20	29	36	37	50.88	25	52	59	58.33	29.68	Mild
9	Insufficient lighting	9	15	26	39	47	45.29	13	48	75	51.47	23.31	Mild
10	Diff. site conditions from plan	8	17	28	32	51	45.15	16	41	79	51.23	23.13	Mild

The factors such as shortage of water/power supply; material storage location; insufficient lighting; diff. site conditions from plan are the remaining four factors that have ‘mild’ effect on labour productivity. These factors have Severity index less than 32%, relative importance index less than 52% and frequency index less than 60%. Day to day inspections, good bond between workers and higher authorities due to regular meetings, follow ups on previous instructions and guidelines are some factors which can improve site management.

4.2.5 Labour Welfare Factors: There are total eight factors in this group. It is clear from the Table 4.5 that five factors have moderate effect whereas the remaining three have mild effect on labour productivity. The factor ‘no provision of annual holidays’ is the top ranked and only factor with relative importance index of 74%, frequency index of 76% and severity index of 56%. Absence of fixed annual holidays exhausts the worker and affects physically as well as mentally. ‘Improper sanitation and housekeeping’ is the second ranked factor in this group. Most of the workers are unfamiliar with any health coverage and insurance policies thus, this factor is ranked third in this group. Lack of medical facilities on construction site creates a negative impression on workers. Similarly, unavailability or defected personal protective equipment’s creates psychological impact on workers mind resulting in reduced performance.

Table 4.5: Analyses result for factors related to Labour Welfare

No. Labour Welfare Factors	Importance					RII (%)	Frequency			FI (%)	SI (%)	Class
	5	4	3	2	1		3	2	1			
1 No provision of annual holidays	42	37	36	15	6	73.82	56	61	19	75.74	55.91	Moderate
2 Improper sanitation/housekeeping	24	29	37	25	21	61.47	41	57	38	67.40	41.43	Moderate
3 No health coverage/insurance	18	31	35	28	24	58.68	31	62	43	63.73	37.39	Moderate
4 Lack of medical facilities on site	20	28	34	25	29	57.79	29	61	46	62.50	36.12	Moderate
5 Unavailability or defected PPE’s	16	21	31	38	30	53.38	34	54	48	63.24	33.76	Moderate
6 Lack of suitable rest area offered	17	19	20	41	39	50.29	33	54	49	62.75	31.56	Mild
7 No transportation facilities	8	16	28	45	39	46.62	32	72	32	66.67	31.08	Mild
8 Absence of canteen facilities	12	16	24	39	45	46.91	33	39	64	59.07	27.71	Mild

There are some other factors which have mild effect on labourers productivity. Rest is very essential for workers, if proper rest area is not provided to workers, they will not be able to rest properly in given time and thereafter it will affect their performance. Another factor if decreased productivity is due to no transportation facility provided to workers, because of which they have to manage their self to reach to construction site. Mostly labourers walks to site to reach there and meanwhile gets tired before starting any work. Similarly, absence of cheap canteen facility at or near the site creates dissatisfaction in labourers. These factors have mild effect on labour productivity but if these are problems are cured properly, it may lead to considerable improvement in productivity.

4.2.6 External and Unforeseen Factors: In this group there are eight factors out of which one factor have ‘severe’ effects, five factors have ‘moderate’ effect and two factors have ‘mild’ effect on labour productivity. Weather conditions in hilly areas are very unpredictable and results in delays, demotivation in labourers. That can be seen in the analyses result as weather condition is the highest ranked factor in this group with RII of 88%, FI of 75% and SI of 66% that makes this only factor in this group to be classified as ‘severe’. With the RII of 76%, FI of 76% and SI of 58% ‘noise, dust, radiation’ is the second ranked factor in this group, as such external factors decreases comfort and produces hindrance in completing their task. Accidents in any construction sites occurs very rare but their impact is very high which is visible from the results of the survey as RII is 83%, FI is 61% and SI is 51% thus it is classified as factor with ‘moderate’ effect on labour productivity.

Table 4.6: Analyses result for External and Unforeseen Factors

No. External & Unforeseen Factors	Importance					RII (%)	Frequency			FI (%)	SI (%)	Class
	5	4	3	2	1		3	2	1			
1 Weather conditions	81	38	10	6	1	88.24	58	55	23	75.25	66.39	Severe
2 Noise, dust, radiation	44	51	19	15	7	76.18	63	47	26	75.74	57.69	Moderate
3 Accidents during construction	64	41	20	9	2	82.94	33	50	53	61.76	51.23	Moderate
4 Availability of labour	38	30	35	18	15	68.53	31	58	47	62.75	43.00	Moderate
5 Labour union rules and influences	29	31	34	29	13	65.00	26	57	53	60.05	39.03	Moderate
6 Work stopped due to strikes	24	27	31	32	22	59.85	24	39	73	54.66	32.71	Moderate
7 Change in government laws	15	27	32	35	27	55.29	8	47	81	48.77	26.97	Mild
8 Increase in the price of materials	8	13	25	39	51	43.53	11	42	83	49.02	21.34	Mild

Availability of labour is one such unforeseen factor which also have negative effect on other workers and classified as moderate. Labour union rules and influences; work stopped due to strikes are the next ranked factors in moderate class with RII of 69% and 60%; FI of 60% and 55%; SI of 39% and 33% respectively. Remaining factors such as change in government laws; increase in price of material are ranked at last in this group with RII of less than 56%, FI less than 49% and SI less than 27%. This is because these external factors have very less impacts on workers and also their frequency of occurrence is also very low.

4.3 Overall Classification

For this research work a total of 51 factors from different researches were taken. Relative importance index, frequency index and severity index for all such factors were calculated. On the basis of severity index all the factors were classified in three different classes. Classification in their respective groups has been already discussed above. In Table 4.7, we can see an overall classification of all 51 factors that negatively affects labour productivity. There are four severe factors having severity index more than 66%. It can also be noticed that all such factors have RII greater than 85% and frequency index more than 75%. ‘Fairness of pay’ factor is the top ranked factor as working in such harsh environment and rough geographical hilly areas requires justification of payment. Performance incentives is rated as second ranked factor with great scope of improvement which can boost productivity immensely.

Table 4.7: Classification of all factors and their analyses results

No.	Factors	RII (%)	FI (%)	SI (%)	Class
1	Fairness of pay	86.76	85.29	74.01	Severe
2	Performance incentives	86.03	82.11	70.64	Severe
3	Weather conditions	88.24	75.25	66.39	Severe
4	Payment delays	84.56	77.94	65.91	Severe
5	Personal problems	80.00	76.96	61.57	Moderate
6	Noise, dust, radiation	76.18	75.74	57.69	Moderate
7	Lack of experience/skill	79.71	71.57	57.04	Moderate
8	No provision of annual holidays	73.82	75.74	55.91	Moderate
9	Job security	78.68	67.40	53.03	Moderate
10	Accidents during construction	82.94	61.76	51.23	Moderate
11	Working overtime	79.26	64.22	50.90	Moderate
12	Concurrent operations	70.88	66.18	46.91	Moderate
13	Quality of material and tool	69.12	64.46	44.55	Moderate
14	Age	68.09	64.95	44.22	Moderate
15	Migrant labour	69.12	62.75	43.37	Moderate
16	Availability of labour	68.53	62.75	43.00	Moderate
17	Unavailability of material and tool	64.85	65.44	42.44	Moderate
18	Slow repair of machine or tool	66.91	62.01	41.49	Moderate

19	Improper sanitation and housekeeping	61.47	67.40	41.43	Moderate
20	Team spirit	59.41	65.93	39.17	Moderate
21	Labour union rules and influences	65.00	60.05	39.03	Moderate
22	Misunderstanding among laborers	61.76	61.27	37.85	Moderate
23	No health coverage or insurance	58.68	63.73	37.39	Moderate
24	Supervision delays	51.18	73.04	37.38	Moderate
25	Poor access within job site	55.29	66.18	36.59	Moderate
26	Poor site conditions	51.62	70.34	36.31	Moderate
27	Lack of medical facilities at site	57.79	62.50	36.12	Moderate
28	Rework	57.94	62.01	35.93	Moderate
29	Absenteeism	55.29	64.95	35.91	Moderate
30	Size of Crew	53.68	66.18	35.52	Moderate
31	Alcoholism	57.35	61.27	35.14	Moderate
32	Unavailability or defected PPE's	53.38	63.24	33.76	Moderate
33	Violations of safety laws	47.94	69.61	33.37	Moderate
34	Change orders from higher authorities	49.85	66.91	33.36	Moderate
35	Training sessions	56.03	59.07	33.10	Moderate
36	Work stopped due to strikes	59.85	54.66	32.71	Moderate
37	Lack of suitable rest area offered	50.29	62.75	31.56	Mild
38	Shortage of water/power supply	52.35	59.56	31.18	Mild
39	No transportation facilities for workers	46.62	66.67	31.08	Mild
40	Material storage location	50.88	58.33	29.68	Mild
41	Absence of canteen facilities	46.91	59.07	27.71	Mild
42	Inadequate construction method	46.76	58.33	27.28	Mild
43	Design Changes	49.85	54.59	27.21	Mild
44	Change in government laws	55.29	48.77	26.97	Mild
45	Disputes b/w higher authorities	45.29	55.64	25.20	Mild
46	Complex designs in drawings	46.91	51.23	24.03	Mild
47	Insufficient lighting	45.29	51.47	23.31	Mild
48	Differing site conditions from plan	45.15	51.23	23.13	Mild
49	Increase in price of materials	43.53	49.02	21.34	Mild
50	Nature and size project	40.44	52.45	21.21	Mild
51	Project objective is not well defined	38.68	49.26	19.05	Mild

From all 51 factors weather condition is ranked third as directly or indirectly weather of hilly areas is the one of the main reason of delays of construction projects in these areas. Delays in payment is ranked fourth, all these four factors are classified as factors having severe effect on labour productivity in hilly areas.

4.4 Ranking of Groups

All 51 factors are divided into six main groups. Classification of all factors are already discussed above. To identify the main group affecting labour productivity, ranking of all the groups is done on the basis of average score of severity index as shown in Table 4.8. As we can see ‘work and payment factor’ is the top ranked group followed by ‘labour issues; external and unforeseen factors; labour welfare; poor site management; and poor project management’.

Table 4.8: Ranking of groups on the basis of average severity index score

Groups	Avg. RII	Avg. FI	Avg. SI	Ranking
Work and Payment Factors	75.96	71.57	55.95	1
Labour Issues	66.34	66.21	44.28	2
External and unforeseen factors	67.44	61.00	42.30	3
Labour Welfare	56.12	65.13	36.87	4
Poor Site Management	55.51	61.52	34.42	5
Poor Project Management	51.03	60.53	31.17	6

Average relative importance index and frequency index is also shown with average severity index score, but ranking of the groups is done on the basis of severity index only as it incorporates the relative importance index as well as frequency index.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 General

This chapter talks about all the conclusions made on the basis of analyses of all the factors and their results. From the results recommendations are suggested for the treatment of top severe factors. Working on these recommendations will improve labour productivity which ultimately will increase company's profit by finishing off the project on/before time or by reducing the need of labourers in project.

5.2 Conclusions

In this research 51 factors that have negative impact on construction labour productivity in hilly areas were selected from the suggestions of past research work published related to this field. These factors were selected as top ranked and most commons among those studies. All 51 factors were divided into six main groups. A questionnaire survey was conducted on 136 construction industry personals having considerable experience in construction work in hilly areas. The survey data was collected and analyses was performed on this data. Ranking and classification methods such as relative importance index, frequency index and severity index methods were applied on survey data. On the basis of severity index all the factors were classified in three classes having 'severe', 'moderate' and 'low' impact on labour productivity. On the basis of results following conclusions were made from this research study.

- Relative importance index alone was not able to analyze all the factors properly thus, it is used in conjunction with frequency index known as severity index to classify all the factors.
- Ranking method as used in earlier studies was not that much efficient thus, all the factors were classified in three classes instead of ranking them.
- 'Fairness of pay; performance incentives; weather conditions; and payment delays' are the top four factors and classified as factors with severe effect on labour productivity in hilly areas.

- All these severe factors have severity index greater than 66 %, relative importance index greater than 85% and frequency index greater than 75%.
- There are 32 factors with moderate effect on labour productivity of hilly areas where as 15 factors with mild effect.
- ‘Work and payment factor’ is the top ranked group with highest average relative importance, frequency and severity index among all six groups.
- ‘Labour issues’ is second ranked group, followed by ‘External and unforeseen factors; Labour Welfare; Poor Site Management and; Poor Project Management’
- ‘Accidents during construction’ is one such factor with relative importance of 83% but due to less frequency index of 62% have moderate severity index of 51%.
- Factors such as ‘payment delays’ and ‘work stopped due to strikes’ have severity index close to higher class, thus they were put in upper class.

5.3 Recommendations

To increase the labour productivity in hilly areas we have to take care of all the factors studied in this study, specially the factors in severe and moderate class. Some recommendations on the severe factors gathered from some experienced construction expert’s opinion are discussed as follows.

- Working in hilly areas is very difficult thus, wages of the labourers should be decided on the basis type of work and should justify the efforts of work. Some experts having substantial experience from field in hilly areas should be included when deciding about the wages of labourers for deferent tasks. Wages of labourers should be revised very frequently and should follow all guidelines given by state government.
- Performance incentive is the best productivity increasing method. It creates an environment of competition between workers. These performance incentives can be included in wages revision or may be given annually by awarding the laborers as best worker of the year.
- Weather conditions are such external factors that can’t be predicted. There should always be provisions of extra non-working days that should be included in project

scheduling. Planning and scheduling of tasks that can be done on fair weather and poor weather should be done by considering weather forecasts of that region.

- Payment delays is one of the main reasons in demotivation among workers. If paid monthly, wages payment to the worker should be done on a fixed date of every month. Workers who are paid on daily basis should be paid daily after work.
- Personal problems of workers could also affect workers productivity. It can be solved by creating friendly environment at worksite so that workers can feel relaxed at site and works efficiently. Friendly behavior of superiors makes them comfortable and sometimes they share their problems which makes them even more comfortable.
- Workers should be given proper training before employing new worker and allotting unfamiliar task. This will help them to do work properly and will increase their experience and enhance their skills.
- Accidents at site can only be prevented by equipping the workers with proper personal protecting equipment's and by regular maintenance of every tool, equipment and machine.
- Working overtime exhausts all the energy of the worker and results in reduced efficiency. Overtime should be limited to only few extra hours for every worker and should be paid accordingly.

These are some recommendation given to remediate some critical factors which have negative impact on labour productivity in hilly areas. Adopting these factors in project planning and scheduling will defiantly improve the efficiency of the workers and will result in increased labour productivity.

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APPENDIX

QUESTIONNAIRE SURVEY REGARDING FACTORS AFFECTING LABOUR PRODUCTIVITY IN CONSTRUCTION PROJECTS

(Please tick the appropriate boxes where required)

1. Name *:	
2. Contact No *:	
3. Sex:	Male <input type="checkbox"/> Female <input type="checkbox"/>
4. Educational Qualification:	
5. Name of Company:	
6. Position in company:	
7. Nature of Company:	
Client / Govt. Org.	<input type="checkbox"/>
Contractor	<input type="checkbox"/>
Designer	<input type="checkbox"/>
Consultant	<input type="checkbox"/>
Other (Please Specify)	<input type="checkbox"/>
8. Age of the Company:	
0-5 Years	<input type="checkbox"/>
5-10 Years	<input type="checkbox"/>
10-15 Years	<input type="checkbox"/>
More Than 15 Years	<input type="checkbox"/>
9. Your Experience in the Construction Industry:	
Less than 1 Year	<input type="checkbox"/>
1-5 Years	<input type="checkbox"/>
5-10 Years	<input type="checkbox"/>
10 Years and above	<input type="checkbox"/>

Likert Scale

Sr.no.	Scale	Level of importance (Score)
Importance		
1	Not applicable	1
2	Does not affect it	2
3	Very slight affect	3
4	Affects it	4
5	Directly affects it	5
Frequency		
6	Rare	1
7	Moderate	2
8	Very frequent	3

All the information filled by me is best of my knowledge.

No.	Factors Affecting Labour Productivity in Building Construction	Importance					Frequency		
		1	2	3	4	5	1	2	3
	<i>Factors</i>								
1	Absence of canteen facilities								
2	Absenteeism								
3	Accidents during construction								
4	Age								
5	Alcoholism								
6	Availability of labour								
7	Change in government laws								
8	Change orders from higher authorities								
9	Complex designs in the provided drawings.								
10	Concurrent operations								
11	Design Changes								
12	Differing site conditions from the plan								
13	Fairness of pay								
14	Improper sanitation and housekeeping								
15	Inadequate construction method								
16	Inadequate transportation facilities for workers								
17	Increase in the price of materials								
18	Insufficient lighting								
19	Job security								
20	Labour union rules and influences								
21	Lack of experience / skill								
22	Lack of medical facilities at or near the site								
23	Lack of suitable rest area offered								
24	Material storage location								
25	Migrant labour								
26	Disputes between higher authorities								
27	Misunderstanding among laborers								
28	Nature and size project								
29	No health coverage or insurance policies.								
30	No provision of annual holidays for labourers								
31	Noise, dust, radiation								
32	Payment delays								
33	Performance incentives								
34	Personal problems								
35	Poor access within construction job site								
36	Poor site conditions								
37	Project objective is not well defined								
38	Quality of material and tool								
39	Rework								
40	Shortage of water and/or power supply.								
41	Size of Crew								

42	Slow repair of machine or tool									
43	Supervision delays									
44	Team spirit									
45	Training sessions									
46	Unavailability of material and tool									
47	Unavailability or defected PPE's									
48	Violations of safety laws									
49	Weather conditions									
50	Work stopped due to strikes									
51	Working overtime									

Other Comments on Factors affecting Labour Productivity at Construction Job sites

- a) _____
- b) _____
- c) _____
- d) _____

Thank you for contributing your valuable time, your honest information, and your thoughtful suggestions to complete this survey.

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Contact No. 9418670944 E-mail. hardik94chauhan@gmail.com

Name of the Supervisor: Dr. Saurabh Rawat

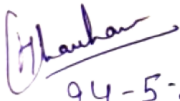
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