Study on Labour Productivity in Hilly Terrain (H.P) in Construction Project and Improved Overall Productivity of the Construction Projects

A Thesis

Submitted in Partial Fulfillment of Requirement for the Degree of

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In

Civil Engineering

With Specialization in

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Under the Guidance of

Mr. Kaushal Kumar
(Assistant Professor)

By

Sonali Mehra
Enrollment No: 162602

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY
WAKNAGHAT, SOLAN-173234, HIMACHAL PARDESH

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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY,

SOLAN-173215

CERTIFICATE

This is to certify that the project report entitled **"Study on Labour Productivity in Hilly Terrain (H.P) in Construction Project and Improve Overall Productivity of the Construction Projects "** submitted by Sonali Mehra Roll No. 162602 in partial fulfillment of the requirements for the award of Masters of Technology in Civil Engineering is carried out under my supervision of Mr. Kaushal Kumar (Assistant Professor) Department of Civil Engineering and guidance at the Jaypee University of Information and Technology, Solan, Himachal Pradesh.

To the best of my knowledge, the matter embodied in this Project Report has not been submitted to any other University/institute for the award of any Degree.

Head of the Department	Supervisor	External Examiner
Dr. Ashok Kumar Gupta	Er. Kaushal Kumar	
Department of Civil Engineering	Assistant Professor	
Jaypee University of Information Technology	Department of Civil Engineering	
Wakanaghat	Jaypee University of Information Technology	
	Wakanaghat	

DECLARATION

This is to certify that project report entitled **"Study on Labour Productivity in Hilly Terrain (H.P) in Construction Project and Improve Overall Productivity of the Construction Projects"** submitted by Sonali Mehra Roll No. 162602 in partial fulfillment of the requirements for the award of Masters in Technology in Civil Engineering in Jaypee University of Information and Technology, Solan Himachal Pradesh comprises only my original work and due acknowledgement has been made in the text to all information used.

Name of the Student	**Roll No.**	**Signature**
Sonali Mehra	162602	

Date:

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(Sonali Mehra)

ABSTRACT

Construction sector is the most vibrant and dynamic sector in the country's economy. This sector in India is contributing more than that of agricultural sector, although India is an agrarian country. Probing in deep it comes to the picture that this sector has not been deployed till now to its maximum capacity. This means still there is lot of potential in this field that has been still in unexplored category. The major advantage of this sector is that it can be further categorized into subsectors. Field can be divided based on the resources that are present for us to be used in this sector, for example labour, material, machinery, finance and many more. Since we are not able to get efficiently productive production here in India, this means there may be some kind of lagging on our part that we are not able to rectify as we are having best of machines, financial assistance, expertize but still we are lagging somewhere. This means there are some other things that are responsible for the failure of the project at site to give efficient productivity. This study has tried to focus on one such sub sector that is labour to improve on so as to increase its contribution to the overall productivity.

Labour productivity primarily focuses on the labor's part on how they work, hoe they are recruited, how the things seems to them. The main thing is the way to improve the labour productivity. Here the focus is to study the literature related to this topic and then by taking a real time project in order to find the inefficiency gap. Lot of methods has been provided till date in order to find the labour productivity. In this study three methods has been used to find the inefficiency and this gap has been tried to reduce down by providing the suggestive model to be used in construction organization related to the labour selection criteria.

Data pertaining to five sites has been considered in this study in order to have an insight of interregional variation of labour productivity. The use of machinery or tools by them, the basic understanding of the materials with which they are required to work and the natural environmental conditions around them are some of the focus area of this study.

Since this sector is one of the major components of secondary sector in our economy therefore in order to further attract FDI and to increase the domestic growth this sector can prove to be the golden sector in the whole economy.

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Chapter 1: INTRODUCTION

1.1 General

Construction is one among most challenging and mammoth industry. After having best labor, best equipments and even high technology the final productivity when checked comes out to be very low. So what is that thing that even after having "the best" of everything hinders the way of 100% productivity and efficiency? The answer behind this stressed question is very simple and that is "labor productivity".

Talking specifically about the labour productivity that means talking specifically about one of the most important resource in of any project. We usually consider all resources as equal but the thing is all resources are not equal in the sense that some all relatively more important than other or in other sense that without those most significant ones we cannot deploy rest of the resources in an efficient manner. For every "project, productivity, cost, quality, and time" have been the main controlling factors as well as important too. It may be wrong to say that only labour is the main concerning factor or machinery is the main concerning factor because all these resources are dependent on one another to get processed.

But since we as the emerging global leaders of the world have best of the resources to be used in construction industry still if we are lagging somewhere then that is the organized manner of labour utilization.

Labor is the first and foremost important resource in the construction. Labor productivity reflects the role of manpower with that of the financial output of the project." Productivity is the rate of having effective outcome of the inputs in order to have set objectives". Increase in efficiency of labour productivity correlating itself with profitability, competition, achievement of key stakeholder propositions as well as long-term growth and sustainability of a company, and country too. This study has tried to focus on defining the term productivity, measuring techniques and also the factors constraining labor productivity.

Construction labor productivity has been studied by researchers to identify the loopholes hindering opportunities for productivity improvement and hence tried to find cost effective as well as most efficient way of project completion.

By selecting Himachal Pradesh as it is a hilly terrain this study has choose five study sites for the purpose of having the idea about the labour performance in this region.

1.2 Scope of the Study

The construction field is very vast and wide. Different methodologies and techniques have made us to reach the edge of efficient and productive construction. Past methods of construction and planning have formed the base of the present and future construction. Construction field is ever green industry that will continue to grow until the human life extinct. To overcome this problem now we need to deeply think over the weak points of our older techniques and methods. Here the term methods specifically deals with planning methods and technologies.

With the growing economy we need to professionalize our assets too in order to be in the race of productive growth. To this thing if we are using the best of best that we have then we can achieve our goal of productive growth in construction industry. But thinking over and again over this we find certain factors that stops our path of achieving the 100%productive project.

"So scope of this project is to find those factors and also to work on the remedies of those factors in order to rectify the faults coming in our way of productive construction."

This scope itself is linked to various things further that are:

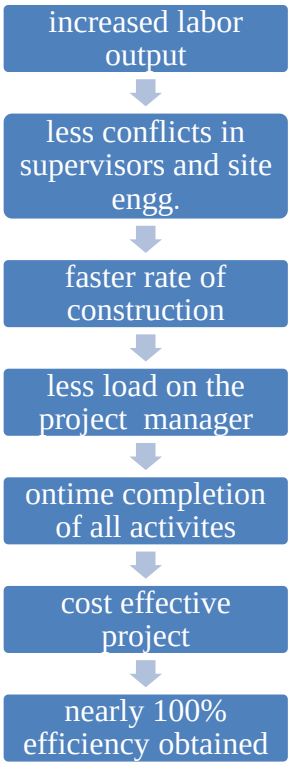

Fig 1.2 Overall Effect of Improving Labour Productivity

1.3 Goal of Study

This project deals with the productivity in a construction industry. So our main motive is to improve the productivity (output) in a project with minimal wastage of resources and in optimized way by studying the hilly terrain of Himachal Pradesh to have a peep inside the loopholes of any project in this region.

1.4 Objective of the Study

The project's main goal is very wide in the sense that different things have to be considered at each step of the project in order to bring the success to the final project. These objectives thus concerns with following things who's completion can lead to the completion of the goal of the study.

- To understand the importance of the productivity in construction industry.
- To find out the factors that affects the real performance of the productivity and the project.
- To see the regional trend of using resources.
- To find out the reasons for the gap in the productivity in that region.

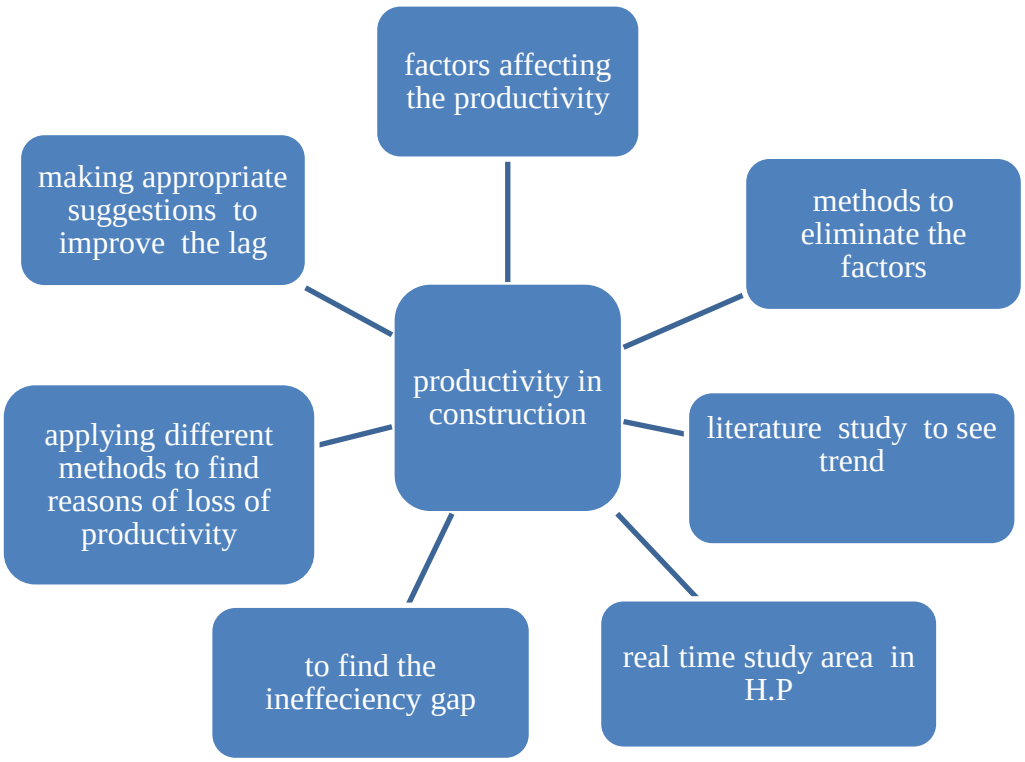

Fig. 1.4 diagram showing the overall objectives of this study

1.5 Meaning of Productivity

Productivity in a general sense is defined as the output of any industrial process.it is defined as the rate at which a company produces goods and services, keeping in view the amount of resources present. But productivity in technical terms can be given as the "ratio of the quantity of input to the quantity of output".

Productivity = quantity of input /quantity of output

the input is defined in terms of labor hours and the denominator is defines as the installed quantities at the end of the project.

Productivity is basically labor intensive.it is measured as the labor hours per unit of the work.

The objectives defined above also shows the significance of the productivity in any project the main concerning factors are the:

- Productivity
- Cost
- Quality and
- Time

Analysis impact of productivity influencing factors on construction production is one of the way of productivity modeling.

1.6 Productivity Significance

- To measure the industrial trend
- To allow comparing performance.
- To see the effect on scheduling of different activities in a project.

1.7 Sources that May Help

These are some of the sources that may help during studying the productivity in a project:

- Contract document
- Progress report
- Project database
- Time studies

1.8 Essentials for the Study

For understanding the productivity result at the end of the project we need following three things:

- Accurate data (past record)
- Consistent data (without any missed data in between)
- Comprehensive data (correlated data)

1.9 Probable Factors Affecting the Labour Productivity

1. Environmental factors
2. Material availability
3. Safety
4. Quality
5. Manpower
6. Time available
7. Motivational leadership
8. Strikes caused by political parties
9. Frequent revision of drawing (rework)
10. Lack of locally available labor
11. Financially weakness of a contractor
12. Scanty financial policies of the government
13. Waging seven days without holidays
14. Previous data not available
15. If available then not consistent
16. Manual collection is time consuming

All these factors and in what way they affect the project productivity are explained.

1. **Environmental Factors:**

Construction industry is one among those industries whose performance directly depends on the environment (climate). If the climate is hot enough like 55deg temperature, like in Dubai then this will adversely affect the performance of the labor. Similarly if the temperature is too low then again it will hinder the workers to work in an efficient way.

2. **Material Availability:**

What if all the labor is on the site to work and the material necessary like cement, aggregates etc. are not there. This lead to wastage of time and hence the overall productivity will be affected.

3. **Safety:**

Safety is the most important part of the construction industry. But sadly this part is generally ignored in India specially. It has a direct relation with the productivity of any project. if there is a facility of first aid at the site and all other necessary amenities are also present at every point of time with the labor then the pace of the work can be fully maintained.

It is also connected with the economy of the project less the tragedies happened at the site less is the medical expense of the project. Thus final productivity will automatically high.

4. **Quality:**

The term quality is defined as the "standardization of the product". It means if we are compromising with the quality we are ultimately compromising with the standards of the project and thus with the productivity of the project.

5. **Manpower:**

Manpower is one of the important resources of the construction industry. Without efficient manpower no progress can even be made. if we have the man power of say 2000 workers and out of those 2000 only 100 workers are efficient and good in their work and the rest cannot put their efforts up to the mark then all the activities will start to be delaying and hence final productivity will be hindered.

6. **Time Available:**

Time is also one of the important factor that actually has a very significant effect on the productivity of the project. What if all the activities are delayed and are not completed on time?

The answer is, in order to maintain that time gap the labor will be forced to work against their fixed schedule and hence this will lead to stress, fatigue, restlessness, mental and physical illness.

All these things are the consequence of short time to complete the project. And due to these things the final productivity will thus be hindered.

7. **Motivational Leadership:**

Motivation is like food that we need every day. It makes man to move further in spite of all the worse things that may had happened. If the workers are pressurized day to day and they are forced to follow their regular routine finally they will be fed up of their work and this will lead to slow down of the work, again hindering the performance of the project.

8. **Strikes Caused by Political Parties**:

Whenever such a situation happens the whole process of working comes to a halt. Labor is not allowed to work and hence the work is forced to be stopped. In such circumstances the time for completion of project and the labor wages are the two important factors that get obstructed. And without these two factors the final productivity is zero.

9. **Frequent Revision f Drawings (Rework):**

When rework has to be performed then it needs a lot of time and manual work both by the labor at the ground and by the higher authorities at the planning level. Thus a lot of time and manual efficiency get wasted in again rescheduling the work also the original work gets deviated from its own path. Hence the productivity is hindered.

10. **Lack of Locally Available Labor**:

In a project the contractor has to arrange the labor for the work. Due to lack knowledge and training of most of the labor class people it becomes difficult for the contractor to arrange the labor. Hence he has to choose the people who have a little more knowledge of work. This work of finding the good labor is actually very tedious and it also affects the economy of the project. Now both economy and time to find such labor has direct relation with the productivity of the project. Hence this is also one of the very important factors that may affect the productivity.

11. **Financial Weakness of Contractor:**

In most of the developing and struggling countries this is a very stressed out factor to be accounted for. The contractor who actually organizes labor suffers from the lack of money. It is not always important that the contractor is also the local person of that area. But it may be possible that he may belong to a much farther place. In such a conditions the contactor has to arrange the money for him for going back to his home also he has to save the money for the labor. Such things put pressure on the contractor for arranging a small labor group and thus the final output is again hindered against large amount of work.

12. Scanty Financial Policies of the Government:

This is a factor which is most prominent in the government sectors. If a government firm is working as a construction body then it needs assets. Those assets are the responsibility of the government to be provided at the exact time of need to the company. To fulfill these purpose of financial help government even start many of the policies ,but the lawful obedience of these policies is very rear. Hence the financial support is very less. And as we know money is the important resource of the project hence the project's productivity will finally be hindered.

13. Working Seven Days Without Holidays:

Working continuously without any holiday is just like running continuously without any break. This will finally lead to ending up of the efficiency at the faster rate. With the repetition of same activities all the seven days of a week the efficiency as well as the enthusiasm of workers will end up resulting in the delay of work and hence affecting the final output of the project.

14. Previous Data Not Available:

When talking about the productivity of a construction project we need to look back in the past to have a view at the previous performance of the company to see what are ways of working ,what are the rules and policies ,is the rules and policies were followed up and all such things . This data helps us to see or focus the weak points of the organization and hence helps us to get a full focused view of the activities performed in the past.

15. Inconsistent Data:

Inconsistent data means the data which is not continuous or is misplaced due to negligence. Now if this situation happens it becomes difficult for the interpreter to interpret the past records and hence the productivity cannot be judged or calculated.

16. Manual collection of past data:

If we try to inculcate the old data manually in a well sequenced way then it will become very cumbersome to do this in such a way because then we need to look back into the past and each activity performed in the past should be accounted well and thus all the resources included in it should also be accounted . thus it leads to time consumption and also the final successful result is also not guaranteed.

1.10 Study Area

All these factors in this study are considered pertaining to the locations in Himachal Pradesh.

For the study of overall trend of labour productivity five sites are chosen for the purpose namely:

Site1: Residential area in Palampur district kangra

Site2: Road side construction Kangra District Kangra

Site 3: River side Rajgardh district Sirmour

Site 4: Topographically plain region Kasauli district Solan

Site 5: Urban area solan district Solan

The main purpose of choosing these sites is as follows:

1. To see the effect of location of the construction on the availability of resources and speed of construction like river side, road side etc.
2. To see the effect of population or crowd on the construction of the project like the urban or the rural area construction.
3. To see the interregional variation of the productivity while taking into consideration the climatic effect in that area.
4. Availability and skills of the labour at different locations as for in rural and urban.

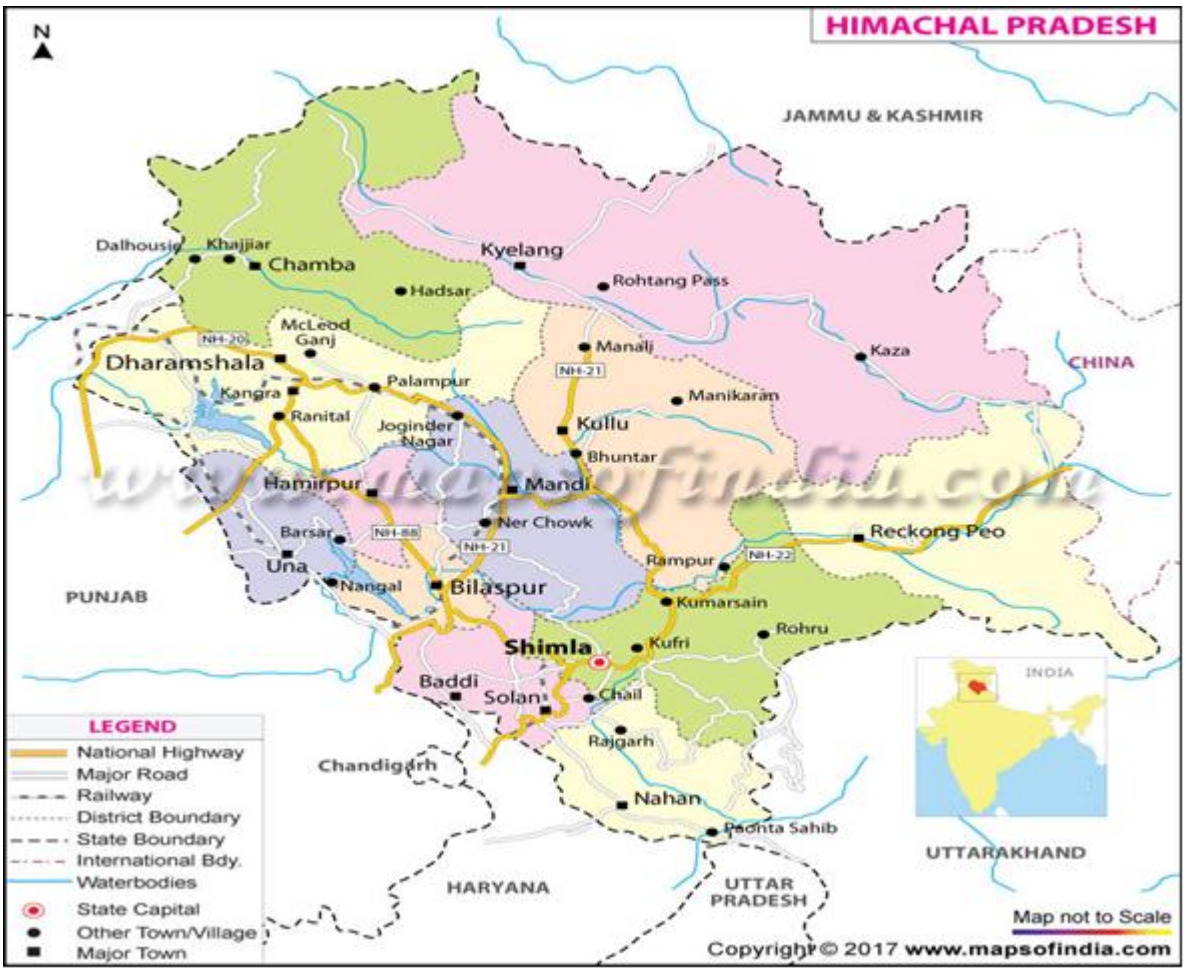

Fig 1.5 Map Showing Districts in Himachal Pradesh

1.11 Techniques for Measuring the Productivity:

1.11(a) Field- Rating Method

Field rating is a method which can be used to estimate the level of activity of construction operation at the field. It is used categorizes the observed workers as either "working" or "non-working" and uses the "working" amount as the measure of effectiveness. Thus different samples can be collected by observing the workers at the site and field rating can be calculated as:

$$field\ rating\ at\ site = \frac{total\ observation\ of\ working\ at\ that\ site}{total\ no.\ of\ obseravtions\ at\ that\ site} + 10\%$$

The total observations of working signify the working labor and total no. of obs. Signifies the working as well as non-working labor in that sample. This 10% accounts for the foreman and supervisory activities.

The no. should generally be above 60% for a job to be satisfactory.

Advantage :

- It is a very simple method.
- Fast method.
- No complicated calculations are involved.

Disadvantages:

- This method does not tell the cause of the unsatisfactory performance, but only tells that there is something wrong .

1.11(b) Work Sampling Method

Work - sampling tool used at site for mammoth observations making at random time intervals for group of resources. The percentage of observations so calculated for specific act or delay is a measure of percentage of time during which that act or delay occurs.

To make it happen , the following approach is to be adopted:

1. Categorize the workers activities as in productive, semi productive(supporting activities), nonproductive.
2. Take the random observations of workers at the site who are involved in a given operation in a field (random means choosing without any bias as to who is being observed).
3. Jolt down all observations so formed. Enter the check mark under the appropriate mode.
4. Add up all the check marks and calculate the quantity as percentage.

Table 3.2(a) work sampling

Observation no.	Productive	Semi productive	Non productive
1	•		
2		•	
3			•
4	•		
5		•	
	40%	40%	20%

This work sampling sheet shows that in a observed sample 40% (2 out of 5) is the productivity ,40%(2 out of 5) is semi productivity and 20%(1 out of 5) is non-productivity .

For making this method of work sampling to be effective the observer must make a large no. of observations .This obs. is derived from sampling error of 5% and a level of confidence of 95%.

Research shows that the productive category should have per. Greater than 30%.

1.11(c) Five – Minute Rating Method of Construction

Comparing to work sampling this technique does not depends upon observing a large sample of observations. This method simply relies upon simply observing an operation for a short interval of time. The method however provide some insight as to the effectiveness of the crew and can identify areas which need attention.

Following procedure is used in this method:

1. Identify no. of crew to be observed.
2. Observe the crew as and when they are working. For the observation interval, determine whether the crew member has been active for those five minutes, if so then mark the corresponding cell.
3. Add the observations altogether and divide by the total no. of observations.

Table 3.2(b) five-minute rating

Time	Spreader	Screeder	Grader	Bull-floater
9.00	❖	❖	❖	
9.05	❖		❖	❖
9.10		❖		❖
9.15		❖	❖	❖
9.20	❖			
9.25		❖		❖
Effective observations	3	4	3	4

Total observations=24 effectiveness= 14/24

Effective observations=14 five minute rating= 58%

1.11(d) Field Surveys

The methods described above covers efficiencies in site operations but is not able to go behind the boundaries in identifying the leading cause for the efficiency.

Field surveying and questionnaire survey are the organized way of involving the craftsman or the foreman, in doing the site evaluation and productivity improvement process.

- **Foreman Delay Survey**

1. FDSs depend on questionnaire which is to be filled out by foreman at the end of the day's work. This is primarily meant to identify the no. of hours of a day lost due to lags .

2. All the data is recorded in a defined format and information is extracted in the form of percentages. Here the actual cause of the delay can also be easily seen.

- **Craft Man Questionnaires**

1. It deals with the issues and concerns that are related to the craft's man motivation and productivity.
2. The motive is to find out the main factors that in any way affecting the productivity of craft man.

3. The study contain 50 questions addressing different areas such as material accessibility, site plan, equipment, rework items and causes of rework, management interference and suggestions for improving the process.
4. Once the questions are completed results are compiled and statics is prepared.

1.11(e) Method Productivity Delay Model

This method is considered to be the best method that combine both time study and productivity measurements .this method wholly depends on collected data, on a special form, pertaining to a cycle time of a leading resource on the operation.

Here the basic feature of delays during the period is also noted. Once the data collection is completed, a set of computation is required to be performed to measures the productivity of the operation. This shows the delay in particular project.

Following procedures are followed in MPDM technique:

1. First step to identify production unit, and following production cycle.

(Production unit is defined as the measureable amount of work that can be visually identified by person recording data without much effort like bucket of concrete ,truck load of debris etc. production cycle is the total time it takes the crew to place one production unit.)

2. Identification of the leading resource.

(*Leading resource may be defined as resource involved in the operation with the most impact on the productivity*.)

3. Marking different types of lag that has probability to occur in the process.

(*Five probable types of delay include those caused by environment, equipment , labor, material and management*.)

4. Data collection

(Here the production cycle is noticed and the delay is also taken into account if exists including its nature based on categories of delays as explained above.)

5. Processing the Data then model analysis and recommendations should follow.

(*Processing of MPDM is completed by filling up of MPDM data collection data sheet. In that table processing column is first of all filled.)*

6. Compute the summary of MPDM computations and also the delay information.

7. The last but not the least step in MPDM computations needs the development of variability of ideal and overall production rates (*ideally these ratios should be small).*

Table 3.4(a) MPDM data collection sheet

Prod. cycle	**Cycle Time (1)**	**Environ. Delay (2)**	**Equip. Delay (3)**	**Labor Delay (4)**	**Mat. Delay (5)**	**Management. Delay (6)**	**Processing Column (7)**
1							
2							
3							
4							
5							
6							
7							

(Col. 7 has to be completed simply by subtracting col1 with the ang cycle times of the where no delay has occurred).

Any delay if happened in any cycle time is marked under the definite category.

Table 3.4(b) Summary of MPDM Computations

	Production total time (1)	**No. of cycles (2)**	**Mean cycle time (3)**	**Sum.(cycle time-non-delay-cycle time)/n**
Non-delayed Production cycle	Sum of all cycles(col1 of table 3(a)) where no delay was observed	No. of cycles where no delay was occurred	Col 1/Col 2	Col 7 of 3(a) for non-delay/col2.
Overall production cycles	Sum of all cycles(sum of col.1 of 3(a))	Total no. of cycles	Col1/Col2	Col 7 of 3(a) for non-delay/col2.

This table shows the computation values that we get from the above table. The table gives a clear view of non-delay as well as overall production cycles that are the most crucial things to be calculated in this method.

Total production time, no. of cycles, means cycle time are clearly mentioned to be calculated and hence this table gives the initial step of doing this method to calculate the delay.

Table 3.4(C) MPDM Delay Information Table

Time variance	**Environment**	**equipment**	**Labor**	**Material**	**Management**
No. of occurrence	Total delays in col 2in table 3(a) for entire row				
Total added time	Sum of this type of delay from col 7 of 3(a) for the entire row				
P(occurring)	Row a divided by total no. of cycles for the entire row				
Relative severity	Row b*col 3 of 3(a) for the entire row				
Expected percentage of delay time	Row c*d*100				

Therefore the variability rate will be

Ideal cycle variability = col 4/col3 of table 3(b)

Overall cycle variability = col 4/ col 3 of table 3(b)

All the calculations from table 3(c) shows the areas where the management need to focus

1.11(f) Charting Technique for Crew Productivity Comparison

Crew-balancing charts are more veracity providing ways of comparing interrelationships among various crew members and equipments required to carry out various tasks. This method especially applicable such cyclic tasks. Vertical bars representing each persons or resource involved in that task. The ordinate of the chart expresses time either as percentage of total cycle time or actual time of day. Every single bar is subdivided in order to show the time required for every single activity involved in the cycle, including idle, nonproductive, and ineffective time. To follow this method, the time for each activity in cycle is recorded.

Suppose there are 4 people employed in the concrete placing named as man1 man2 man3 man4 with their time required to perform their specific task.

A graph should be plotted and comparison should be made between the existing crew and the proposed crew for comparison.

1.12 Simulation Modeling and Analysis

Simulation is a term that can be attached to any term to get the complete status of the term. Her it means "building a mathematical/logical model of a system and experimenting it on computer". The simulation here is only with the CYCLONE methodology. Although there are another methods also but this is the most promising method under simulation.

1.12(a) Different Steps of Simulation

It consists of two basic phases: modeling and experimentation. This method works in the same way as CPM technique for construction projects. The only difference is that CPM is a static method whereas CYCLONE is a dynamic method. Here the resource used could be in one or more states say, active / idle. An active state is represented by the square where as the idle is represented by the circle.

1.12(b) Building a CYCLONE Model

The directives for modeling cyclone network model using these elements are summarized below:

1. The first step is identifying all resources involved in operation to be modeled.
2. Clarifying nature of task to be modeled. Represent them as square (non constrains tasks as normal tasks) and circle (COMBination a task that is restrained by availability of heterogeneous resource).
3. Elucidating resource scarcity in the task and decide where they should wait a constraint task is not available for service. Here QUEue node is used.
4. Establish the logical relationship between these tasks by affixingthe COMBi, NORMAL and QUEue nodes.

1.13 Other Methods

- Direct measuring technique
- Time study technique
- Foreman delay surveys

In the direct measuring technique two terms are generally used, i.e tool time and non- tool time. The main focus in this method is on the non-tool time.

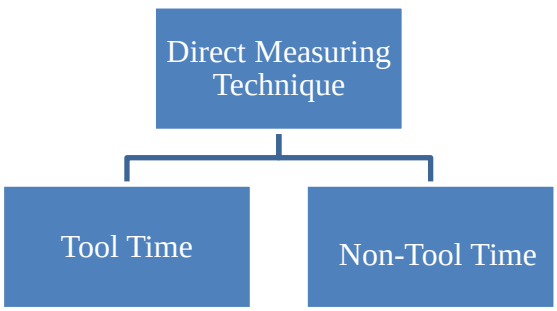

Fig 1.6 Direct Measuring Techniques for measuring labour Productivity

- In time study technique all the activities are recorded as per their time of completion. Here time is one of the main factors that govern.
- Similarly in foreman delay survey a survey is done on the site to have a view of the work from the point of view of the foreman. As foremen is the person who is most closest to the labor and the material on the site.

CHAPTER 2: LITERATURE REVIEW

2.1General

Productivity is the need of all the projects in construction industry. Without healthy productivity any project has its no significance. With the advent of construction field in our society we came to know of lot more things that springs out of this only concept of construction. These things are like productivity in a project, importance of time in a project, importance of labor and at the same time importance of management in a construction company.

With the continuous growth in research field of new and more efficient material's in the construction industry it also became important to fulfill that expenditure on the efficient material with the only possible way of good and healthy productivity.

So here came need of productivity growth in construction field.

With the use of best equipments and best methods however when then the productivity growth of the project remains low then this topic became the hot topic in the construction industry.

In order to demarcate between the healthy project and a bad project this term of productivity growth helps a lot. In order to succeed in this concept we are constantly try to focus on our weak points and we have succeeded in this to a much larger extent. Here are some of the case studies which actually reflect the work done by our researchers and students of construction management. Some of their optimistic work is collected below.

2.2 Studies On Different Methods And Techniques

2.2.1 Case Study on Labor Productivity in Construction Industry

Construction is among the upmost chance availing industry. The quality of being productive in terms of labour performance plays a vital role in determining the outcome of construction project. Labor wage generally bestow 40 to 60% of entire project cost in projects. Thus productivity melioration help reach higher cost savings with minimal investment. Achieving better labor productivity needs elaborate canvas of the actual labor cost. For all project productivity, monetary value, quality, and clip and many more components that vary from site to site have been the main concern. Thus better productivity can be attained via project

management, includes the science of pedagogy and training, the work method, personal wellness, motivational factors, the type of tools, machines, required equipment and materials personal skills, the workload to be executed, expected work quality, work location, the kind of work to be performed, and supervisory personnel. This paper gives the detail study regarding labor productivity such as its definition, its types, different factors affecting on it, different methods used for its analysis[1].

2.2.2 Case Study on Factors Constraining Labor Productivity

(Case Study of Turkmenistan)

The centering area behind this canvas is to place the key ingredients confining labor productivity of Turkish contractors in Turkmenistan. This study based on standpoint of project manager interview, contractors. Qualitative incur via scanning study form the basis for questionnaire appraise carry on among the target populations. In-depth study unveils 28 labor productivity restrained factors, however after the reliability test, corrected scale of the questionnaire consisted of 24 factors. Before going onwards factors were cited as per their mean ratings. At long, testimonials were rendering for improving construction labor productivity of Turkish contractors in the construction industry of Turkmenistan for super scribing the labor productivity hurdles[2].

2.2.3 Case Study on Factors Influencing Construction Labor Productivity

(Indian Case Study)

Diverse study gad been done on this topic as this topic has become hot focus area for the researchers. This area catches everything that comes under the sun in this field. Lot of studies had been concluded in different parts of the world in this regard yet India is lagging in this case. In order to get an idea about the study in India this study focus upon the Kerala state to look at the trend of labour- productivity.

Factors identified as having a significant impact on productivity:

(1) Accessibility of stuff on time at the worksite

(2) Material conveyance lags

(3) Political lockouts

(4) Alteration of plan, ensuing additional work

(5) Detain in handiness of drawings at the worksite.

The resultant is that large no. of factors comes to the light which should be considered while studying this area. The main factors are listed above

The construction sector in India at times bestows to over 5% of the nation's GDP and employs over millions people (Planning Commission, 2008). The contribution of the industry to the economy and job is anticipated to turns importantly in the forthcoming years[3].

.2.2.4 Case Study on Productivity and skillfulness in Development of the Swedish Construction Sector

Sweden labour scenario has also been studied to have an idea about the trend of labour productivity there in. before moving forward value of understanding the already happened and happening scenario is considered of immense importance. The absence of earnest measurement methods, tools for deciding target levels of productivity make disarray for clients, designers, constructors and end-users. The findings of probe using panels of expert practicing channelize by senior researchers unveil defects in the getting of factors of driving productivity as well as uncertainty over where improvements might be achieved. The paper resolves with lineation of further research aimed at improving self-learning in regard to both process and product as part of a broad response to increasing efficiency through creation[4].

2.2.5 Case Study of Construction- Productivity after 2011 Christchurch, Earthquake in New Zealand

More often higher level productivity desired in the construction market. The earthquakes in Christchurch resulted changes in the way, construction sector works. The changes bear on the sector conveys slit to study the impacts on rising productivity and to employ the deterrent example learnt to the wider New Zealand construction environment. This paper focuses on initial results of a pilot case study in Christchurch over residential buildings utilizing a composite approach. The canvas directs answering what legislative and process changes required for Christchurch deconstruction, rebuild and on-going maintenance and its short-term and anticipated long-term effect on productivity. Canterbury offers a unique opportunity to study changes in productivity because the region is undergoing such rapid changes to its construction sector following the earthquakes[5].

2.2.6 Case Study of Delay Impact Analysis of Lost Productivity in Construction Projects

Project depends not only on the single factor but on pile of factors. To have lost productivity at the end of the project cannot be pointed towards single factor but combination of factors. A similar study done in Taiwan to look at the lost productivity in projects. Different view point s been referred in this regard. Delay impact analysis done to get the basic view delay . in the end , here in this study its been seen that productivity is lost on a project when the contractor's actual amount of labor or equipment hours is greater than the hours planned in its bid . Loss of productivity, resulting from some action with owner's or third party's responsibility, may not be easily detected[6].

2.2.7 Case Study on the Wallop of weariness on Labor Productivity

(Case Study of Dam Construction Project in Queensland)

The intent of the research presented here was to deal study on the extent of the weariness on the productivity of a construction crew in a dam construction project in Queensland, Australia. To accomplish the research aims, the Palm Psychomotor Vigilance Task (PVT) reaction tests were used to measure the reaction time of a sample of concrete crew members at different times during the day onsite over a one-week period. Measuring reaction times of workers relevant levels of fatigue determined. It was also found through productivity analysis that the average cost due to fatigue causing decreased production rates was $50,000 per annum for a concrete crew consisting of 10 members. The recommendations to mix the work between difficult and simple work for crew members, scheduling to arrange mix, allowing short breaks when moisture content and temperature are high[7].

2.2.8 Case Study on Construction Productivity Measurement(Comparative Study of Two Cases)

To get an idea of what is happening exactly in this industry we need to compare the old data or another projects data with other project. Recently institutions and industries calling for a growth in productivity suggest a grave need to get the measures of productivity levels right. The research reported in this paper forms part of an ongoing Ph.D. study into the issue of construction labour productivity. Seems like the methods to finding productivity are somewhere lagging to find exactly what is desired. This paper reviews the methods of productivity measurement available and describing two studies conducted during this research, with a view of reporting the problems, issues faced when trying to set productivity levels at a project level[8].

2.2.9 Case Study on Productivity Growth in Construction

Measuring productivity enhancement in construction being considered as challenge. This study reflects first results from a Bureau of Labor Statistics research group convened measuring construction productivity. Findings showing labor productivity growth as positive, and fairly substantial, in all four industries. Shifts of labor between construction industries lessen productivity growth by 0.45% a year. Regulation in industry reflects significant negative on productivity, but lessens productivity growth by only 0.15% a year. Undocumented immigrants are important in construction, and often work off the books, but reasonable allowance for their increased presence reduces productivity growth by only 0.1% a year. The influences examined are not sufficient to explain why productivity growth is so much lower in construction than elsewhere. Further work needs access to restricted Census micro data, and so will take many more time to accomplish[9].

2.2.10 Case Study on Productivity Growth and Business Cycle

The purpose of this paper is to examine the degree of productivity change in the construction industry and relate these changes to variations in the business cycle. Productivity change is estimated by creating a bilateral index using data envelopment analysis, complemented with bootstrapping. The results showed that Spanish firms in building construction experienced a fall in productivity because of a decline in technical and scale efficiencies, despite improvements in technology. The productivity change in civil engineering and specialized construction also was negative; however, the source of this decline was technical regress and negative scale efficiency change, although efficiency change and technology scale change contributed positively. The results further revealed that the firms reacted to the financial crisis of the late 2000s by introducing technological change, although the productive, technical, and scale efficiency changes all were negatively impacted during the economic downturn, suggesting an underuse of resources. The rate of growth of construction productivity in Europe, the United Kingdom, and the United States became an issue in the late 1960s when declining growth in output per hour worked and output per person employed became the focus of a large research program (Allen 1985). Despite efforts over the past few decades in a number of countries, the rate of measured growth of construction productivity has remained low compared with many other industries. The possible reasons behind this stagnant growth of productivity are varied and could include such causes as the industry’s high labour intensity, low economies of scale, a lack of competition[10].

2.2.11 Case Study on Factors Influencing Construction Labour Productivity in Egypt

What may be the possible effect of labour productivity in Egypt and what could this cause to the overall industry. This question been challenged and studied here. For the purpose of getting the trend of productivity there questionnaire method had been chosen. Finding foremost the factors affecting overall performance especially labour then relatively ranking among those factors. The study consisted 30 productivity factors classified as the following three primary categories: (1) manual (2) industrial, and (3) management. The third category ranked first, followed by the labor category and the industrial category. It revealed that the following five factors, ranked in decreasing order, are the main factors having effects on construction labor productivity in Egypt: (1) labor experience and skills; (2) incentive programs; (3) accessibility of the material and ease of handling; (4) leadership, competency of construction management[11].

2.2.12 Case Study on Measuring Construction Industry Productivity and Performance

The egress is to rectify productivity and performance in the industry that produces around 40% of all capital formed in New Zealand and that is vital for New Zealand's overall economic performance. To rectify productivity and performance, we must first be able to describe and measure them. There are many possible reasons for the failure in this sector, including failure to pass on price increases, the mix of what is built, how the industry responds to demand, uncertainty over workloads, and how quality, capital and labour units are measured. But firms have little control over these factors. In reality, most firms focused on maximizing returns for shareholders, rather than technical measures of productivity. To do this effectively (i.e. to perform well), a firm must maintain its workforce, use time effectively, adopt new technologies and so on, all of which have the additional effect of boosting overall industry productivity[12].

2.2.13 Case Study of Australian Construction Labour Industry

Australian construction productivity has grown slowly since 1985 and inclined stagnant. Importance behind this study, hence to probe various drivers of construction productivity and to understand possible avenues for improvement. The drivers tested at the national level were R$D, prentice, wage ontogeny, unionization. Choice of these drivers based on earlier construction and productivity research. The findings are significant since these three states collectively account for a majority of construction activity in Australia. This paper begins with productivity growth for Australian construction at the national level, and then produces more detailed state level estimates. Conversely, state based construction data availability dictated a shorter time series analysis[13].

2.2.14 Measuring the Construction Industry's Productivity Performance: Critique of International Productivity Comparisons at Industry Level

International comparisons of construction productivity performance by providing in-depth criticism of the existing literature and highlighting the existing discipline challenges. Using studies on the UKs relative construction productivity performance as an exemplar, it is implicative that any investigation of international productivity differences in this industry level is highly problematic. Productivity estimates do not compare same ones. Data definitions and coverage differ considerably across countries. This paper's contribution is to discuss the methodological challenges facing us today and propose a research agenda. The authors argue that cross-country productivity at the project level can enable a more detailed analysis of the tangible and intangible inputs to the construction process while accounting for the heterogeneous nature of the industry[14].

2.2.15 Optimal Productivity in Labor-Intensive Construction Operations: Pilot Study

Optimal productivity is the highest sustainable productivity level achievable under good management and typical working conditions. This research bestow to the current body of cognition by introducing a two-prong strategy for gauging optimal productivity in labor-intensive construction operations and by applying this strategy to a pilot study on the replacement of electrical lighting fixtures. The starting step, or top-down approach, tries to approximate the upper limit of optimal productivity, introducing system inefficiencies into the productivity frontier—the productivity attained under perfect conditions. This study uses a qualitative factor model to identify this upper limit. The next step, or bottom-up approach, estimates the lower limit of optimal productivity by taking away operational inefficiencies from actual productivity. A discrete-event simulation model provides lower-limit value. An average of the upper and lower limits yields the best estimate of optimal productivity[15].

2.2.16 Study of Factors Affecting Labour Productivity at a Building Construction Project in the USA: Web Survey

Construction projects having lot of heterogeneous factors such as monetary, duration, quality and safety. Construction sector being diverse as it contains, contractors and others. The focus of this study is to find factors affecting labor productivity at a building construction project. 40 factors, categorized into 5 groups, were analyzed and ranked considering Relative Importance Index. The questionnaires were distributed to people at site. Conclusion was the final cost of the projects higher than estimated cost. It's recommended to work on human resources via continuous training programs[16].

2.2.17 Modeling Construction Labour Productivity

This study reviews various work-study models that have been brought from industrial engineering. These are hold ups, activity, and task models. Using research data, these models are shown to be lean productivity models. Two reliable productivity models validated specifically for construction situations are presented. These are the factor model, which accounts for project, site, and management factors affecting productivity, and the expectancy model of motivation, which describes why a crew exerts an effort to perform and how this effort relates to productivity. The indispensable lineaments of the models are described, and suggested the models to be integrated into one comprehensive model to quantify the factors affecting productivity and to forecast performance. Current misunderstandings about productivity appear to stem from at least two problems: (1) Nonstandard terminology; and (2) the application of industrial engineering work-study techniques to construction. When contractors price an activity, they estimate the cumulative productivity based on the broad conditions under which the work will be carried out. Thus, contractors seem to be interested in the cumulative average productivity value that will apply throughout the activity. This goal requires an understanding of what results productivity to vary and by what amount[17].

2.2.18 Productivity Forecasting of Newly Added Workers Based on Time-Series Analysis and Site Learning

Addition of new laborers during construction usually advised the easiest alternative to execute when a schedule delay happens in a construction project. To determine the proper number of new laborers to add is quite challenging because newly added laborers' short-term productivity for their first several production cycles could be significantly different from that of existing laborers. While existing studies suggest that newly added laborers' site-learning might cause such a difference, this process has not been considered when forecasting newly added laborers' short-term productivity. Results showing 'Site learning' means that the more a laborer acclimates to the environs and other laborers at corresponding site, the higher that laborer's productivity will be that the consideration of the site-learning effect prevents the frequent and counterproductive underestimation of the required number of newly added laborers in establishing an accelerated recovery schedule[18].

2.2.19 Construction Labour Productivity Modeling with Neural Network

Regression and neural network modeling techniques is presented for quantitative evaluation of the impact of multiple factors on productivity. The methodology applied to generate productivity models for various activities at site. This task of identifying a mapping function from the independent variables to the dependent variable is analogous to that performed by some of the neural network models such as back-propagation. In the common use of neural network models, on the other hand, apart from the choice of a neural network architecture (which constrains the class of the models or the functions that can be learned), the user does not need to exert much effort to decide about the class of relationships. However, it must be highlighted here that many neural network, approaches to model fitting are closely related to their statistical counterparts. A pragmatic approach, therefore, is to use a mix of tools and techniques drawn from both neural networks and statistical approaches for complex real-world applications such as construction productivity modeling, which is the focus of this study[19].

CHAPTER 3: METHODOLOGY FOLLOWED

3.1 General

The gap between the standard time required to complete the task and the time that we got from the actual execution need to be assessed. This time gap can be a result of many factors that may cause the delay of the work by which these time gaps may result. The effect of this time gap is no single effect but a sum up of many effects that got result. This time lag may result into:

- Financial imbalance of the money in rework
- Extra time for the same task to complete again
- Extra labour may sometimes require to be hired
- Effect on the resources for the project
- Final cost of the project may got changed

Penalties need again financial resources to be recalculated

These are some of the things that results due to even minor change or due to minor gap.

Therefore this is very important or rather we can say that it becomes the need of the time that we should look upon these factors that result into the delayed gap and off course the penalties that we need to bear.

Analytical tools provide the easiest and the fastest way to find these gaps. All the details regarding the project are required to be entered and thus the standard time that must be required to complete the project should be calculated.

3.2 Methodology Followed

1. The very first one is to study different findings , case studies, research papers, models to have a basic idea about the concept here in this stage different meanings, definitions related to productivity has been studied depending upon the specific need of the different industries. The factor therefore already considered and found out which are affecting the most are thus also studied.
2. The next stage is to perform a work sampling on each site to get the overview about the productivity, semi productivity and non-productivity as per the method described above.
3. The next stage that follows the previous one is five minute observation of workers on each site about their working on site and to find the effectiveness of the productivity in percentage at each site.

4. In order to answer the inefficiencies a questionnaire survey is done on each site regarding some already researched factors.
5. The relative weightage is also found out at each site to see the most concerning factors at each site.
6. Sensitivity analysis is done to check the line of difference by which we come to know the financial or time values below which the contractor has to bear the loss.
7. The whole data is compiled at the end.

Before getting into the analysis part of the data it is important to have an idea about the resource leveling:

Resource leveling:

1. Here the constraint is the fixed project duration
2. Resource is distributed among the required activities during fixed duration
3. It is usually done to reduce peak requirement of resources and to smooth out period to period assignment
4. Also called time limited resource consideration problems

Now considering the following data the analytical calculations for sensitivity analysis of factors:

Rework	5000/- per year for 10 years
Material Acquisition Cost	500,000/-
Efficiency of the labour	100,000/- per year for 10 years
Working Without Holidays	50,000/-
Interest Rate(disbursement rate)	12%
Service life	10years

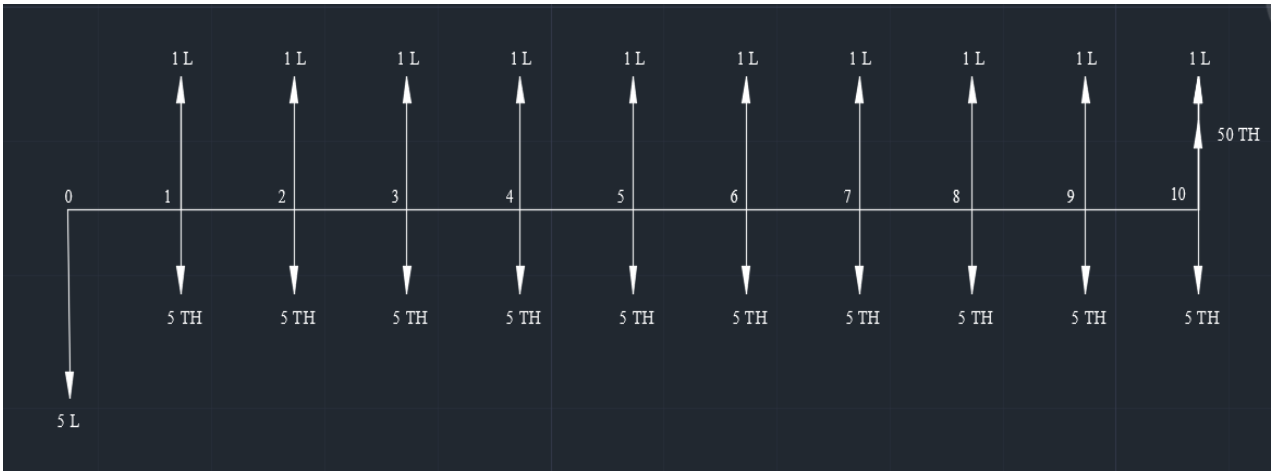

Fig 3.1 Cash flow diagram pertaining to the considered data

$$NPW = -500{,}000 - 5000\left[\frac{P}{A}, 12\%, 10\right] + 100{,}000\left[\frac{P}{A}, 12\%, 10\%\right] + 50{,}000[\frac{P}{F}, 12\%, 10]$$

CHAPTER 4: RESULTS AND DISCUSSIONS

4.1 General

The very first step in this study is to have an idea about the lag in a project. In order to find this inefficiency gap, real site data is made to enter in the analytical tool (Primeavera Contractor). From that a time gap of 59 days had been found as the original time taken by the laborers on site was 180 days and what we get at the analytical tool was just 121 days. This was done in order to have an idea about the delay in terms of time. Picture captured from the analysis is shown here.

Activity ID	Activity Name	Original Duration	Remaining Duration	Schedule % Complete	Start	Finish	Total Float
assignment building estimate wbs		121	121	0%	03-May-17	02-Sep-17	0
SUBSTRUCTURE		19	19	0%	03-May-17	22-May-17	0
Foundation work		19	19	0%	03-May-17	22-May-17	0
A	Excavation	7	7	0%	03-May-17	09-May-17	0
C	first class brickwork	6	6	0%	16-May-17	22-May-17	0
B	Lime concerete	6	6	0%	10-May-17	15-May-17	0
D	reinforcement	4	4	0%	16-May-17	20-May-17	2
SUPERSTRUCTURE		102	102	0%	23-May-17	02-Sep-17	0
Concrete work		62	62	0%	23-May-17	24-Jul-17	0
F	brickwork	32	32	0%	29-May-17	29-Jun-17	0
E	DPC	5	5	0%	23-May-17	28-May-17	0
G	Plastering	25	25	0%	29-Jun-17	24-Jul-17	0
Steel work		15	15	0%	29-May-17	12-Jun-17	17
I	MS work	6	6	0%	29-May-17	03-Jun-17	26
H	RCC work	15	15	0%	29-May-17	12-Jun-17	17
Finishes		40	40	0%	25-Jul-17	02-Sep-17	0
M	Floor finish	20	20	0%	14-Aug-17	02-Sep-17	0
J	panels and hold fastings	7	7	0%	25-Jul-17	31-Jul-17	0
K	pipe fittings	5	5	0%	25-Jul-17	29-Jul-17	2
L	white washing	13	13	0%	01-Aug-17	13-Aug-17	0

Fig 4.1 analytical tool work sheet

4.2 Work Sampling Method Data Results

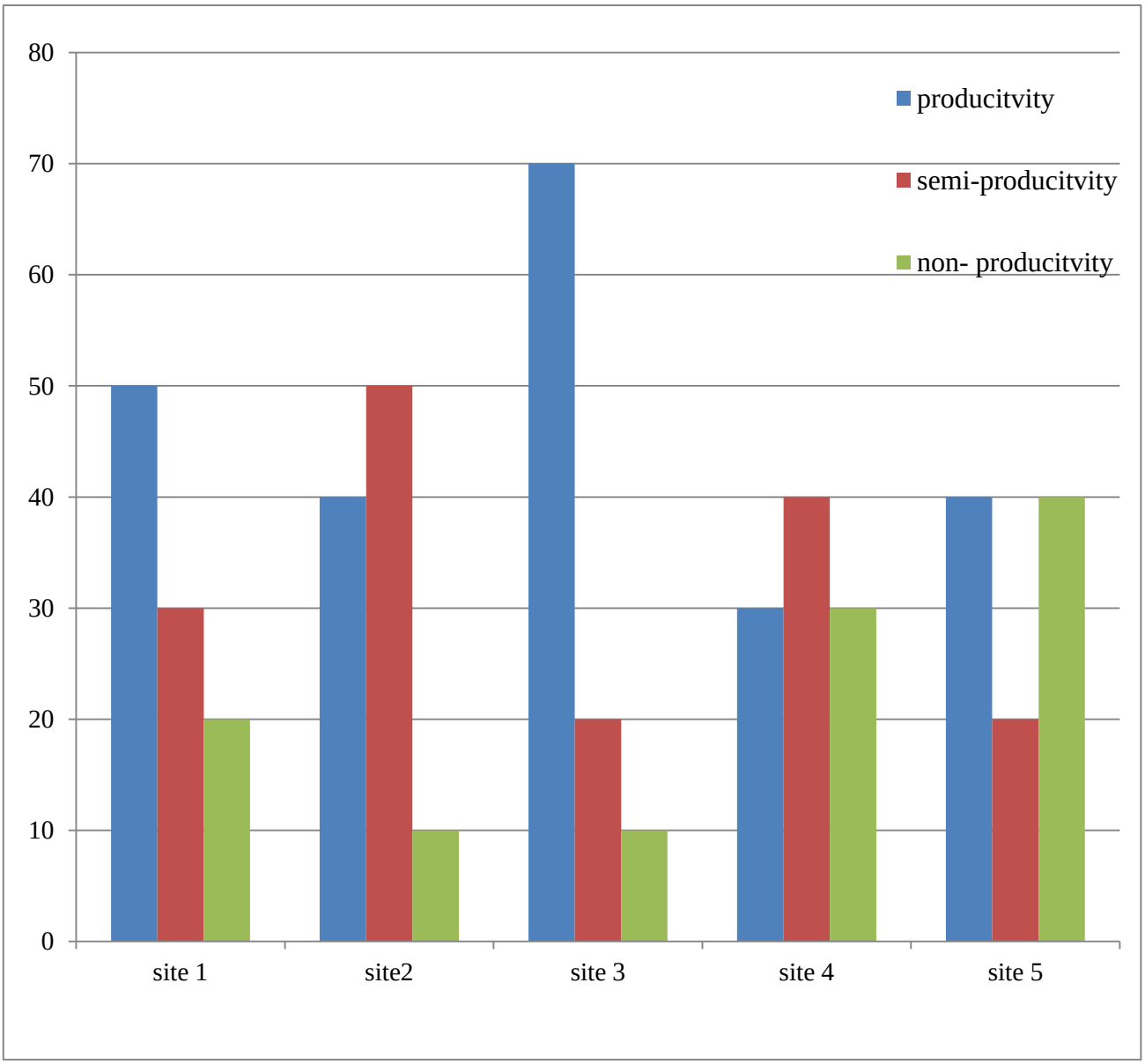

Fig 4.2 Histogram Showing Productivity of Different Sites Where X Axis Shows Different Sites and Y is Representing Productivity, Semi Productivity , Non- Productivity at in Percentage at Different Sites.

The basic idea behind constructing different levels of productivity, semi productivity and non-productivity is to compare the level of productivity rate at different sites.

Data has been calculated in percentage to show the overall performance at each site.

4.3 Five Minute Rating Method Results

Main purpose of conducting this method in this study is to have an idea about the use of various machines used at the site. For the four resources the percentage use is calculated at each site and the results are shown in the form of pie representation.

4.3.1 Residential Area of Palampur (Site 1)

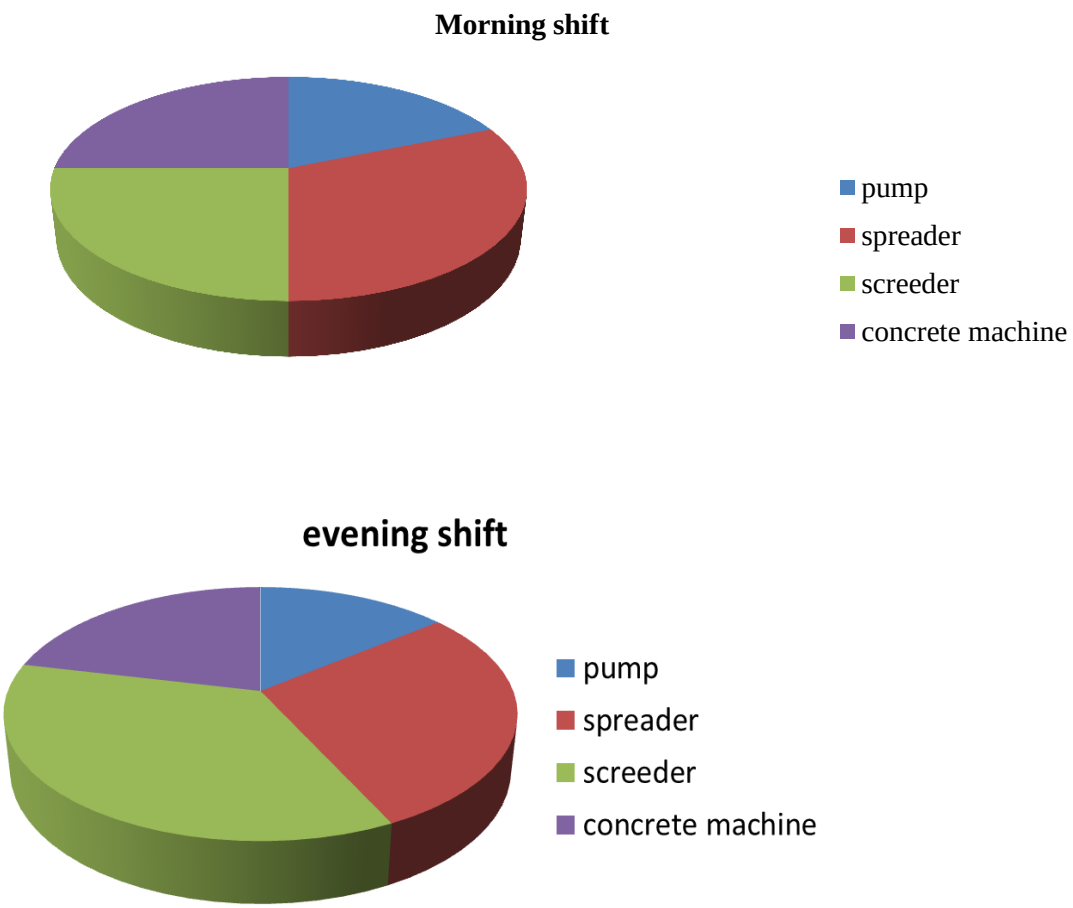

Fig 4.3.1 Distribution Pattern of Resources Used at Site 1 During Morning and Evening Shifts

Table No. 4.3(a) Resources Use Effectiveness at Site 1

Total observations	Effectiveness in morning shift	Effectiveness in evening shift
24	66%	58.3%

4.3.2Road Side Construction Kangra (Site 2)

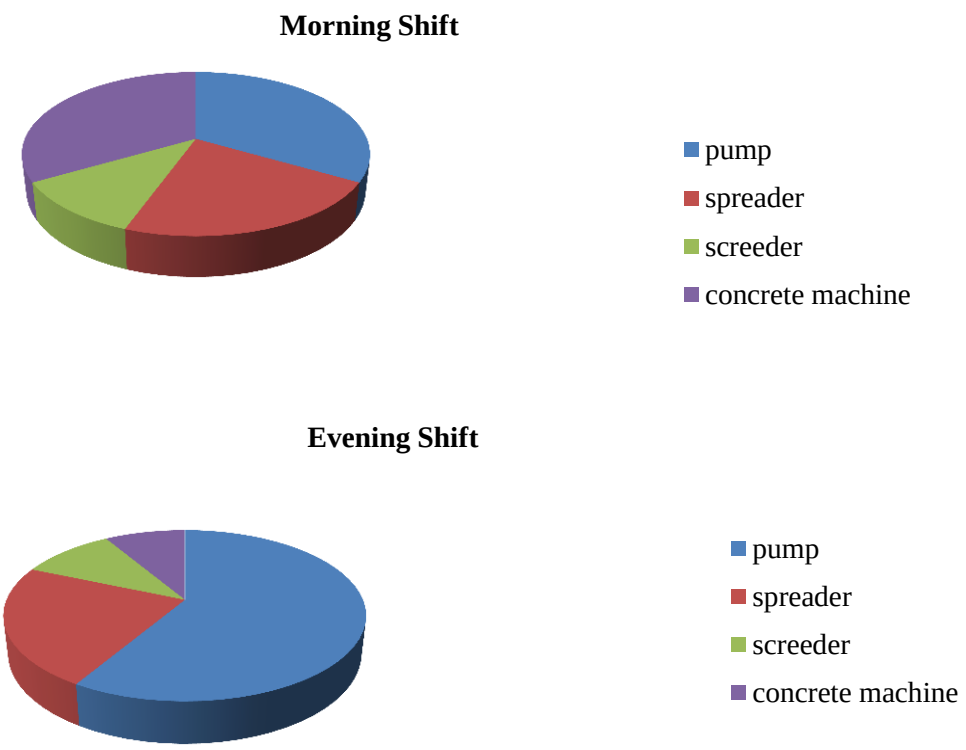

Fig 4.3.2 Distribution Pattern of Resources Used at Site 2 During Morning and Evening Shifts

Table No. 4.3(b) Resources Use Effectiveness at Site 2

Total observations	Morning shift effectiveness	Evening shift effectiveness
24	37.5%	70.8%

4.3.3 River Side Construction Rajgardh(Site 3)

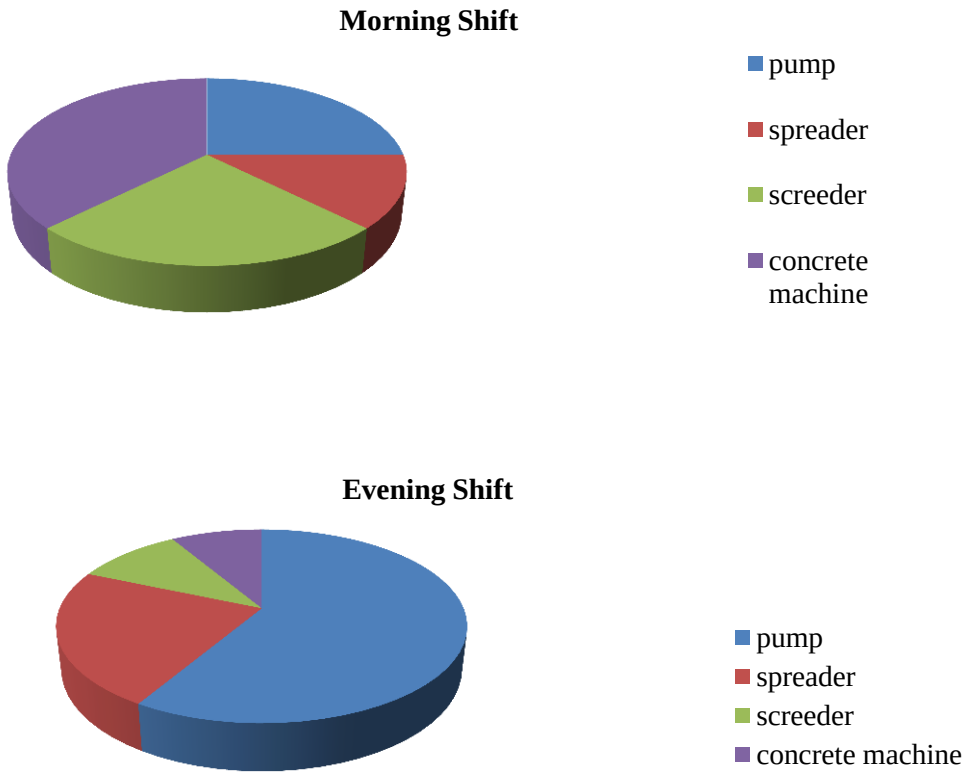

Fig 4.3.3 Distribution Pattern of Resources Used at Site 3During Morning and Evening Shifts

Table No. 4.3(c) Resources Use Effectiveness at Site 3

Total observations	Effectiveness in morning shift	Effectiveness in evening shift
24	33%	54%

4.3.4Topographically plain area kasauli (site 4)

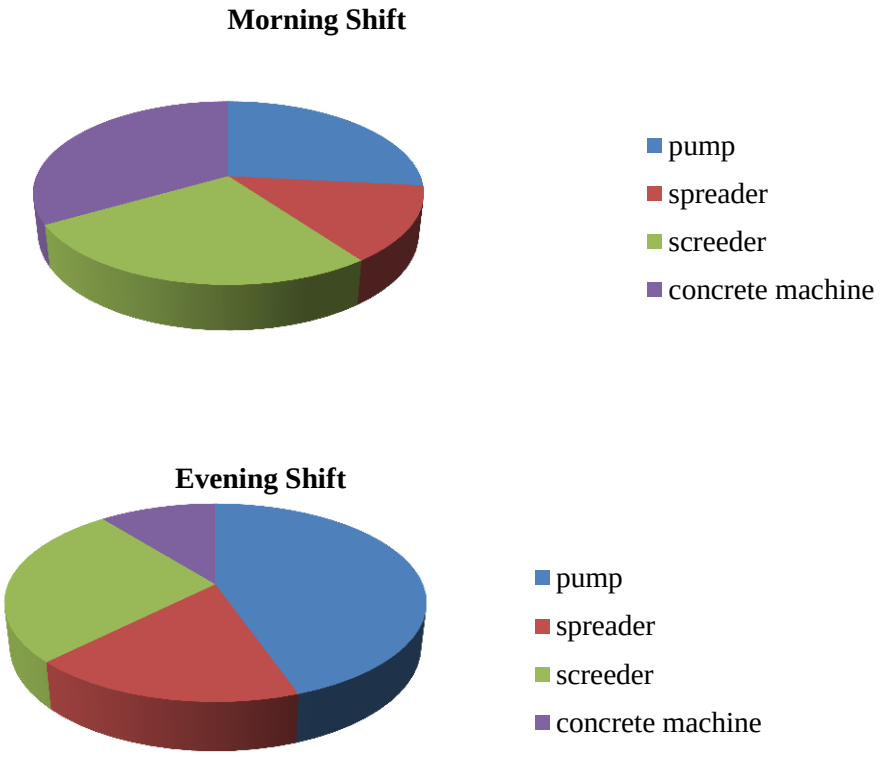

Fig 4.3.4 Distribution Pattern of Resources Used at Site 2 During Morning and Evening Shifts

Table No. 4.3(d) Resources Use Effectiveness at Site 4

Total observations	Morning shift effectiveness	Evening shift effectiveness
24	62%	54%

4.3.5 Urban Area of Solan (Site 5)

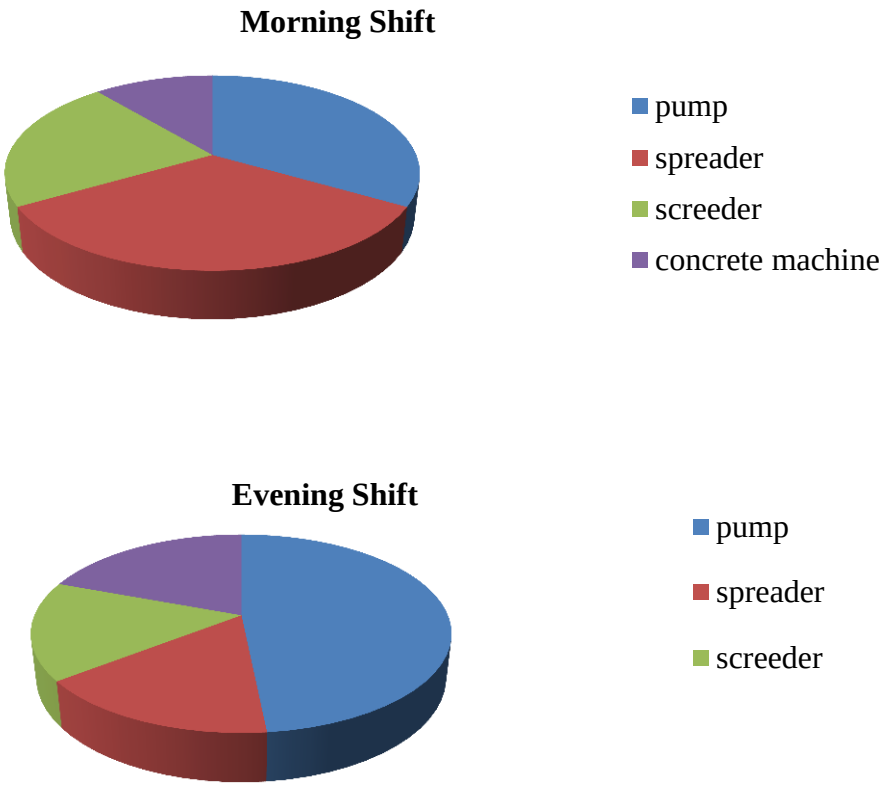

Fig 4.3.5 Distribution Pattern of Resources Used at Site 5 During Morning and Evening

Table No. 4.3(e) Resources Use Effectiveness at Site 1

Total observations	Morning shift effectiveness	Evening shift effectiveness
24	45%	41%

4.4 Questionnaire Survey Data

Table no. 4.4(a) Data collection site 1

S.No.	Factors	Subjective Weightage	Maximum Weightage	Total No. Of Respondents
1	Environment	4	4	8
2	Material availability	2	4	1
3	Safety	4	4	7
4	Quality	3	4	8
5	Labour supervision	1	4	8
6	Time availability	3	4	7
7	Motivational leadership	2	4	7
8	Political strikes	4	4	7
9	Rework	4	4	1
10	Lack of locally availably labour	3	4	7
11	Financial weakness of contractor	3	4	7
12	Inadequate policies of govt.	2	4	8
13	Working without holidays	4	4	1
14	Availability of tools	4	4	8
15	Miscommunication between contractor and labour	4	4	8
16	Efficiency of labour	3	4	1

Table 4.4(b) relative weightage of factors at site 1

S.No.	Factors	RII	Ranking
1	Environment	0.125	5
2	Material availability	0.500	3
3	Safety	0.142	4
4	Quality	0.093	6
5	Labour supervision	0.031	9
6	Time availability	0.142	4
7	Motivational leadership	0.071	7
8	Political strikes	0.142	4
9	Rework	1.00	1
10	Lack of locally availably labour	0.107	6
11	Financial weakness of contractor	0.107	6
12	Inadequate policies of govt.	0.162	8
13	Working without holidays	1.00	1
14	Availability of tools	0.125	5
15	Miscommunication between contractor and labour	0.125	5
16	Efficiency of labour	0.750	2

4.4.1 Most Crucial Top Five Factors

Table 4.4(c) top five factors at each site

Site/factors	**Site1 (rural dense area Palmpur)**	**Site2(road side constructio n kangra)**	**Site 3(river side construction Rajgardh)**	**Site 4(urban dense area kasauli)**	**Site 5(urban dense area Solan)**
Factor 1	Rework	rework	Material availability	rework	Rework
Factor 2	Efficiency of labour	Efficiency of labour	Working without holidays	Efficiency of labour	Efficiency of labour
Factor 3	Material availability	Material availability	Efficiency of labour	Working without holidays	Working without holidays
Factor 4	Safety	Safety	Rework	Material availability	Financial weakness of contractor
Factor 5	Labour supervision	Political strikes	Financial weakness of contractor	Financial weakness of contractor	Time availability

These factors are considered based on the relative weightage formula given below:

Relative importance index (RII) = {∑ (w)/ A* N}

Where,

W is the weight given factor by each respondent that covers 1 to 4 as defined below

- 1 representing not-applicable
- 2 as not affecting
- 3 as affecting some way
- 4 as heavily affecting
- A highest weightage as 4

N showing total no. of responses collected

4.5 Sensitivity Analysis From Iso Quants

The red zone in all the graphs are reflecting the rejection zone in the sense that any value in terms of rupees if falls in this category it will surely leads to loss for the contractor.

The term "Th" is representing thousand as all the units in these graphs are in rupees.

4.5.1 Residential Area Palampur (Site 1)

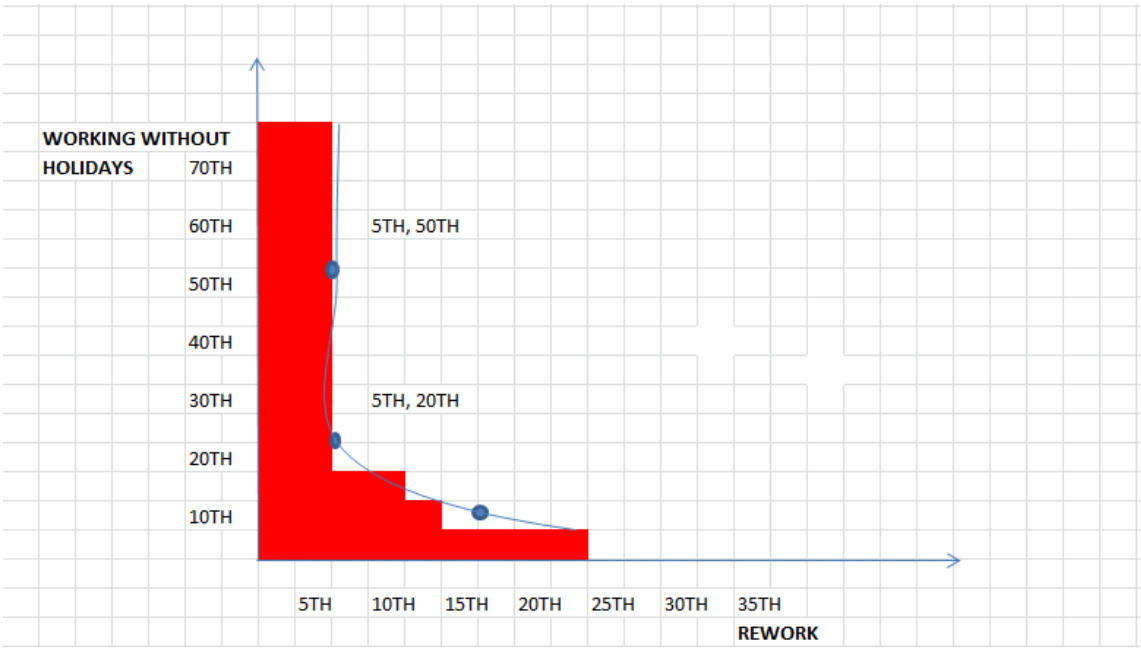

Fig 4.5.1 graph showing rework vs. working without holiday on X and Y axis respectively and the red zone of rejection

4.5.2 Road side construction Kangra(Site 2):

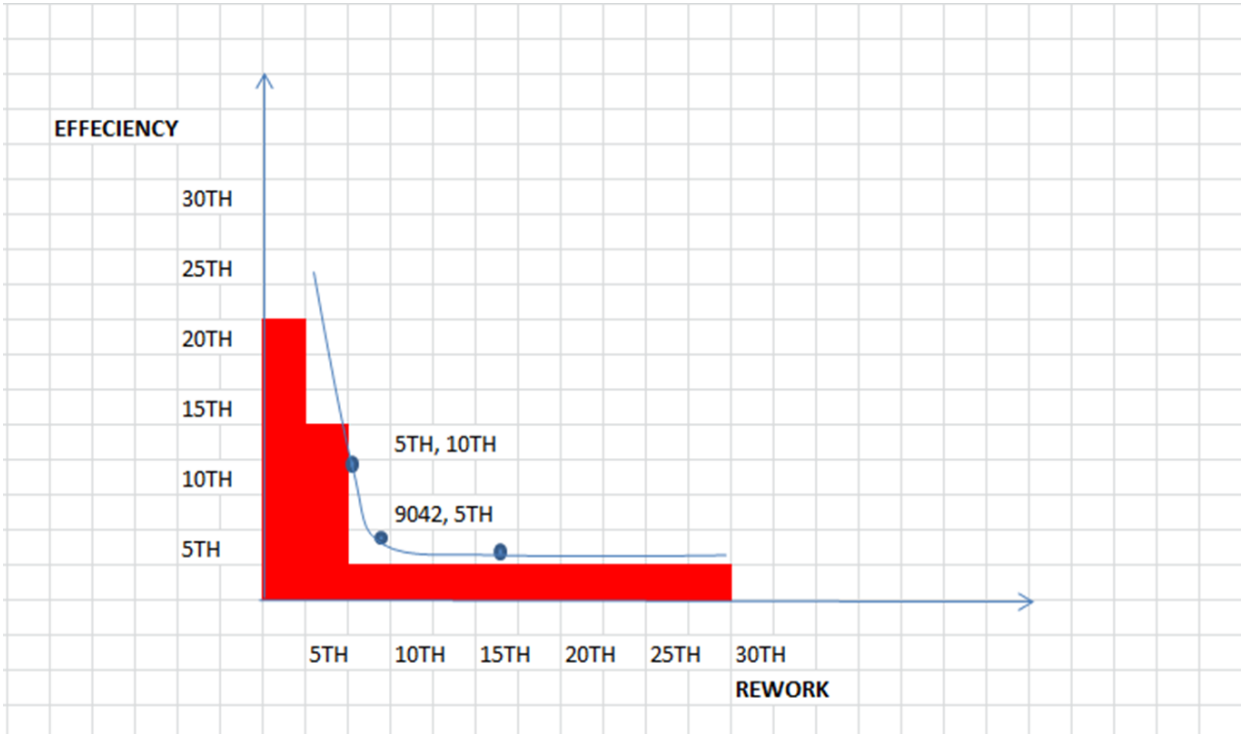

Fig 4.5.2 graph showing rework vs. efficiency of labour on X and Y axis respectively and the red zone of rejection

4.5.3 River Side Construction Rajgardh (Site 3)

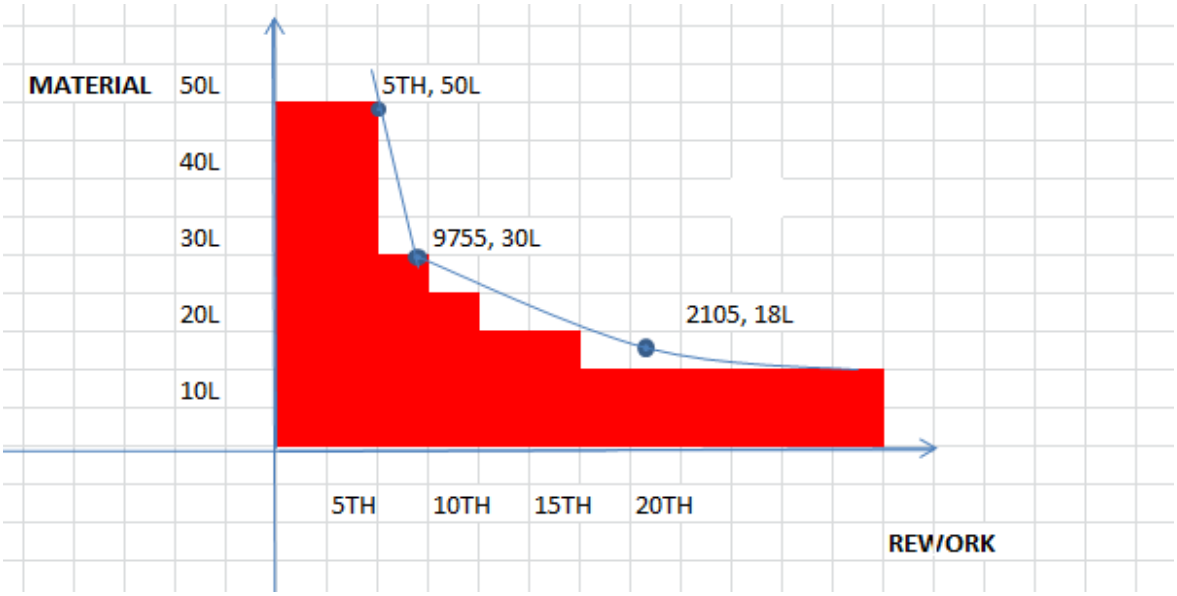

Fig 4.5.3 graph showing rework vs. material availability on X and Y axis respectively and the red zone of rejection

4.5.4 Topographically Plain Area Construction Kasauli (Site 4)

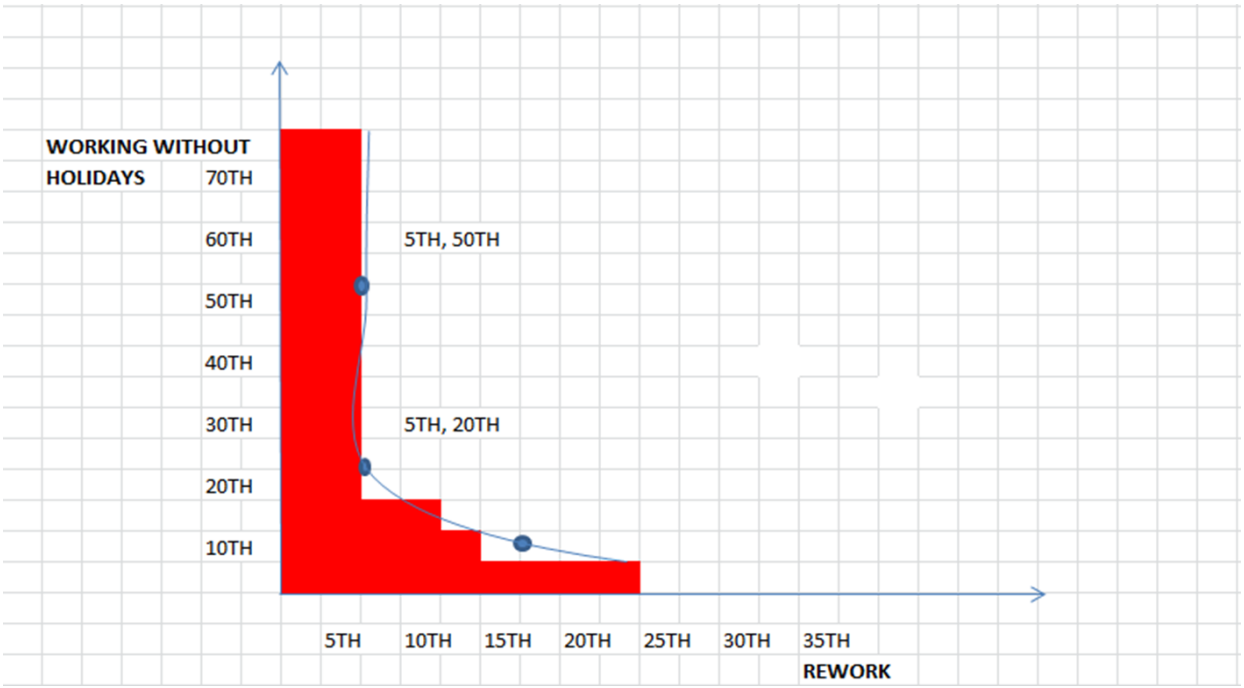

Fig 4.5.4 graph showing rework vs. working without holiday on X and Y axis respectively and the red zone of rejection

4.5.5 Urban Dense Area Solan(Site 5)

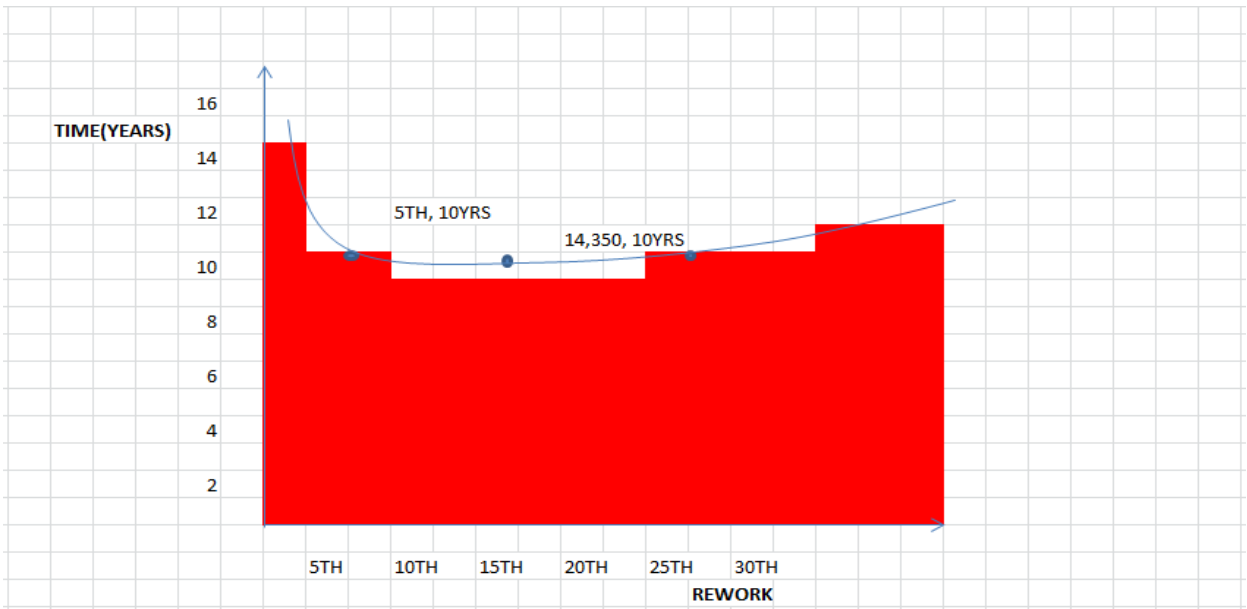

Fig 4.5.5 graph showing rework vs. time on X and Y axis respectively and the red zone of rejection

4.6 Observations in Terms of Factors From Above Study

1. Topographical factors variation
2. Tradition use of tools(urban area or local area)
3. Climatic conditions
4. Location of construction
5. Training of the labour(speed in doing work)
6. Batching plant distance
7. Haul distance
8. Literacy of labour(way to do work)
9. Material availability(easiness)

From the insight of the study till date we can say that lot of work has been don. But still we are unable to groom up the industry. The reason behind this may be poor or non-implementation of the method and ignorance of things that are very much important for the project but are ignored. There may be different reasons for this and these loopholes results in ineffective output of labour productivity even if we have lot of research till date:

1) The studies are region specific and thus the conditions are always different for any new locality. Therefore the methods or precaution that we have reviewed may vary as per the location.
2) Similar to the nature of region the nature of labour at different regions is different within country or outside country depending upon the living standard and needs of the laborer's family.
3) There may be lot of models to find out the effective product ivy but all these methods or techniques are based upon some predefined assumptions. And those ideal conditions are difficult to maintain
4) Since construction industry is very vast but the studies or experiments are always done on a sample of tangible people, this earmarks another limitation to implement those solution and methods on that vast labour force.
5) Labour industry is dynamic in the sense that continuous day by day changes are coming either in the materials or machinery etc and thus to focus on labour with only those old methods is another point of inefficiency.

4.7 Suggestions to Rectify the Loopholes

1. Generalized methods are required to be found is that most of the regional disparities can be accommodated.
2. Labour selection model should be standardized so that in every company the contractor has to fulfill those criteria so that labour literacy, health, living conditions and such criteria s can be fulfilled.
3. Segregation of labour based on skilled, unskilled and such should me made.
4. Hierarchy of work from top manage meant to bottom laborer should be fully divided so that there may be no overlap of ordered sort miss communications.
5. All those important factors that hinder the labour productivity should be standardized by the global organization so that their ignorance means hug loss to the organization.

4.8 Suggestive Selection Criteria

1. Identify main goal and associated objectives

2. Identify the kind of resources we have and the estimate of time of whole project

3. Identify the activities to be performed:

- CPM and PERT
- SIMULATION MODEL

4. Identify nature of work:

- Skilled
- Unskilled
- Experienced

5. Screening for the labour:

Main aim to do so:

a. Segregation of labour as

Technical

No technical

b. On the basis of performance and ranking

c. Expertise in tools to be used in particular projects

d. Segregate helper labour and technical labour

Certain tests that can be performed are:

- PILOT SURVEY
- RATING(project specific)
- LABOUR SHIFT TES

6. Prepare a ranking table as shown

S.No.	Id No.	Speed	Knowledge	Accuracy
Overall ranking				

7. Apply analysis methods:

- MPDM METHOD
- CREW BALANCE CHART
- FIELD SURVEYS

8. Exclude the factors that deviates the goal fulfillment using

- MANUAL ANALYSIS
- NEURAL NETWORKS

9.Again filter the selection criteria using

- NEURAL NETWORKS
- SPSS SOFTWARE

10. Compare RATING graph data with SPSS data

11. Underline the new factors hindering output

12. Apply same criteria until SPSS indicates the optimal resources

13. Compare on global standards (under consideration)

14. New selection of labour periodically

4.9 Advantages of Proposed Model

a. Since working on productivity means to work on our future realistic projects.
b. With the improved productivity manpower on the field can be reduced.
c. The amount of money to be invested in the project should comparably be less as compared to past and some of the present projects.
d. Output will automatically enhance.
e. Quality improvement should definitely be improved.
f. Time required for rework is also reduced to much large extend.
g. Well efficient ways will pave a path for the construction organization to less sweat over their projects.
h. Moreover safety aspect will also be improved.
i. All type resources such as time, money, manpower will all be consumed in a optimized way.

4.10 Disadvantages of Proposed Model

Since the new emerging methods are quite professional so we need professionals to work with these new methods.

a. Management of the organization need to work on in and have to installed new soft wares and which is time consuming.
b. To opt these new techniques higher authorities are required to have sessions organized for the workers.
c. For those it will be costly too to hire new workers as well as new specialists to work on these new techniques.

4.11 Applications of Study in this Area

a. With proper research we can take this construction industry to higher levels. The concept of India being a developing country can be fulfilled to some extent if we opt these new methodologies.
b. Since construction is the main objective of every country there using productivity as one of the important tool we can accomplish this objective.
c. More reliable, beautiful, well planned and on time projects can be completed.
d. Even opting these concept standards of living of the labor class can also be improved.

CHAPTER 5: CONCLUSIONS AND FUTURE SCOPE

Construction industry is the world's largest and dynamic industry. The materials, labour, methodologies are continuously changing over here. To be in the race of developed countries this industry needs to be strengthens the most. Till now we have come across large variety of ideas and techniques to enhance the efficiency of our nation in this field.

In this study the main focus is on the labour intensive productivity. We are trying to find out new ways to make us in the race of developed countries. This labour intensive productivity is not only a single concept but rather it can solve many more problems like unemployment, illiteracy rate, improves standards of life apart from technical development.

Some new techniques have already been evolved and the researchers are still working on new ideas. The best of the techniques are inculcated in this repot and the future scope and advantages to make easy understanding about the things has been added too.

Work sampling method

Reflects how much non-productive, semi-productive works are taking place at each site. Thus this is directly reflecting the weaker areas of the laborers as well as their surrounding conditions, personal problems and many more factors that have been defined above that how these factors are obstructing the labour to come into the segment of productive one.

Five- minute method of rating

This shows the labor's resource usage and handling at various sites. This trend shows how much labour within Himachal Pradesh is efficient at different places or how much labour is comfortable in using different resources at different regions within H.P.

This trend is directly reflecting that there is a grave need to implement labour training to the laborers as well as they should have basic ideas about the use or working with different construction material like cement, admixtures, water cement ratio etc. at the work site.

Questionnaire survey to find reasons of inefficiency

This data sheet is giving the reasons that why there is any kind of labors inefficiency in the project that is leading to the overall deficiency of productivity in the project. These gaps are Cleary pointing towards the vulnerabilities in the surrounding, labour training in efficiencies as well as many different factors that may lead to poor productivity at the end of the project.

Future Scope

Overall in the end if we conclude we can say that this new approach can lift our construction industry to even more higher levels. So we can proceed with the progress of this nation in parallel with the technical growth in construction industry too.

Using the concept of PRODUCTIVITY GROWTH IN CONSTRUCTION we can accomplish our aim of constructing the efficient buildings. In any project time is one of the most important factor that can lift the project to great success or even make the project to suffer from the penalties. These factors may lay finally pressure on those who are owners of the projects. Thus using new software and field techniques which are much more fast and efficient we can save such of our time in planning and also we can work on our weaker sections too.

Thus our projects then can be completed will 100% surety ,on time completion, no tension of output and even beautify our construction industry. This may lead to increase in clients thus increasing investment in not only single project but in multiple projects.

In short we can accomplish all those things which are required in any idle project by just focusing on the productivity growth of project.

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APPENDIX

Isoquant calculations for acceptance and rejection zone:

Rural dense area Palampur (site 1):

$$NPW = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + 50{,}000[0.3220]$$

Major concerning factors at this site:

1. Rework
2. Working without holidays

Assuming or keeping one value constant say rework in this case and finding the optimum value of the other factor by equating the NPW equation to zero.

$$0 = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + x[0.3220]$$

After getting this one value then moving to another value by assuming two different values and finding the value of NPW.

Putting Rework as 5000 again and other factor as 10,000/- and calculating the NPW again

NPW= -114189/- (rejection zone)

Therefore trying another value where this NPW turns to be positive.

Therefore another points are Rework as 5000/- and Working without holidays as 20,000/-.

Road side construction Kangra (site 2):

$$NPW = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + 50{,}000[0.3220]$$

Major concerning factors at this site:

Rework

Efficiency of the Labour

Assuming or keeping one value constant say rework in this case and finding the optimum value of the other factor by equating the NPW equation to zero.

$$0 = -500{,}000 - 5000[5.6502] + x[5.6502] + 50{,}000[0.3220]$$

After getting this one value then moving to another value by assuming two different values and finding the value of NPW.

From above equation value of x comes out to be 9042.9/-

Trying other values for which NPW doesn't turn to negative value and plotting the lines and get the desired line.

Topographically plain region Kausauli (site 4):

$$NPW = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + 50{,}000[0.3220]$$

Major concerning factors at this site:

1. Rework
2. Working without holidays

Assuming or keeping one value constant say rework in this case and finding the optimum value of the other factor by equating the NPW equation to zero.

$$0 = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + x[0.3220]$$

After getting this one value then moving to another value by assuming two different values and finding the value of NPW.

Putting Rework as 5000 again and other factor as 10,000/- and calculating the NPW again

NPW= -114189/- (rejection zone)

Therefore trying another value where this NPW turns to be positive.

Therefore another points are Rework as 5000/- and Working without holidays as 20,000/-.

Urban densely populated area Solan (site 5):

$$NPW = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + 50{,}000[0.3220]$$

Major concerning factors at this site:

1. Rework
2. Time

Assuming or keeping one value constant say rework in this case and finding the optimum value of the other factor by equating the NPW equation to zero.

$$0 = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + x[0.3220]$$

After getting this one value then moving to another value by assuming two different values and finding the value of NPW.

Value of x come out as 14,3570/- (acceptance zone)

Trying another pair of values for which NPW doesn't come out to be negative.

River side construction Rajgardh (site 3):

$$NPW = -500{,}000 - 5000[5.6502] + 100{,}000[5.6502] + 50000[0.3220]$$

Major concerning factors at this site:

1. Rework
2. Material availability

Assuming or keeping one value constant say rework in this case and finding the optimum value of the other factor by equating the NPW equation to zero.

$$0 = -(x) - 5000[5.6502] + 100{,}000[5.6502] + 50000[0.3220]$$

After getting this one value then moving to another value by assuming two different values and finding the value of NPW.

Value of x come out as 9755.4 /- (acceptance zone)

Trying another pair of values for which NPW doesn't come out to be negative.