STUDY ON LABOR PRODUCTIVITY OF CONSTRUCTION PROJECTS IN BIHAR

A

Thesis

Submitted in partial fulfillment of requirement for the degree of

MASTERS OF TECHNOLOGY

IN

CIVIL ENGINEERING

With specialization in

CONSTRUCTION MANAGEMENT

Under the supervision

of

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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY
WAKNAGHAT, SOLAN-173234, HIMACHAL PARDESH
May-2022

CERTIFICATE

This is to certify that the project report entitled **"STUDY ON LABOR PRODUCTIVITY OF CONSTRUCTION PROJECTS IN BIHAR"** submitted by Biprendra Kumar, Roll No. 202604 in partial fulfillment of the requirements for the award of Masters of Technology in Civil Engineering with specialization in Construction Management has carried out under the supervision of Mr. Kaushal Kumar (Assistant Professor) & Mr. Akash Bhardwaj 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.

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This is to certify that project report entitled **"Study on Labour Productivity in BIHAR in Construction Project and Improve Overall Productivity of the Construction Projects"** submitted by Biprendra Kumar Roll No. 202604 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.

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ACKNOWLEDGMENT

I would like to extend my sincere thanks to my supervisor Mr. Kaushal Kumar, Assistant Professor, & Mr. Akash Bhardwaj, Assistant Professor, Department of Civil Engineering for his able guidance and support till now in understanding the core of this subject. Without his help, encouragement and generous counsel, it would have been impossible for me to understand the things and proceed further.

I would like to express my immense gratitude to the Jaypee University of Information and Technology for assistance and help till now with their excellent source provided for students.

(BIPRENDRA KUMAR)

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 of the most challenging and very large sector. After having world-class equipment and highly skilled labour and even high technology the end productivity when checked results out to be very less than expected. So what is that thing that even after having "the best" of everything hinders the way of 100% productivity and efficiency? The answer to this tough question is not very complicated and the answer is "labour productivity in the field".
Precisely talking about the labour productivity that summarises to talking specifically about the key resource in of any construction project. In the construction industry, We generally assume all resources as having equal weight-age but the important thing is all aspects are not similar in the context that some of them are arguably having more weightage than others or in another context that with the absence of those more significant ones, we will be unable to allocate rest of the resources in an optimized manner. For every project, "productivity, cost, quality, and time" have been the major limiting factors as well as having more importance in the construction. It is a wrong hypothesis to talk about only labour being the main governing factor or machinery to be used being the main factor to be concerned because all the resources/materials are in close proximity to one another.

As we are the one to be the emerging global leaders of the world, we have to optimize the best practices for resource utilization in the construction industry, but the fact is that still if we are limping behind anywhere then that is the lack of optimized ways of labour utilization.

Manpower is the top and foremost valuable asset in construction. Man power productivity reflects the role of labour with that of the economical aspects and output of the project. Prolificacy is the rate of having an optimized outcome of the inputs to gain desired objectives. An increase in output capacity of manpower prolificacy correlates itself with profit margins, competitiveness, achieving the key shareholder's propositions as well as long-term goals of growth and to secure the of a company sustainably, and to the nation too. This study has tried to bring the light on explaining the terms labour productivity, measurement of productivity techniques and also the factors hampering the productivity of the labours.

"Construction labour 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 a most efficient way of project completion."

For our study, we have selected Bihar's Construction Industry; five study sites have been chosen to have an understanding of the labour performance in this region.

1.2 Research Scope

The field of infrastructure industry is very large and widespread. Various hypotheses; methods and procedures have given us a favorable start ahead of efficient and profitable construction. "Previous construction and planning methods laid the foundation for current and future construction. The construction industry has always been a green industry and will continue to grow until it loses its lives. To overcome this problem right away, you need to ponder the weaknesses of old methods and methods. The term method here specifically deals with planning methods and technologies."

As the economies of countries are rising, we need to accelerate our asset expertise to track productivity growth. With the best we have, we can reach our goal of productive growth in the construction industry. But if you keep thinking about it, you'll find certain factors that prevent you from achieving a 100% productive projects. "Therefore, the purpose of this project is to find these factors and work on fixing them to fix the errors that occur in a productive building journey."

The area itself has variety of other things. It can be shown with the schematic diagram

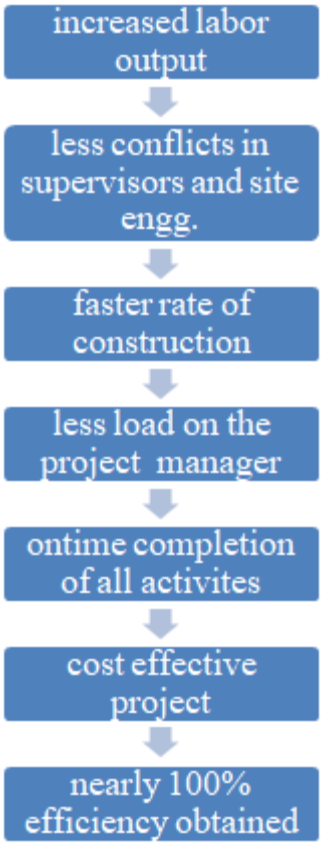

Fig 1.1 Scheme for increasing productiveness of labour

1.3 Research Goals

This research work will try to limit the work in the field to the productivity of the construction projects. So the main motive is to improve the productivity (output) in a project with minimal wastage of resources and in an optimized way by studying the construction works being carried out in the BIHAR state of India, to have a Broad perspective of the deficiencies of any construction works carrying out in this region.

1.4 Research Outcomes

The research's top aim is big in the context that many parameters have to be considered at each step of the research to fulfil the objectives of the project. These outcomes thus concern with various parameters whose completion can wave a path to the finalization of the goal of the study.

- To understand the importance of productivity in the 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.

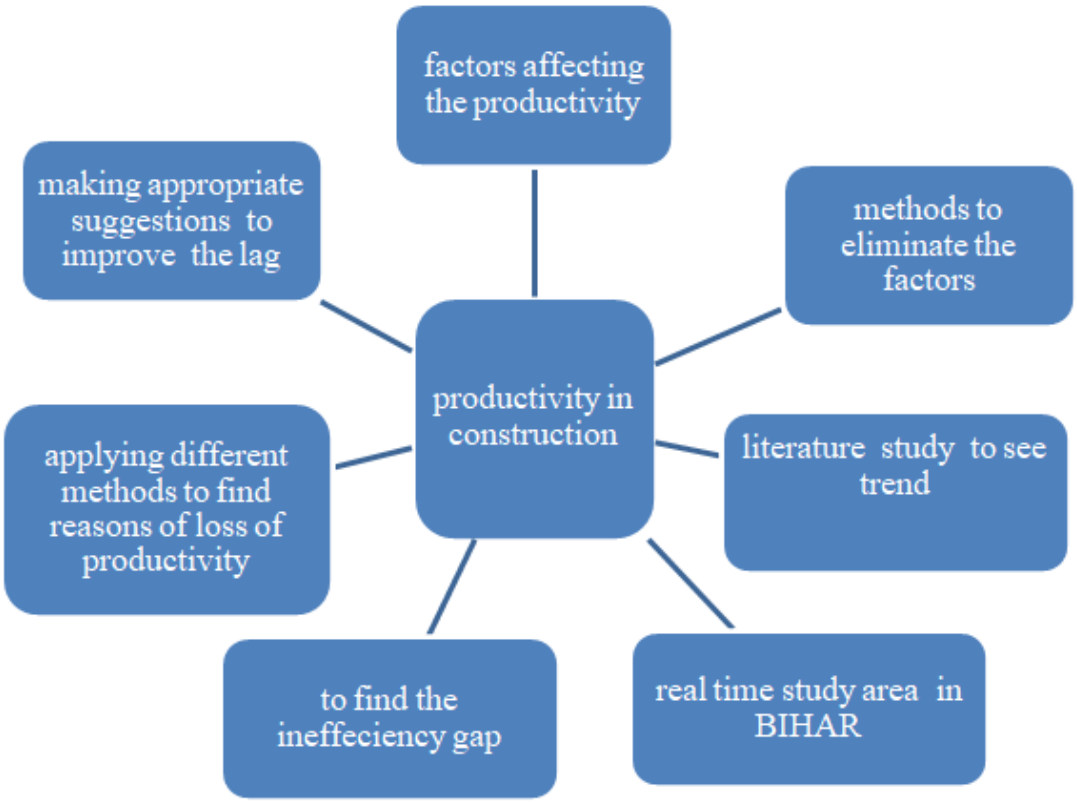

Fig. 1.2 Outcomes of the research

1.5 Defining Productivity/Construction Productivity and its Significance

Productivity is defined as the yeild of any industrial process. It is defined as the rate at which an industry yeilds product and services. Productivity in technical terms can be given as the "ratio of the quantity of input to the quantity of output".

$$Productivity = \frac{Quantity\ of\ inputs}{Quantity\ of\ Output}$$

Input can be difined as in terms of working hours and the minimum value is defined as the amount entered at the completion of the project. Production requires more staff. Measured as working hours per unit of work.

The objectives described above also reflect the productivity of any project and the main features are:

• Production

• Cost

• Quality of Product

• Time of Completion

Analysis of the impact of productive impact on building materials is one of the modes of production model.

Significance of the productivity is as follows

- Observing Construction Industry Trends
- To differentiate the Performance
- To see the effect on scheduling of different activities in a project.

1.6 Important References to look at;

The references that can be helpful while researching the lack of the productivity in a project:

- Contractual files
- Weekly/Monthly/Yearly Construction Progress reports
- Project Metadata
- Time schedules

1.7 Indispensability of the Research

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

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

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Production is a necessity for all projects in the construction industry. Without sound production, every project is worthless. As the construction industry emerges in our society, we know much that comes only from this concept of architecture. These are the productivity of the project, the value of the project time, the value of the staff, as well as the importance of the management of the construction company.

With continued growth in the field of innovative and effective research in the construction industry, replenishing these costs for efficient materials is the only way to produce good quality and healthy products. It is becoming more and more important.

This created the need to increase production in the construction industry. If you are using the best equipment and methods, but your project's productivity growth remains low, this issue has become a hot topic in the construction industry.

The concept of growth of this product is very helpful in distinguishing between healthy and bad projects. To achieve this goal, we always focus on our weaknesses and strive to do it on a much larger scale. Here are some examples of studies that explain the work of our researchers and students in construction management. Some of their hopeful work are summarized below.

For any nation’s economy to grow, construction productivity is very important and plays a significant role in the industry (Naoum 2016). The construction industry serves significantly as a source of employment and makes a remarkable contribution to the performance of the overall economy (Giang and Pheng 2011). Labour is known as the most crucial and flexible resource used in construction projects and construction productivity is directly related to labour (Muqeem et al. 2012). Construction projects hire a large number of workers, thereby, it can be stated that manpower is the dominant productive resource; therefore construction productivity is highly dependent on human effort, efficiency and performance (Jarkas 2010).

There are several definitions provided of productivity by different researchers. The term ‘productivity’ is generally defined as the maximization of output while optimizing input (Naoum 2016; Durdyev et al. 2018). Henceforth, it is known as a measure of the ratio between an output value and an input value used to produce the output (Borcherding 1977; Ameh and Osegbo 2011; Durdyev and Mbachu 2011; Jang et al. 2011; Ibbs 2012; Jarkas and Radosavljevic 2013;

Gundecha 2013; Yi and Chan 2014; Rami Huges 2014; Robles et al. 2014; Shashank et al. 2014; Naoum 2016; Sveikauskas et al. 2016; Dixit et al. 2017; Durdyev and Mbachu 2018; Ohueri et al. 2018; Alaghbari et al. 2019; Ayele and Fayek 2019; Dixit et al. 2019; Shoar and Banaitis 2019; Zhiqiang et al. 2019). The output consists of products or services and the input consists of materials, labour, capital and energy (Drewin 1982).

Construction Labour Productivity (CLP) is defined as the units of work placed or produced per man-hour (Bekr 2017). Therefore it can be measured in terms of earned hours (Thomas et al. 1990). Yi and Chan (2014) defined 'Productivity' as the power of being productive, and efficient and the rate at which goods are produced. Griego and Leite (2017) defined productivity as work produced by the workers in a construction project. The most common CLP metrics are unit rate (ratio of labour cost to units of output); labour productivity (ratio of work hours to units of output) and productivity factor (ratio of scheduled or planned to actual work hours) (Gouett et al. 2011).

A low level of productivity is one of the most challenging concerns faced by the construction sector (Jarkas and Bitar 2012). Construction industries in many countries across the world are greatly concerned about the low level of productivity (Lim and Alum 1995; Egan 1998; Ayele and Fayek 2019). A low level of productivity is dangerous and causes inflationary pressure, social conflicts and mutual suspicion in the nation's economy (Drucker 2012; Dixit et al. 2019; Shoar and Banaitis 2019). By acknowledging the factors that cause low CLP, project managers can address the problems at an early stage, thus minimising the time and cost overruns (Kaming et al. 1997; Kaming et al. 1998; Abdul Kadir et al. 2005; Palikhe et al. 2019; Seddeeq et al. 2019). The CLP significantly influences the profitability of construction companies; however, CLP exhibits the highest variability among project resources and thus, a major source of project risk (Tsehayae 2015). Labour in projects is also the most difficult element to define, manage and quantify the impact. In this sense, it remains important to determine the factors affecting labour productivity to manage the labour force effectively (Kazaz and Acıkara 2015). Understanding critical factors that affect CLP can help to develop strategies to reduce inefficiencies and to more effectively manage construction labour forces. This will not only improve the project performance of construction companies but also make them more competitive and consequently increase the chances of survival within this highly competitive sector (Ailabouni et al. 2007; Robles et al. 2014).

The major objective of this study is to review the research carried out to date on the identification of the factors related to CLP. A thorough literature review was conducted using available scientific databases to identify the factors related to CLP and rank them according to their importance as mentioned in different studies. The methods used for CLP estimation from the factors are briefly discussed and recommendations are made for the improvement of CLP. The findings of the study can be used, not only by academics, who are interested in the effect of the subject matter on the construction workforce but also by both local and international industry practitioners, who may be further keen to venture into potential mega-scale projects. The study can help construction project management to develop a wider and deeper perspective of the motivational factors impacting the performance of skilled operatives and to provide project managers with guidance for focusing, acting upon, and controlling the critical factors influencing productivity. Thus, the study would assist in achieving efficient utilization of the workforce, and a reasonable level of competitiveness and cost-effective operation

2.2 Literature Review On multiple Methodology and Techniques.

2.2.1 Construction Labor Productivity in Construction Industry a case study

Construction is among the utmost chance availing industry. The quality of being productive in terms of labour performance plays a vital role in determining the outcome of the construction project. Labour wages generally bestow 40 to 60% of the entire project cost in projects. Thus productivity melioration help reaches higher cost savings with minimal investment. Achieving better labour productivity needs an elaborate canvas of the actual labour cost. For all project productivity, monetary value, quality, 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, which 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 a detailed study regarding labour productivity such as its definition, its types, different factors affecting it, and different methods used for its analysis.

2.2.2 Factors affecting Labor Productivity (a *Case Study of a "Turkmenistan"*)

The centring area behind this canvas is to place the key ingredients confining labour productivity of Turkish contractors in Turkmenistan. This study is based on the standpoint of

project manager interviews, and contractors. Qualitative incur via scanning study form the basis for questionnaire appraises carry on among the target populations. An in-depth study unveils 28 labour productivity restrained factors, however, after the reliability test, the corrected scale of the questionnaire consisted of 24 factors. Before going onwards factors were cited as per their mean ratings. For a long, testimonials were rendered for improving the construction labour productivity of Turkish contractors in the construction industry of Turkmenistan for super scribing the labour productivity hurdles [2].

2.2.3 An Indian Case Study on Factors Influencing CLP

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

Elements pointed out to have a critical effect on Construction productivity:

(1) Accessibility of stuff on time at the worksite

(2) Material conveyance lags

(3) Political lockouts

(4) Alteration of the plan, ensuring additional work

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

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

The construction industry in this country at times adds over 10% of the national Gross Domestic Product and gives employment to lakhs of people (Planning Commission, 2008). The importance of providing jobs to the construction industry in the coming year will have a very high impact [3].

2.2.4 Case Study from Swedish Construction Sector on Productivity and skilfulness

Sweden's labour scenario has also been studied to have an idea about the trend of labour productivity there. before moving forward value of understanding the already happened and happening scenario is considered of immense importance. The absence of earnest measurement methods and tools for deciding target levels of productivity make disarray for clients, designers, constructors and end-users. The findings of the probe using panels of expert practising 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 a lineation of further research aimed at improving self-learning regarding both process and product as part of a broad response to increasing efficiency through creation [4].

2.2.5 New Zealand's Case Study of Construction Productivity

More often a higher level of productivity is desired in the construction market. The earthquakes in Christchurch resulted in changes in the way, the 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 the 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 are required for Christchurch deconstruction, rebuild and ongoing 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 Delay Impact Assessment of Lost Productivity in Projects, a case study

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

2.2.7 Labour Productivity (*Case Study of Dam Construction Project in Queenslands*)

The research presented here intended to deal with a 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 one week. 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 are to mix the work between difficult and simple work for crew members, schedule to arrange mix, allowing short breaks when moisture content and temperature are high[7].

2.2.8 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 the data of another project with other projects. Recently institutions and industries calling for productivity growth suggest a grave need to get the measures of productivity levels right. The research reported in this paper forms part of an ongoing PhD study into the issue of construction labour productivity. Other studies highlighted, that less than 50% of the industry measure and monitors productivity levels, with a majority of those companies that claim to measure go about measuring based on the intuition of key site management personnel. Seems like the methods to finding productivity are somewhere lagging to finding exactly what is desired. This paper reviews the methods of productivity measurement available and describes two studies conducted during this research, intending to report the problems, and 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 is considered a challenge. This study reflects the first results from a Bureau of Labor Statistics research group convened to measure construction productivity. Findings show labour productivity growth as positive and fairly substantial, in all four industries. Shifts of labour between construction industries lessen productivity growth by 0.45% a year. Regulation in the industry reflects a 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 much 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 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 several 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, and a lack of competition[10].

2.2.11 Factors Influencing Egypt's Construction Labour Productivity

What may be the possible effect of labour productivity in Egypt and what could this cause to the overall industry. This question has been challenged and studied here. To get the trend of productivity there questionnaire method had been chosen. Finding foremost the factors affecting overall performance especially labour than relatively ranking among those factors. The study consisted of 30 productivity factors classified into the following three primary categories: (1) manual (2) industrial, and (3) management. The third category ranked first, followed by the

labour category and the industrial category. It revealed that the following five factors, ranked in decreasing order, are the main factors having effects on construction labour productivity in Egypt: (1) labour 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 the Australian Construction Labour Industry)

Australian construction productivity has grown slowly since 1985 and is inclined to stagnant. The importance of 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, and 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 the 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 UK's relative construction productivity performance as an exemplar, it is implicative that any investigation of international productivity differences at 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 bestows to the current body of cognition by introducing a two-prong strategy for gauging optimal productivity in labour-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 the bottom-up approach, estimates the lower limit of optimal productivity by taking away operational inefficiencies from actual productivity. A discrete-event simulation model provides a lower-limit value. An average of the upper and lower limits yields the best estimate of optimal productivity [15].

2.2.16 Web Survey Study of Labour Productivity from USA

Construction projects have a lot of heterogeneous factors such as monetary, duration, quality and safety. The construction sector is diverse as it contains, contractors and others. The focus of this study is to find factors affecting labour productivity in a building construction project.

40 factors, categorized into 5 groups, were analyzed and ranked considering the Relative Importance Index. The questionnaires were distributed to people at the site. The conclusion was the final cost of the projects higher than the estimated cost. It's recommended to work on human resources via continuous training programs [16].

2.2.17Modeling of CLP

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 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 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 in productivity vary and by what amount[17].

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

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

2.2.19 CLP Modelling with Neural Network

Regression and neural network modelling techniques are presented for quantitative evaluation of the impact of multiple factors on productivity. The methodology applied to generate productivity models for various activities at the 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 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 networks, and 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 modelling, which is the focus of this study [19].

Based on the literature survey, the following factors have been identified which may affect "construction labour productivity". The following factors are similar to the one where my study site is, that is the Bihar state of India. These factors are mentioned below:-

1. Environmental factors
2. Material availability
3. Safety
4. Quality
5. Manpower
6. Time available
7. Motivational leadership
8. Political Party's Strikes
9. Frequent rescheduling of the work plan
10. Local workforce shortage
11. Contractors Financial condition
12. Irregular policies of the state.
13. Seven days a week work schedule
14. Lack of past record/data
15. Inconsistent available data
16. The manual collection is time-consuming

Above key terms which hindered the Const. Labour Productivity are defined below.

1. **Environmental Conditions:**

The construction industry is one of 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 labour. Similarly, if the temperature is too low then again it will hinder the workers to work efficiently.

2. **Availability of Material:**

What if all the labour 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. **Labor's Safety measures at the site:**

Safety is the most important part of the construction industry. But sadly this part is generally ignored in India especially. 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 labour then the pace of the work can be fully maintained. It is also connected with the economy of the project less the tragedies that happened at the site less is the medical expense of the project. Thus final productivity will automatically be high.

4. **Quality of Material:**

Quality can be explained as the "standardization of the product". It is the way to check the standards of the product at any site with the designed code of standards, it is helpful in a fact that having poor quality of work at site can reduce the productivity of overall project, also the product will not last the desired life.

5. **Workforce:**

Manpower is one of the important resources of the construction industry. Without efficient manpower, no progress can ever be made. if we have the manpower 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 delayed and hence final productivity will be hindered.

6. **Availability of time:**

Time is also one of the important factors that have 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, to maintain that time gap the labour will be forced to work against their fixed schedule and hence this will lead to stress, fatigue, and restlessness, mental and physical illness.

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

7. **The motivational capacity of Leaders:**

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

8. **Political Parties Strikes**:

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

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

When rework has to be performed then it needs a lot of time and manual work both by the labour on 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 path. Hence productivity is hindered.

10. **Local Labor inavailability**:

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

11. **Financially poor Contractor:**

In most developing and struggling countries, this is a much-stressed factor to be accounted for. The contractor who organizes labour suffers from a 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 conditions, the contractor has to arrange the money for him to go back to his home also he has to save the money for the labour. Such things put pressure on the contractor for arranging a small labour group and thus the final output is again hindered against a 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 fulfil these purposes of financial help government even start many of the policies, but the lawful obedience to these policies is very rear. Hence the financial support is very less. And as we know money is an important resource for 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 the ending up of efficiency at a faster rate. With the repetition of the 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. Unavailability of past record:

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 on 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 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 for 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.

CHAPTER 3: METHODOLOGY

3.1 General

The gap between the standard time required to complete the task and the time we get from actual execution needs to be evaluated. This time gap can be the result of many factors that can cause delay in work that these time gaps can cause. The effect of this time interval is not a single effect, but the sum of many effects that take the result. This time delay can cause:

- Financial imbalance of money in reprocessing
- Additional time to complete the same task again
- Extra worker sometimes requires hiring
- Impact on project resources
- The final cost of the project may vary

Needs financial resources to recalculate fines

These are some of the things that come up because of even small deviation or diversion from schedule path.

Therefore, we can say that this is very important, or rather, it has become a necessity of our time to look at these factors that cause delays and of course the penalties we have to endure.

Analytical tools provide the easiest and fastest way to find these gaps. All details about the project need to be entered and therefore the standard time required to complete the project must be calculated..

3.2 Techniques for Measuring the Productivity:

3.2. (a) Field Rating Method

Field Rating is a method that can be used to estimate the activity level of construction operations in the field. It is used to classify observed workers as "working" or "non-working" and uses the "working" amount as a measure of effectiveness. In this way it is possible to collect different samples by observing the workers on the site and the evaluation in the field 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 labour and total no. of obs. Signifies the working as well as non-working labour 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.

3.2(b) Work Sampling Method

Work-sampling tool used at the site for mammoth observations made at random time intervals for a group of resources. The percentage of observations so calculated for a specific act or delay is a measure of the 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 productive, semi-productive (supporting activities), and 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 a percentage.

3.2(c) Charting Technique for Crew Productivity Comparison

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

Suppose there are 4 people employed in the concrete placing named as man1 man2 man3 man4 with their time required performing their specific task. A graph should be plotted and a comparison should be made between the existing crew and the proposed crew for comparison.

3.2(d) Simulation Modelling and Analysis

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

(a) Different Steps of Simulation

It consists of two basic phases: modelling and experimentation. This method works in the same way as the 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.

(b) Building a CYCLONE Model

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

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

3.2(e) 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 of this method is on the non-tool time.

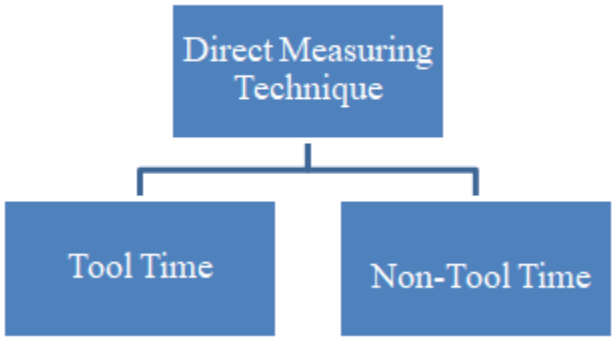

Fig 3.1 Technique of Direct measurement for measuring labour Productivity

- In the 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 the 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. A foreman is a person who is closest to the labour and the material on the site.
- All these methods provide quick calculation of the labour productivity and that too with many transparent results.

These data have been collected on part of the foreman and the craftsman and hence it validates the real-site scenar

3.3 Methodology Followed

1. The very first one is to study different findings, case studies, research papers, and models to have a basic idea about the concept here in this stage different meanings, and 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 an overview of the productivity, semi-productivity and non-productivity as per the method described above.
3. The next stage that follows the previous one is the five-minute observation of workers on each site their working site to find the effectiveness of the productivity in percentage at each site.
4. To answer the inefficiencies, a questionnaire survey is done on each site regarding some already researched factors.

5. The relative weight age is calculated at every location to to figure out the troublesome keys which can affect prolificacy.
6. Sensitivity analysis is executed to examine the deviation that will enable us to be prepare for any contingency.
7. The complete data is organized at the finish.

Levelling or Optimization of the data must be done first before proceeding to optimization.

3.3 Major area for the Analysis

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 results of the survey so far, it can be said that a lot of work is being done. But nevertheless, we are not in a position to sustain the industry. The reason for this may be that the method is poorly implemented or not executed, and that you do not know that it is very important to your project but is being ignored. There are many possible reasons for this, and much research has been done so far, but these loopholes lead to ineffective results in labour productivity.

1) Because the study is region-specific, the conditions are always different from new location to new location. Therefore, the method of confirmation and precautions may vary from place to place.

2) Similar to the nature of the region, the nature of work varies in different regions, both domestic and foreign, depending on the standard of living and the needs of the worker's family.

3) There may be many models for finding effective product ivy, but all of these methods and techniques are based on some predefined assumptions. And it is difficult to maintain these ideal conditions.

4) The construction industry is very large, but research and experimentation are always done with a sample of concrete people, so the implementation of these solutions and methods in this huge workforce is subject to different restrictions. ..

5) The labour industry is dynamic in the sense that changes in materials, machinery, etc. are happening every day, so concentrating on labour using only these old methods is another point of inefficiency. is.

CHAPTER 4: ANALYSIS AND RESULTS

4.1 General

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

4.2 Study Area

Various factors in this research have been accounted to the location used in Bihar state.

For the research of the overall trendline of labour productivity 5 sites are selected for the purpose namely:

Construction Site#1: The Residential area in Ara district Bhojpur

Construction Site#2: Roadside development in District Bhojpur

Construction Site#3: Riverfront Buxar district Buxar

Construction Site#4: Plain field region of Hajipur district Vaishali

Construction Site#5: Urban Development in Sasaram district Rohtas

The main purpose of choosing these sites is as follows:

1. To see the effect of the location of the construction on the availability of resources and speed of construction like riverside, roadside 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.

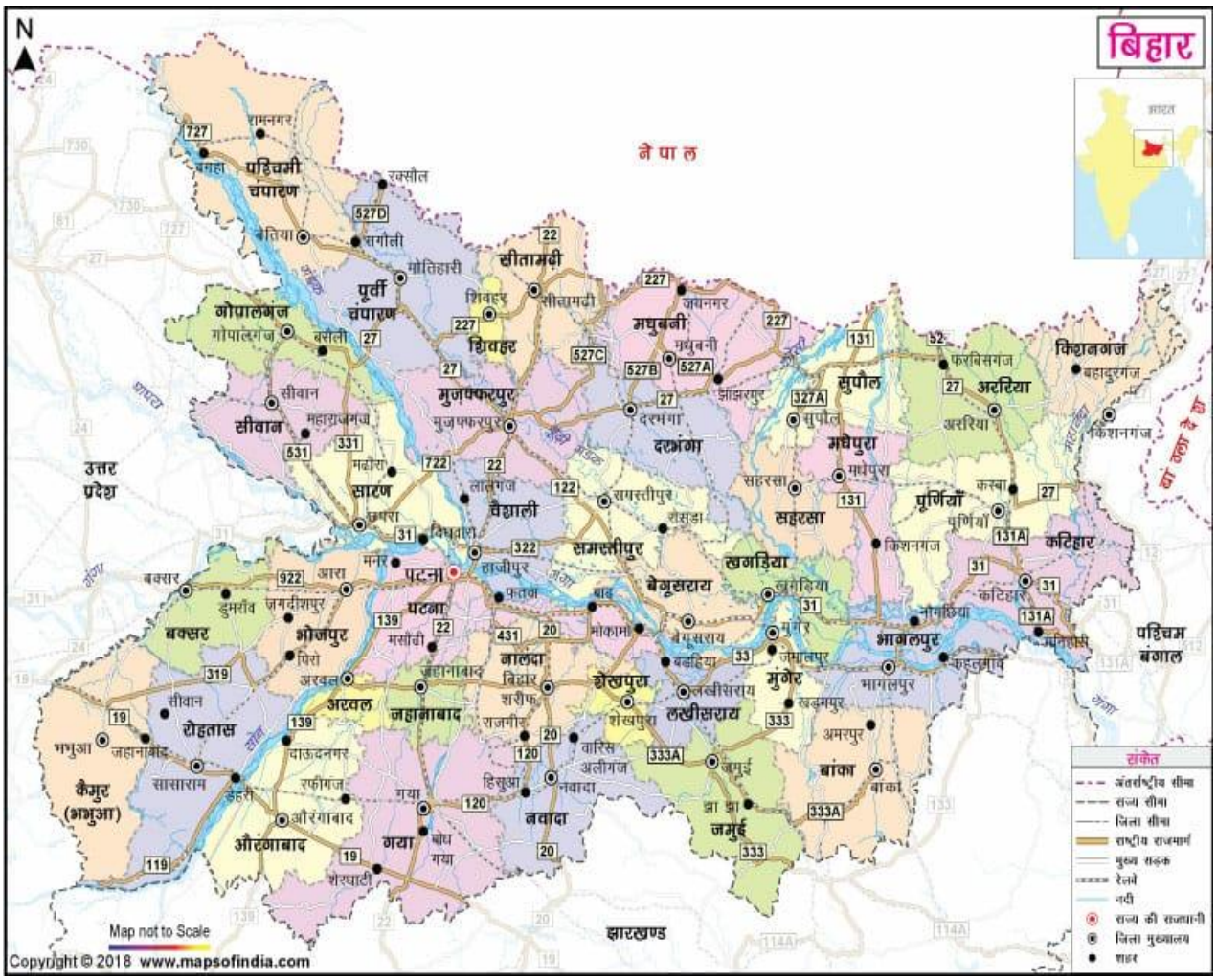

Fig 4.1 Districts of Bihar state (Source: Internet)

4.3 Questionnaire Survey Data Results:

To find the factors affecting labour productivity, a questionnaire was devised by reviewing literature and then was updated according to the study objective to get the responses. Factors of the questionnaire were cross-checked by experts from the field of construction management. After which a list of important factors affecting labour productivity in Himachal Pradesh was prepared and the questionnaire was sent to different sites to get the responses to find the most critical ones. The list is the response to the factors is as follows:

Table: Questionnaire Survey Data

S.No.	Factor	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Lack Of Locally Available Labour	122	131	49	110	98
2	Lack Of Competition B/W Lebourers	46	32	193	142	97
3	Disloyality Of Staff	31	56	109	198	116

4	Environmental Factor	90	94	110	166	52
5	Personal Problem	19	67	110	202	112
6	Alcohalism By Labours At Site	53	62	123	185	87
7	Working Without Holidays	180	121	93	76	40
8	Supervision Delays	62	87	106	137	118
9	Rework Due To Improper Guides	297	109	11	48	45
10	Financially Weakness Of Contractor	78	81	129	129	93
11	Unfavorable Weather Condition	64	105	103	109	129
12	Inappropriate Government Law	12	9	149	156	184
13	Accident Due To Construction	17	12	187	128	166
14	Change Order From Designer	6	18	203	107	176
15	Change Order From Owners	62	87	106	137	118
16	Poor Comunication B/W Labours And Supervisior	62	87	106	137	118
17	Suspension Of Work By Government Engineer	12	22	169	105	202
18	Lack Of Consultant Experience In Project	87	96	112	129	86
19	Delay In Performing Inspection & Testing	12	22	169	105	202
20	Implementation Of Government Laws	5	22	229	139	115
21	Lack Of Required Construction Materials	87	92	20	169	142
22	Increase In The Price Of Material	87	92	20	169	142
23	Material Storage Location	87	92	20	169	142
24	Late Delivery Material	52	68	108	153	129
25	Poor Quality Of Construction Material	17	12	187	128	166
26	Material Availablity	269	148	7	56	30
27	Variation Of Drawing	63	82	91	152	122
28	Shortage Of Water And Poor Supply	46	59	114	156	125
29	Working Without Holidays	196	108	89	61	55
30	Project Objective Is Not Well Defined	40	69	159	120	101
31	Lack Of Required Tools And Equipments	203	159	42	64	42
32	Low Efficiency Of Equipment	64	78	143	116	109
33	Shortage Of Equipment Operators	68	56	123	169	94
34	Payment Delays	89	102	48	116	155
35	Differing Site Condition From Plan	89	102	48	116	155
36	Poor Site Condition	122	131	49	110	98
37	Slowness In Decision Making	12	29	198	165	106
38	Inadequate Transportation Facilities For Worker	12	29	198	165	106
39	Misunderstanding B/W Labours And Supervisior	52	68	108	153	129
40	Miscommunication B/W Contractor And Labour	92	108	126	106	78
41	Safety	162	153	87	59	49
42	Labour Rest Place	70	84	102	134	120
43	Safety Meeting	44	57	123	152	134
44	Sanitation & Hygiene Of The	12	16	201	145	136

	Construction					
45	Drinking Water Facilities	44	57	123	152	134
46	Engineer Improper Supervision	197	108	89	61	55
47	Engineer Incharge Knowledge	52	68	108	153	129
48	Political Pressure	29	42	112	148	179
49	Police Interest Less	46	59	114	156	125
50	Land Interference By The Local Public	72	74	98	162	104
51	Medical Facilities	46	59	114	156	125
52	Strike Caused By Political Parties	183	126	89	76	36
53	Bribe	74	78	56	161	141
54	Foreman Communication Skill	89	94	109	166	52
55	Motivational Leadership	92	108	126	106	78
56	Unskilled Labour	89	94	109	166	52

4.4 Relative Importance Index of the all the Factors Affecting Labour Productivity

S.NO.	Factor	R.I.I
1	Lack Of Locally Available Labor	0.6271
2	Lack Of Competition B/W Laborers	0.5169
3	Disloyalty Of Staff	0.4776
4	Environmental Factor	0.6039
5	Personal Problem	0.4741
6	Alcohalism By Labors At Site	0.5252
7	Working Without Holidays	0.7275
8	Supervision Delays	0.5364
9	Rework Due To Improper Guides	0.8216
10	Financially Weakness Of Contractor	0.5690
11	Unfavorable Weather Condition	0.5475
12	Inappropriate Government Law	0.4074
13	Accident Due To Construction	0.4376
14	Change Order From Designer	0.4318
15	Change Order From Owners	0.5364
16	Poor Communication B/W Labours And Supervisior	0.5364
17	Suspension Of Work By Government Engineer	0.4184
18	Lack Of Consultant Experience In Project	0.5878
19	Delay In Performing Inspection & Testing	0.4184
20	Implementation Of Government Laws	0.4678
21	Unavailibility of Construction Materials	0.5267
22	Inconsistent Price of Building Materials	0.5267
23	Material Storage Location	0.5267
24	Late Delivery Material	0.5063
25	Poor Quality Of Construction Material	0.4376
26	Material Availablity	0.8129
27	Variation Of Drawing	0.5263
28	Shortage Of Water And Poor Supply	0.4882
29	Working Without Holidays	0.7275

30	Project Objective Is Not Well Defined	0.5024
31	Lack Of Required Tools And Equipments	0.7635
32	Low Efficiency Of Equipment	0.5498
33	Shortage Of Equipment Operators	0.5353
34	Payment Delays	0.5427
35	Differing Site Condition From Plan	0.5427
36	Poor Site Condition	0.6271
37	Slowness In Decision Making	0.4729
38	Inadequate Transportation Facilities For Worker	0.4729
39	Misunderstanding B/W Labours And Supervisor	0.5024
40	Miscommunication B/W Contractor And Labour	0.6118
41	Safety	0.7255
42	Labour Rest Place	0.5412
43	Safety Meeting	0.4922
44	Sanitation & Hygiene Of The Construction	0.4522
45	Drinking Water Facilities	0.4922
46	Engineer Improper Supervision	0.7298
47	Engineer Incharge Knowladge	0.5063
48	Political Pressure	0.4407
49	Police Intrest Less	0.4882
50	Land Interference By The Local Public	0.5404
51	Medical Facilities	0.4882
52	Strike Caused By Political Parties	0.7349
53	Bribe	0.5149
54	Foreman Communication Skill	0.6007
55	Motivational Leadership	0.6118
56	Unskilled Labour	0.6007

4.5 Key Factors having negative impact on Labor Productivity

S. No.	Factors	RII	Ranking
1	Work Environment	0.6063	10
2	Material availability	0.8129	2
3	Safety	0.7255	7
4	Lack of required tools and equipment	0.7635	3
5	Engineer improper supervision	0.7298	5
6	Foreman communication skill	0.6007	11

7	Regrouping skill of leadership	0.6119	9
8	Political strike	0.7349	4
9	Re-work	0.8216	1
10	Unavailability of local workforce	0.6272	8
11	Financial weakness of contractor	0.5691	13
12	Lack in consultant experience in projects	0.5878	12
13	Working without holidays	0.7275	6
14	Poor site condition	0.6271	8
15	Instruction not passed correctly to labour	0.6119	9
16	Unskilled labour	0.6008	11

4.5.1 Most critical top five factors

Table 4.2(b) top five factors at each site

Site/factor	Site#1 (Residential area of Ara)	Site#2 (Roadside constructions Bhojpur)	Site#3 (Riverside construction Buxar)	Site#4 (Plain area Hajipur)	Site#5 (Urban area of Sasaram)
Factor#1	Re-work	Re-work	Availability of Materials	Re-work	Re-work
Factor#2	Material availability	Material availability	Lack of required tools and equipment	Material availability	Unskilled labour
Factor 3	Deficiency of required tools and equipments	Deficiency of required tools and equipments	Re-work	Deficiency of required tools and equipments	Deficiency of required tools and equipments
Factor 4	Political strikes	Political strikes	safety	Political strikes	Working without holidays
Factor 5	Engineer improper supervision	Engineer improper supervision	Working without holidays	safety	Engineer improper supervision

Following factors are taken into consideration based on the relative weight age formula given below:

$$Relative\ importance\ index\ (RII) = \frac{SUM\ OF(\ W)}{(A * N)}$$

Where,

W= “weight given factor by each respondent that covers 1 to 5 as defined below”

- Weightage 5 = Strongly Agree
- Weightage 4= Agree
- Weightage 3=Neutral
- Weightage 2= Disagree
- Weightage 1= Strongly Disagree

A = Highest weight (it is 5)

N = Total number in the sample

4.3 Observation;

1. Topographical factor variation

2. Traditional use of equipments (urban or local areas)

3. Climatical condition at site

4. Construction site location

5. Labour skill improvement

6. Mixing plant distance from the place of execution

7. Haul distances

8. Education of labour

9. Material availability

From the insight of the study, we have done a lot of work from the point of view of studies. still, we are unable to groom the industry well the reason behind this is poor implementation, which is very important for the project but they are ignored. which can have different reasons and as a result of these flaws are ineffective. There may be different reasons for this and these loopholes result in an ineffective output of labour productivity even if we have a lot of research to date.

a) The given research is area-specific so the situations and environments are generally different for any new region. the methodology or precautions that were reviewed differ with in area selected.

b) Similar to the nature of the region the nature of labour in different regions is different within a country or outside the country depending upon the living standard and needs of the labourer's family.

c) There may be a lot of models to find out the effective productivity but all these methods or techniques are based upon some predefined assumption. and those ideal conditions are difficult to maintain.

d) The construction industry is very vast but the studies and experiments were always done on a sample of tangible people; this earmarks another limitation to implement that solution and methods on that vast labour force.

e) The Labour industry is dynamic in the sense that continuous day-by-day changes are coming either in the material and machinery etc. and thus to focus on labour with only those old methods as another point of inefficiency.

4.4 Way for Improvement:

a). Generalized methods are required to be found is that most of the regional disparities can be accommodated.

b). Labour selection model should be standardized so that in every company the contractor has fulfilled those criteria so that labour literacy, health, living condition and such criteria can be fulfilled.

c). Segregation of labour based on skilled, unskilled and such should be made.

d). Sequence of work from top manage meant to bottom labourer should be fully divided so that there may be no overlap of ordered sort miss communications.

e). All those important factors that hinder labour productivity should be standardized by the global organization so that their ignorance means a huge loss to the organization.

4.5 STATISTICAL INDEX for Analysing Labour Productivity

4.5.1 Correlation Coefficient 'R'

The correlation coefficient R is used to measure the relationship between the variables.

$$R = \frac{\sum_{i=1}^{n}(x_i - \bar{x}_i)(y_i - \bar{y}_i)}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x}_i)^2}\ \sqrt{\sum_{i=1}^{n}(y_i - \bar{y}_i)^2}}$$

Where R is a dimensionless quantity that can be used to measure the linear association between pairs of variables. *Xi and Yi* are a pair of variables studied, *xi* and *yi* are their respective means. *n* is the number of pairs of data used in the analysis. R ranges from -1 to +1. In general, the closer that *R* is to +1 (or -1) the higher the degree of correlation. The sign of R indicates the positive or negative slope of the trend line. The critical R-value used in this study is 0.7.

4.5.1 Correlation Model Significance

An F-test was modelled and executed for the significance analysis, The F-test is a statistical test that has an F distribution in the test statistic under the null hypothesis. It is most commonly used to compare statistical models that fit a dataset to identify the model that best fits the population from which the data was extracted.

$$\text{F-value} = \frac{SSR/1}{SSE/(n-2)}$$

Where, SSR, Regression Sum of Squares, which can be computed by

$$\sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2$$

SSE is Error Sum of Squares, and it can be computed as given below;

$$\sum_{i=1}^{n}(y_i-\hat{y}_i)^2$$

Where yi and y^i are measured and predicted data respectively; and yi is the mean value of measured data. When F is greater than F0 which is the critical value of the F-test, the association between *X* and *Y* would be regarded as significant. For this study, at the confidence of 0.95, then for the 8 pairs of data is 5.99. In this study, the critical value used for R is 0.7, this is stronger than some studies that apply, as indicated by R = 0.64 (Smith, 1999) and R = 0.566 (Thomas et al., 2002). This means that when the R-value is greater than 0.7 and the regression is significant as given by the F-test, there is some correlation between the project level factor and the kind of waste source.

4.6RESULTS AND DISCUSSION

In this section of the research, eight key factors are associated with project-level factors to find the root cause. The correlation between significant waste and critical elements at the project level is distinguished.

4.6.1Analysis of Work Environment

Table 4.6(a) gives the correlations b/w the project level factors with the waste from waiting due to crews' interference.

Table 4.6(a) Correlated project-level factors to Work Environment

	Project feature	Project manager's feature	Design feature	Organization	Management
1. Productivity loss due to Work Environment	Housekeeping of working area F = 8.35 R = 0.76	PM's construction experience (years) F = 12 R = 0.82			Frequency of planning F = 7.7 R = 0.75
	Suitability of construction method F = 6 R = 0.7	PM's Project management experience (years) F = 21.6 R = 0.88			Frequency of progress control F=6 R=0.7
	Suitability of construction sequence F = 7.7 R = 0.75	PM's experience of working as a PM (years) F = 6 R = 0.7			Teamwork F = 7.7 R = 0.75

The work environment on site is found to have the most effect on productivity from the earlier study. This refers to delays or time lost due to interference by others. These delays include time travelling to other working places, or waiting at a particular location because other crews or workers are engaged in the working area. Table 4.6(a) shows the project-level factors that are highly correlated with the work environment. From the table4.6 (a), the delay could be traced to

1. Poor site housekeeping: The site space is too congested or obstructed by construction debris or materials.
2. Improper working method: On-site versus off-site fabrication is one of the major factors known to affect the workforce required.
3. Improper work sequence: Inappropriate sequencing could not link up the preceding trade and following trade effectively. Sometimes the following trade has to wait until the preceding work's completion.

All of the above-mentioned three causes, as components of planning, should be considered to be manageable with proper project management. It is an exception when the congested working space is due to the location of the site and restrictions from the surrounding environment. Therefore the project manager can play an important role to reduce this source of waste activity.

The competency of the project manager that is found to be significantly correlated is his total years of experience in construction and total years of working as a project manager. The proficiency of the project management could be increased with frequent planning and progress control, through which the existing problems would be detected in time; and the correspondingly updated Therefore Table 4.6(a) indicates that projects with experienced project managers tend to waste fewer man-hours on the crews' interference, and the frequencies of planning and progress control have the positive effect of reducing the crews' interference.

4.6.2Analysis of Waiting Due to Inspection

Table 4.6(b) summarizes the correlation between the project-level factors with the waste from waiting due to inspection and the correlated project-level factors.

Table 4.6(b) Correlated project-level factors to waiting for inspection

	Project feature	Project manager's feature	Design feature	Organization	Management
2. Waiting due to inspection	The complexity of the inspection procedure F = 6.2 R = 0.71		Degree of standardization F = 16.1 R = 0.85	Communication between the main contractor and subcontractor F = 12.2 R = 0.82	Frequency of site management meeting F = 6 R = 0.7
	Difficulty of construction F = 55.1 R = 0.95		Degree of simplicity F = 13.5 R = 0.83		Frequency of quality inspection* F = 12.4 R = -0.82
					Frequency of safety inspection* F = 12.4 R = -0.82

Note: * The factor with a sign of star denotes that it has a negative value of R.

Many researchers and interviewees in this study believe that the test is the cause of the delay. They complain that the inspections are not planned and placed properly or in a timely manner, so much time is spent in the field without doing anything other than waiting for the inspections. It is recognized that knowledgeable and experienced officers (responsible for inspections) can reduce repair costs and improve the quality of projects, but excessive or long-term inspections are useful. It has an adverse effect. This result is also reflected in Table 4.6 (b), and the frequency of quality and safety inspections has an adverse effect on "waiting for inspection". This means that the more frequently you check, the longer the wait time. Inspection efficiency is reduced due to several factors. Subcontractors usually start the inspection when some of the work is completed. The prime contractor then contacts the case officer to arrange an inspection. Therefore, good communication between the prime contractor and the subcontractor is very important to reduce the waiting time. Good communication means the right communication channels and their effectiveness in communicating enough information to the right people. The site management meeting provides an opportunity to improve communication between the various stakeholders involved in the project. The data in Table 4.6 (b) show that improved quality of communication between the prime contractor and subcontractors and more on-site meetings can reduce wasted time during inspections. ..

4.6.3Analysis of Waiting for Equipment

Table 4.6(c) summarizes the correlation between the project-level factors with the waste from waiting for the equipment.

Table 4.6(c) Correlated project-level factors to non-availability of the equipment

	Project feature	Project manager's feature	Design feature	Organization	Management
3. Waiting due to equipment being used by other crew				Communication between the main contractor and subcontractor F = 6 R = 0.7	Frequency of site management meeting F = 6 R = 0.7
					PM's field visits* F = 11.4 R = -0.81
					Materials handling F = 10.5 R = 0.8

4. Waiting due to equipment installation	Assessment of working area F = 16.2 R = 0.85			Communication between the main contractor and subcontractor F = 8.9 R = 0.77	Frequency of planning F = 60 R = 0.95
	Construction sequence F = 60 R = 0.95				Frequency of site management meeting F = 18 R = 0.87
					PM's field visits * F = 27 R = -0.91

Note:* The factor with a sign of star denotes that it has a (-ve) value of R.

Major equipment on site includes cranes, passenger/cargo lift, trailer/lorry, Concrete pump, truck mixer, and safety scaffolding. The entire construction process depends heavily on this equipment. For example, cranes are needed to move and position formwork, hoist and place reinforcement; the truck mixer and concrete pump are indispensable to transport and place concrete. Any interruption in the use of the equipment will lead to serious material handling problems and slow down or even stoppage of operations. Therefore the availability of equipment was regarded as crucially important for construction progress.

However, in practice, in consideration of cost, main contractors are inclined to provide a minimum amount of equipment on site. The amount of equipment is always planned under the assumption of the optimal situation, in which all the trades are linked to each other without any need for queuing or idling. As such the equipment is shared and planned for high utilization. While the optimal condition is difficult to achieve in reality, even the most proper planning cannot prevent an unforeseen circumstance from occurring. Consequently, this phenomenon has caused the most complaints from the respondents. This is evident in Table, where waiting for equipment is a frequently encountered problem, which has contributed to about 72.5 man-hours lost on average each month, forming the highest proportion of all waste sources. Besides the high utilization rate, the frequent material handling and congested working area increase the equipment demand, and the installation or movement of equipment will aggravate the situation of waiting for equipment. It is observed that improved communication and coordination among

the various parties can help to reduce this conflict. Better communication could be effected through more site management meetings and planning.

Via the correlation coefficient value, Table 4.6(c) indicates that the frequency of the project manager (PM)'s field visits has a negative influence on man-hours waste. The more often the PM visits the site, the more man-hours are wasted. This result seems contradictory to common sense that the time of the site visit reflects the PM's effort devoted to the project. The possible explanation could be that it is the problems that occurred that bring the PM to the site more frequently**.**

4.6.4Analysis of Waiting for Instruction

Table 4.6(d) summarizes the correlation between the project-level factors with the waste from waiting for instruction.

4.6(d) Correlated project-level factors to waiting for instruction

	Project feature	Project manager's feature	Design feature	Organization	Management
5. Waiting for instruction	The difficulty of the project F = 9.9; R = 0.79		%Detail design finished before project starting F=9.3;R = 0.78	Coordination with the designer F=6.4; R=0.72	Frequency of planning F = 10; R = 0.79
			Capacity of solving problem of the designer F = 10; R = 0.79	Communication between the main contractor and subcontractor F=11.4;R = 0.81	Frequency of site management meeting F = 15; R = 0.84
			Degree of the repetition F = 9.5; R = 0.78	Number of subordinates of the PM F = 15; R = 0.84	
			Degree of the standardization F=80.8;R=0.96		
			Degree of the simplicity F = 24.9; R = 0.9		

Waiting for instruction refers to the time spent waiting for and/or receiving directions from managers or supervisors on site. This waste category was found to be very considerable,

accounting for 12% of all the wasted time. The correlated organizational factors shown in Table 4.6(d) (disclose its likely causes Firstly, insufficient management personnel were identified as one correlated factor. This phenomenon has a ubiquitous trend in the construction industry. During the project estimating stage, an insufficient number of supervisors and managers are normally allocated o the construction site due to budgetary problems. This lack of supervision on site causes the busy managers to be confronted with more severe time constraints and problems with time management and consequently influences the proceeding of the project. Reinforcement in site supervision could help reduce the man-hour waste due to waiting for instructions.

Other project-level factors include the design feature and the communication among various parties. Accurate and detailed drawings make the work proceed smoothly and reduce the requests for instruction, and the adequacy of communication channels and their effectiveness in providing sufficient information to the appropriate persons would increase the efficiency of the site.

Another reason for the waiting can be attributed to the difficulty of the project. The degree of difficulty includes both construction and design aspects. A more difficult project would bring in more technical challenges to construction, and therefore more supervision and instruction would be needed. Although the difficulty of a project is beyond management control, it is possible and necessary to organize the project team accordingly.

For the crucial project, the client as well as project manager needs to purposefully apply more resources and management force to it.

When there is a high degree of repetition of the work, it will have a majorly positive effect on the project for the repetition of work could help workers to learn and get to know the job well and consequently require less instruction.

A more simple and standard design means higher buildability, which can help the construction of the project to go forward in a more efficient way (Sui, 2001).

4.6.5 Analysis of Waiting for Materials

Table 4.6(e) summarizes the correlation between the project-level factors with the waste from waiting for materials.

Table 4.6(e) Correlated project-level factors to waiting for materials

	Project feature	Project manager's feature	Design feature	Organization	Management
6. Stock problem	Assessment of working area F = 18.8 R = 0.87				Frequency of stocktaking for materials F = 6.9 R = 0.73
					Convenience in accessing of stock F = 9; R = 0.77
7. Material delivery delay			Degree of the repetition F = 6.3 R = 0.0.71	Coordination with the material supplier F = 9.3 R = 0.78	Frequency of site management meeting F = 6; R = 0.7
			Frequency of design variation F = 7.6 R = 0.75	Communication between the main contractor and subcontractor F = 10.5; R = 0.8	Material handling F = 6.3 R = 0.71

"In this part of the discussion, the stock and material delivery problems are discussed together. They are both associated with material availability.

Lack of material refers to inaccessibility of certain materials or excessive time expended to obtain them. The subsequent loss includes the work time wasted due to waiting for materials, crew slowdown in anticipation of material shortages, and crew"

4.6.6 Analysis of Rework due to Design Change

Table 4.6(f) summarizes the correlation between the project-level factors with the wastes from rework due to design change.

Table 4.6(f) Correlated project-level factors to design change

	Project feature	Project manager's feature	Design feature	Organization	Management
8. Rework due to design change	Difficulty of the project F = 9.9 R = 0.79		% Detail design finished before project starting F = 9.3; R = 0.78	Coordination with the designer F = 6.4; R = 0.72	PM's field visits * F = 25.67 R = -0.9
			Capability of the designer in solving problem F = 10; R = 0.79	Communication b/w the main contractor and subcontractor F =11.4; R = 0.81	
			Degree of repetition F = 9.5; R = 0.78		
			Degree of standardization F = 80.8; R = 0.96		
			Degree of simplicity F=24.9; R=0.9		
			Frequency of design variation F = 21.4; R = 0.88		

Note: * The factor with a sign of star denotes that it has a negative value of R.

Redesign due to design change, as expected, is greatly affected by the shortcomings of the design process. This source of waste creates time losses due to reconstruction work and many hidden problems. Changes in construction often lead to changes in many rules that include size and shape, leading to re-scaling and reassembling of previously selected parts. Another result of design change is the disruption of the sequence of tasks. The team needs to suspend its current work and reorganize and redesign the new work or change its completed structure. The result is sometimes called loss of pace or loss of sync, in which workers may need to rearrange the scaffolding and update the pipe and line schedules.

Collaborate with other staff, and plan many other aspects of the work by the level of detail that would not need the details if they were well integrated into the original design (Thomas and Napolitan, 1995). Design modification was considered one of the worst barriers to craftsmanship by Russell (1993) and Kamling, et al. (1997). This study comes to the same conclusion, 15.5% of wastage of human hours is caused by variance, in that, 30% of design variations (Table 4.6 (e)). As shown in Table 4.6 (e), the main causes of design change can be traced to the following factors.

"Another reason is the accuracy and detailed level of the design for the builder, which is very important for the project. Adequate design enables the project to proceed with minor changes, ambiguities and missing information."

"The second reason is design. From the Building Design Program (BDAS), additional duplication, suspension, and simplicity to the project design, higher constructive points will be achieved, allowing for more efficient construction (Sui, 2001)."

The third reason is the coordination and communication between the various structures involved in this work. Designers, for the most part, are skilled at building and often focus on design rather than design problems. So if construction managers are involved in the design phase, higher construction potential is possible.

4.7 SUMMARY

From the previous analysis, other factors closely related to production are available, based on which specific conditions are developed. These methods can help improve productivity and should be under the control of a project manager. They focus on planning and projecting in a way that will reduce unproductive activities on site.
There are five project level groups.

1. Project features

• Keeping the workplace well maintained
• Having the right building approach

• Have a good work sequence
• Simplify the assessment process

2. Features of a project manager

• Must have experience in the construction site

• Must have experience in project management

• Must have a wealth of experience

3. Design features

• A detailed project should be completed as fully as possible before the project can begin

• Designer has the competentancy in problem solving

• High repetition

• Higher rating

• Higher simplicity

• Minor or non-existent design changes

4. Project planning

• Maintain interaction with the designers

• Maintain communication b/w the contractor and client

• Maintain interaction with the materials suppliers

• The PM should have subordinates to take care of the various aspects.

5. Project managements

• Regular planning

• Continuous control

• Build good working relationships

• Regular site managements meetings

• Avoid too much of inspection

• Less shipping time

• Regular innovation updates

• Make stock more accessible

CHAPTER 5: SENSITIVITY ANALYSIS OF CRITICAL FACTORS

5.1 Sensitivity Analysis from Iso Quants: The sensitivity analysis is being carried out using 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 will surely lead to a loss to the contractors.

"Th" is being used to represent thousands as all the units are in rupees.

5.1.1 Residential Area Construction in Ara District (Construction Site#1):

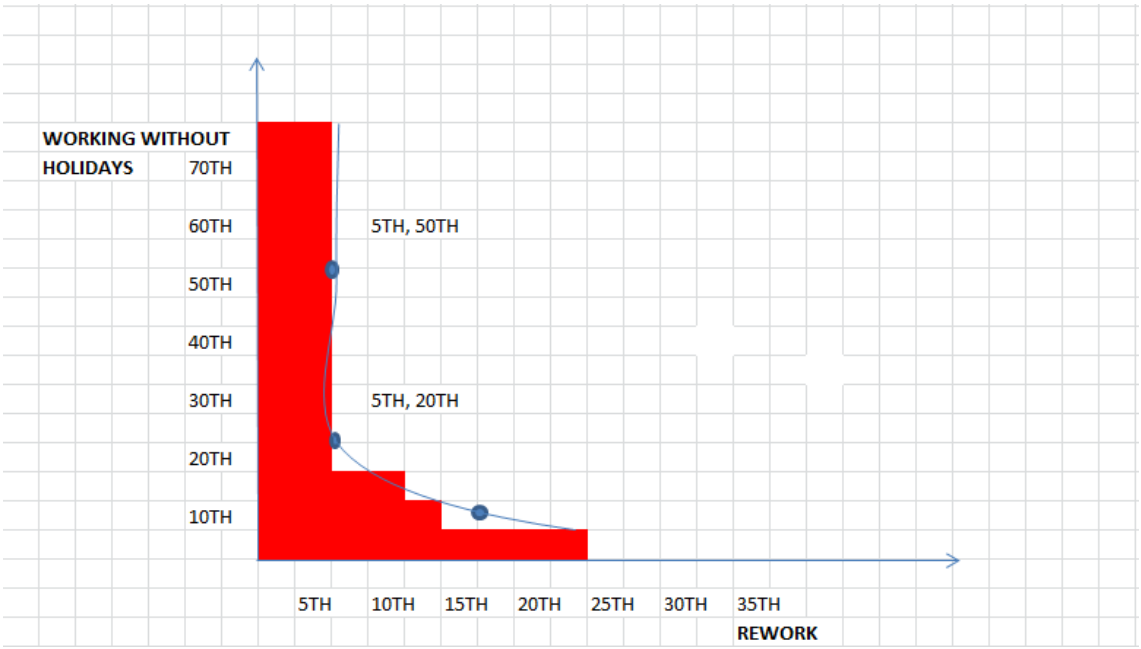

Fig 5.1 Rework vs. Working w/o holidays and the red zone of rejection

5.1.2 Roadside construction work in Bhojpur District (ConstructionSite#2);

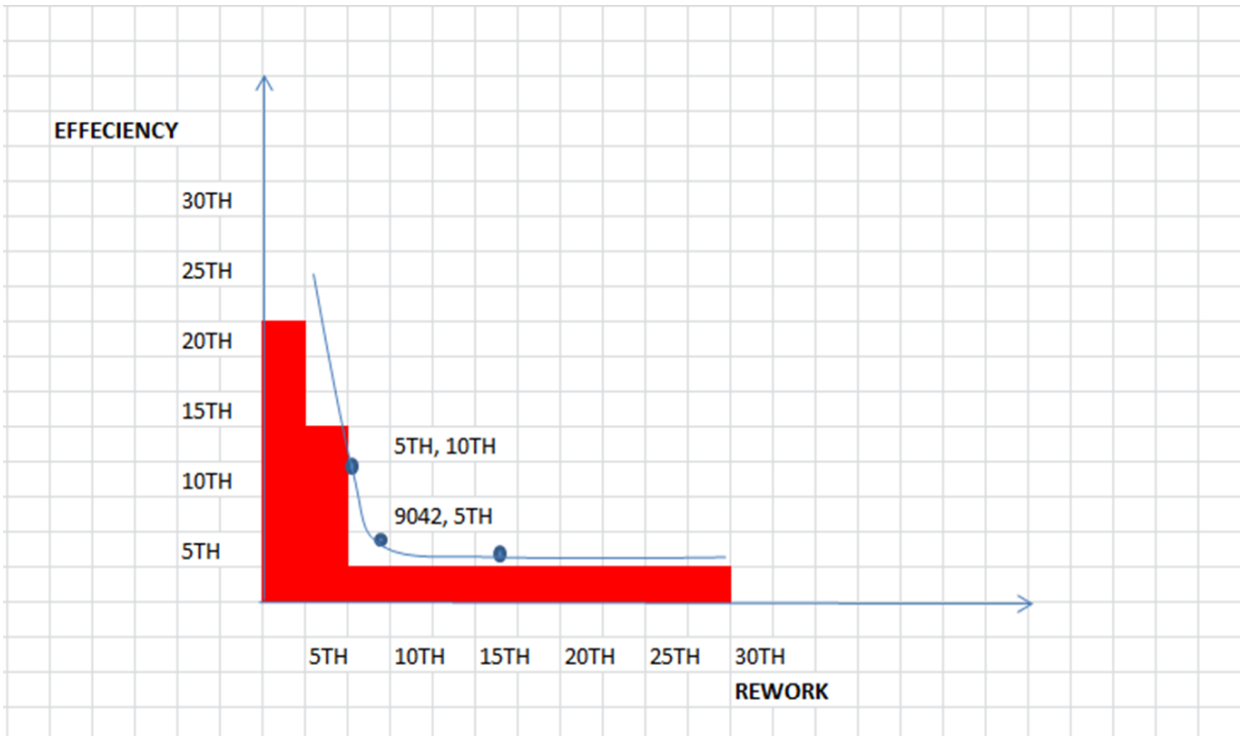

Figure 5.2 Re-work vs. Efficiency of labour and the red zone of rejection

5.1.3 RiverSide Construction at Buxar District (ConstructionSite#3);

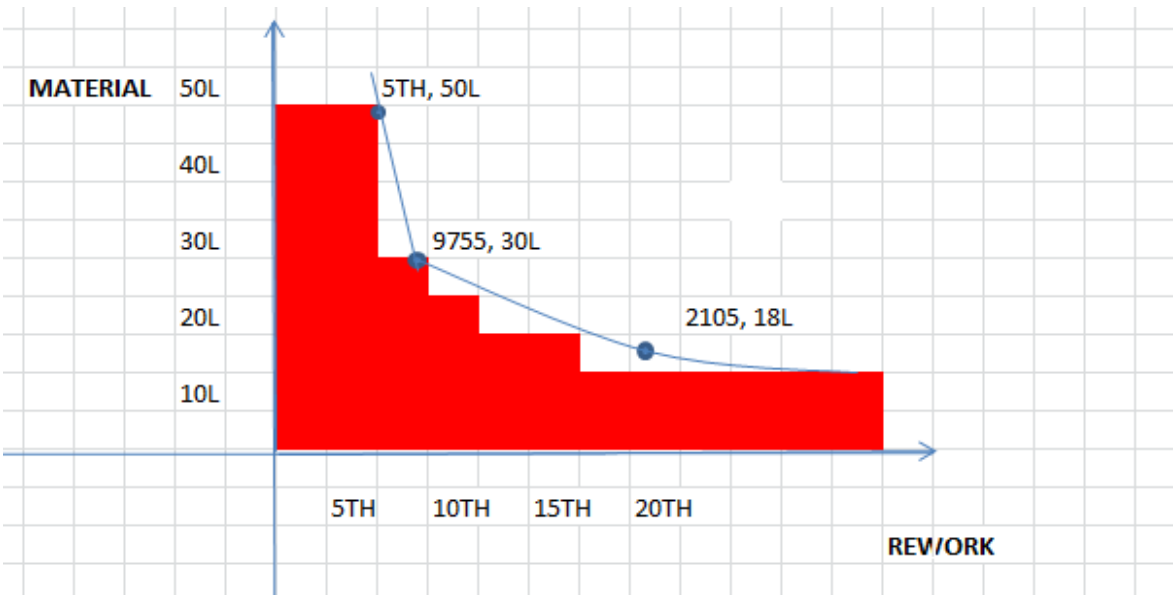

Fig 5.3 Rework vs. Material availability and the red zone of rejection

5.1.4 Plain Area Construction of Hajipur District (ConstructionSite#4);

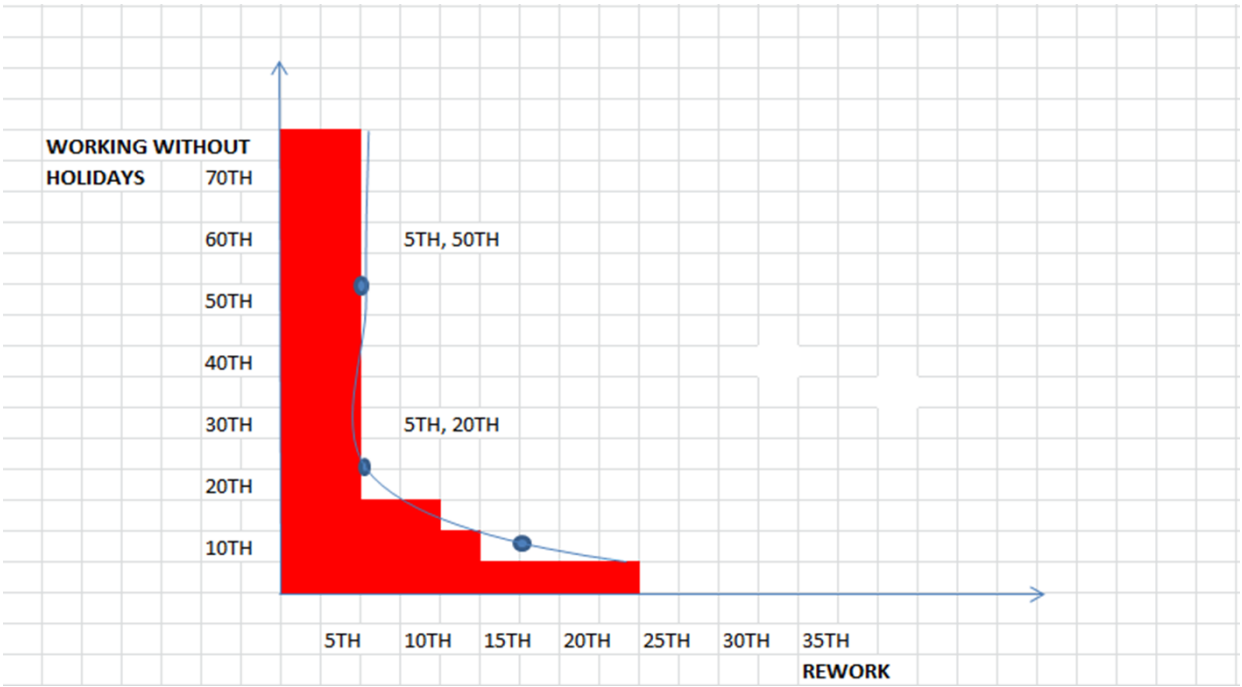

Fig 5.4 Re-work vs. Working w/o breaks and the red zone of rejection

5.1.5 UrbanArea of Sasaram District (ConstructionSite#5);

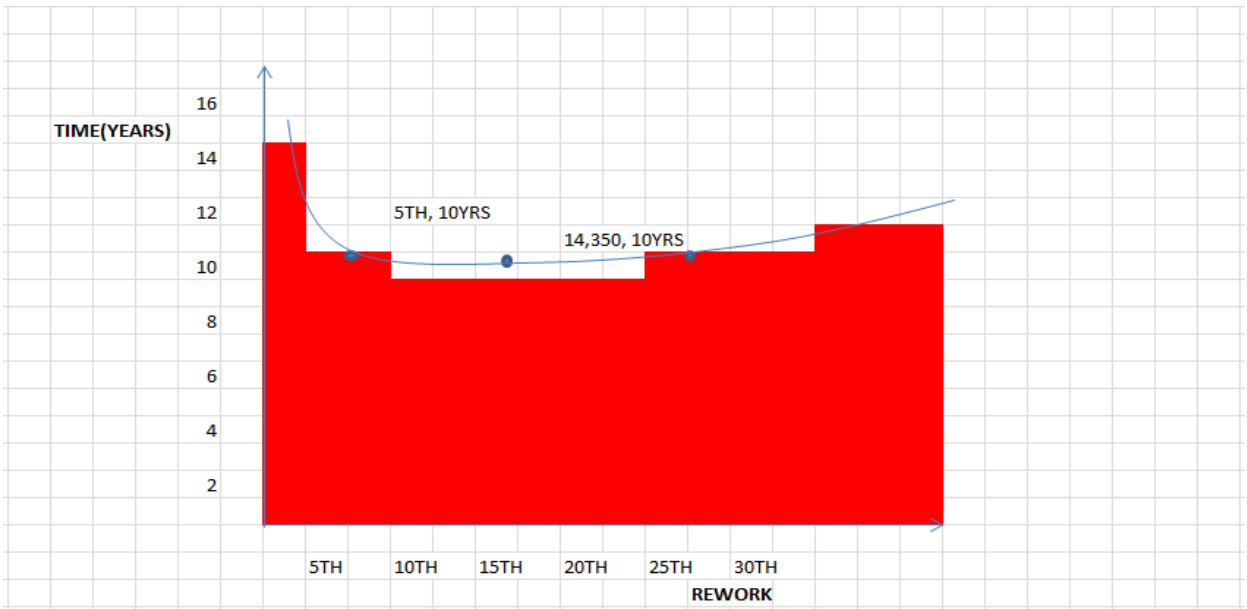

Fig 5.5 Re-work Vs Duration of completion of Project and the red zone of rejection

5.2 Isoquant calculations for acceptance and rejection zone:

5.2.1 Residential Construction in Ara District (Site 1):

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

Factors of concern at the above site:

i. Re-work

ii. Working w/o holiday

Let us keep one of the value fixed, suppose re-work in site 1 and calculate the optimized value of the other parameter by equating the N.P.W. equation to 0.

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

Once the value off one parameter is calculated then we jump into the other value by taking two very different amounts to calculate the N.P.W.

Putting Rework as 6000 again and other factors as 9,900/- and computing the NPW again

$$NPW= -124189/- \textbf{(zone of rejection)}$$

Hit and trial of another value will be done till the NPW becomes non-negative.

Therefore other points are Rework as 6000/- and Working without holidays as 18,000/-.

5.2.2 Roadside construction in Bhojpur District (ConstructionSite#2):

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

Factors of concern at this site:

i. Re-work
ii. Efficiency of the Labour

Let us keep one of the values fixed, suppose re-work in site 2 and calculate the optimized value of the other parameter by equating the N.P.W. equations to 0.

.

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

After finding this one value, then move on to another value by taking two different values and finding the NPW value

The above equation results in the value of x to be **9043.9**/-

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

5.2.3 River Side Construction Buxar District (Site 3):

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

Major concerning factors at this site:

- Rework
- Material availability

Let us keep one of the values fixed, suppose re-work in site 3 and calculate the optimized value of the other parameter by equating the N.P.W. equations to 0.

$$0 = - (x)-5000[5.6502]+100,000[5.6502]+ 50,000[0.3220]$$

Once the value off one parameter is calculated then we jump into the other value by taking two very different amounts to calculate the N.P.W.

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

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

5.2.4 Plain Area Construction of Hajipur District (Site 4):

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

Major concerning factors at this site:

- Rework
- Working without holidays

Let us keep one of the value fixed, suppose re-work in site 4 and calculate the optimized value of the other parameter by equating the N.P.W. equation to 0.

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

Once the value off one parameter is calculated then we jump into the other value by taking two very different amounts to calculate the N.P.W.

Putting Re-work as 6000 again and other factor as 11,000/- and calculating the NPW again

NPW= -114289/- (**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/-.

5.2.5 Urban Area of Sasaram District (Site 5):

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

Major concerning factors at this site:

- Rework
- Time of Project Completion

Let us keep one of the value fixed, suppose re-work in site 1 and calculate the optimized value of the other parameter by equating the N.P.W. equation to 0.

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

Once the value off one parameter is calculated then we jump into the other value by taking two very different amounts to calculate the N.P.W.

Values of x has come out as 14, 3571/- (**zone of acceptance**)

Working out with different values for that also N.P.W. has not been positive.

CHAPTER 6: CONCLUSION AND DISCUSSION

6.1 Critical Factors observed from the research

a. Differences in environmental factors
b. Traditional use of tools (urban or local area)
c. Weather conditions
d. Construction site
e. Job training (work speed)
f. Combining plant distance
g. Move the distance
h. Literacy (how to do work)
i. Material availability (simplicity)

From a research perspective in current scenario, we have seen that a lot of progress is made. But till now, we are far away from fixing the sector. The cause may be bad or inaccurate method and ignorance of the most important things in the project but they are ignored. There may be various reasons for this and these loopholes lead to poor productivity of labour production even though we have a lot of research to do:

1. The research is regionally specific so the conditions are always different for any new location. Therefore the methods or warnings we have reviewed may vary by location.

2. with the regional environment the working environment in different districts varies from country to country or country depending on the level of life and needs of the employee's family.

3. There may be many models to find effective product ivy but all of these methods or strategies are based on the predictions described earlier. And those ideal conditions are hard to care for.

4. As the construction industry is very large but studies or assessments are done regularly with a sample of concrete people, this places another limit on the application of those solutions and methods to the majority of the workforce.

5. The labour industry fluctuates in the sense that continuous day-to-day changes come in the form of materials or machinery etc and thus focusing on working in those old ways only is another point of inefficiency.

6.2 Recommendations to reduce demerits

i. Conventional methods are needed to determine how many regional variations can be made.

ii. The staff selection model must be structured in such a way that in every company the contractor must meet those requirements in order to be able to read and write, health, living conditions and those conditions are met.

iii. Classification of staff based on skills, incompetence and should be done.

iv. The work category from the intended senior management to the subordinate employee should be fully separated so that there is no overlap of the ordered type missing communication.

v. All those important factors that hinder the production of workers must be the same as a industry, so that their ignorance, means the losses of the fortune in the organization.

6.3 Recommended criteria for selection

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:

    - Critical Path Method and Program Evaluation and Review Technique
    - Optimization Models

4. Identification of the worker type:

    - Skilled
    - Unskilled
    - Experienced

5. Differentiation of workforce:

    Aim are:

    a. Distinctions of the labour as (i). Technicall and (ii) Non-technical

    b. On the basis of performance and quality

    c. Tool technology will be used for specific projects

    d. Divide the work of assistants and professional work

Different Exams to be taken may be:

- PILOT SURVEY
- RATING (work defined)
- LABOUR-SHIFT-TEST

1. Preparation of ranking as per table given below

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

7. Using Simulation Techniques:

    - MPDM METHOD
    - CREW BALANCE-CHART
    - FIELD SURVEYS

8. Exclusion of features diverting fulfilment of the desired outputs
    - MANUAL ANALYSIS
    - NEURAL NETWORKS

9. Filtering out different techniques with the help of
    - NEURAL NETWORKS
    - SPSS SOFTWARE

10. Comparative analysis of graphical data with SPSS's software data
11. Notifying the new findings affecting yeild of the construction productivity.
12. Application of the conditions till appropriate resource allocation.
13. Comparative analysis with world standard (hypothetical)
14. Occasional staff recruitment from time to time.

6.4 Summary

The construction sector is very large and most powerful industry in the world. Materials, work, methods are always changing here. To be in the race for the developed world this industry needs to be very strong. To date we have come up with a variety of ideas and strategies to improve the efficiency of our nation in this regard.

In this study the main focus is on high productivity of workers. We are trying to find new ways to make it in the race for developed countries. This labour-intensive production is not just one concept but can solve many other problems such as unemployment, illiteracy, improved living standards without technological advancement.

Some new techniques have already been developed and researchers are still working on new ideas. The best strategies are focused on this report and the scope of the future and the benefits of making it easier to understand more.

#Work-sampling-method

It shows how many non-productive, less productive activities occur on each site. This therefore directly reflects the weak areas of the workforce and the environment, personal problems and many other factors that have been described above in how these factors prevent the work from entering the manufacturing sector.

Five minute method of measuring

This reflects the use of human resources and management in various areas. This practice shows how well the efficiency of Bihar state in different areas or how much the workers are comfortable using different resources in different regions within Bihar State.

This practice clearly shows that there is a great need to start staff training for staff and they should have verybasic ideas about the use or operation of various construction materials such as cement, mixers, water cement etc. in the workplace.

Questionnaire survey to find out the reasons for the inefficiency

This data sheet provides reasons why there is any type of staff malfunction in a project that leads to a complete lack of productivity of the project. These shortcomings to environmental vulnerabilities, effective staff training and the many different factors that can lead to low productivity at the end of a career.

6.5 Future Scope

All in one, we can conclude by saying that a new perspective and direction may elevate the infrastructure industry to a higher level. Therefore, to continue the prosperity of our country in sync with the growth of technology in the construction industry.

By applying the method of product growth in the field of construction, we can achieve the goal of building efficientt and sustainable infrastructure. At a given moment, time of completion of project is one of the most critical things that can elevate a project to great success or make the project suffer as a result of fines. These factors may put a strain on the future of those who own the projects. So using new software and platform strategies that are faster and more efficient can save us time in planning and can also work in our most vulnerable areas.

Therefore our completed projects will be 100% guaranteed, at the time of completion, there is no product density and adorn the construction.sector. This can lead to an increase in clients thus increasing investment in not just one project but in many.

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APPENDIX -1

QUESTIONNAIRE : LABOUR PRODUCTIVITY OF CONSTRUCTION IN BIHAR

As part of my M.TECH research thesis at the JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY,SOLAN HIMACHAL PRADESH .I am conducting a survey that investigates the "LABOUR PRODUCTIVITY OF CONSTRUCTION IN BIHAR".I will appreciate if you could complete the table.Any information obtained in connection with this study that can be identified with you will remain confidential.

Respondent's Details:

Name:-_____. Age:-_____. Gender;Male/Female

Mobile no.:_____.

Strongly Agree(1)	Agree(2)	Neutral(3)	Disagree(4)	Strongly Disagree(5)

S.NO	FACTORS	(1)	(2)	(3)	(4)	(5)
1	LackOfExperience					
2	LackOf Compitition B/W Labourers					
3	MisunderstandingAmong Labourers					
4	DisloyalityOf Staff					
5	PersonalProblems					
6	AlcoholismBy labours at site					
7	Absenteeism by staff					
8	Supervision Delays					
9	ReworkDue To Improper Guide					
10	Inspection DelaysFrom The Authorities					
11	UnfavourableWeather Condition					
12	Inappropriate Government Laws					
13	Accident Due To Construction					
14	Change Order From Designer					
15	Change Order From Owners					
16	Poor Comunication B/W LaboursAndSupervisior					
17	Suspension Of Work By Government Engineer					
18	Lack Of Consultant Experience In Project					
19	Delay In Performing Inspection & Testing					
20	Implementation Of Gov. Laws					
21	Lack Of Required Construction Materials					
22	Increase In The Price Of Material					

23	**Material Storage Location**					
24	**Late Delivery Of Material**					
25	**Poor Quality Of Construction Material**					
26	**Shortage Of Construction Material**					
27	**Variation In The Drawing**					
28	**Shortage Of Water And Power Supply**					
29	**Working Over Time**					
30	**Project Objective Is Not Well Defined**					
31	**Lack Of Required Tools And Equipment's**					
32	**Low Efficiency Of Equipment**					
33	**Shortage Of Equipment Operators**					
34	**Payment Delays**					
35	**Differing Site Condition From Plan**					
36	**Poor Site Condition**					
37	**Slowness In Decision Making**					
38	**Inadequate Transportation Facilities For Worker**					
39	**Misunderstanding B/W LaboursAndSupervisior**					
40	**Musunderstanding B/W Engineers &Supervisior**					
41	**Voilations Of Safety Laws**					
42	**Safety Meeting**					
43	**Labour Rest Place**					
44	**Sanitation & Hygiene Of The Construction**					
45	**Drinking Water Facilities**					
46	**Engineer Improper Supervision**					
47	**Engineer InchargeKnowladage**					
48	**Political Pressure**					
49	**Police Intrest Less**					
50	**Land interference By TheLocal Public**					
51	**Medical Facilities**					
52	**Foreman Communication Skill**					
53	**Strike On Site By Staff**					
54	**Bribe**					
55	**Long Period B/W Design And Time Of Bidding Tendering**					
56	**MOTIVATIONAL LEADERSHIP**					

CERTIFICATE

This is to certify that the project report entitled **"STUDY ON LABOR PRODUCTIVITY OF CONSTRUCTION PROJECTS IN BIHAR"** submitted by Biprendra Kumar, Roll No. 202604 in partial fulfillment of the requirements for the award of Masters of Technology in Civil Engineering with specialization in Construction Management has carried out under the supervision of Mr. Kaushal Kumar (Assistant Professor) & Mr. Akash Bhardwaj 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.

Kaushal Kr. 11/06/22

Akash

Mr. Kaushal Kumar &
Mr. Akash Bhardwaj
Supervisors
Assistant Professors
Department of Civil Engineering
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11/6/22

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Surjeet Singh

[SURJEET SI

External Examiner
Asst. Professor
Dept. of CSE
JUIT, Wakna

DECLARATION

This is to certify that project report entitled **"Study on Labour Productivity in BIHAR in Construction Project and Improve Overall Productivity of the Construction Projects"** submitted by Biprendra Kumar Roll No. 202604 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**
Biprendra Kumar	202604	Biprendra

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