

Evaluation of Factors affecting on Labour Productivity by AHP Method

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Abstract:

Productivity is a problem of great relevance around the globe, just as it is in many developing nations. Beyond the post-conflict phase of each country's development cycle, this is seen as one of the strategic objectives to be achieved. Many countries lack adequate study upon construction efficiency, also based upon experience of several nations, it's even presumed as any determination made for increasing productivity would significantly increase nation's probabilities of achieving its premeditated progress aims. It can be done by researching, looking for, and identifying the factors that influence it. Amongst least studied subjects into construction business is labour productivity. Increased productivity results in greater cost reductions with little further expenditure.

Construction project profitability are typically less, making increased efficiency and reduced expenses crucial to a contractor's success. Measurable labour productivity is the main obstacle to raising labour productivity. The major goal of our research is identifying important variables impacting worker productivity. Survey has been carried out in gandhidham and adipur two cities with total 126 questionnaire distributed. And analysed through analytical hierarchy process.

Keywords: Labour productivity, AHP, Weight, Ranking, Optimization

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1. Introduction

People *General*

Quality there are many types of construction project and most of are the residence, industrial and commercial projects. Also a road construction project and utility types of construction project. There are different stages of construction planning designing and building it. After they utilized, maintained, repair and refurbished until being finally tor down and rebuilt. The different moves and initiative make management more challenging to manage project. The main question is how to assess construction productivity with all stages and factors.

The construction industries is amongst some highest labour concentrated industry into developing nations, so that's why we need to understand the idea of labour productivity in construction sector. According to researchers and papers the measurement of productivity is very expensive for company to use less than 50% of the construction industries measure and monitor the productivity.

Many researchers are working on construction productivity give more attention to it. Researchers also give recommendation for that and working on some areas of productivity. by we know that it is very hard or difficult issue because of affects some factors like manpower, material, technologies, tools, not proper communication, lack of supervision, uneducated workers, weak management, misguidance to the workers, many more factors are affecting labour productivity some design problems and work is not completed as per engineers plan this can also decrease productivity in construction.

By increase productivity in construction can help contractor also. Project complete before time, cost of project getting lowered and project can more profitable it will improve companies reputation also in front of others stakeholders. by calculating productivity and recognize various factor which are affects the productivity and to improve them can be most important part for the contractors for make profit and complete task within time and cost.

By making some kind of model and by using some techniques can know the exact issue which factor is affecting the most and by solving it can increase labour productivity.

Background of Productivity

There some term used for explain the productivity in construction are performance rate, rate of production, person rate per hour person work per hour. Productivity term is output of all resources utilize to achieve desired result. Resources are like manpower, time, energy and material. Productivity is equivalent to save cost & can gain profit.

$$\text{Productivity} = \frac{\text{Output}}{\text{Resource used}}$$

Productivity In Construction

In building construction, productivity term means labour productivity that how much work has been done by a man in one hour. And productivity is sum of total work done in hour and total cost of labour. Construction work is increasing day by day and sector is expanding. Lots of industrial construction works are increasing. Construction industry is fast growing industry and in other there are lower employment ration that' s why many workers are is in this sector in search of employment. There are 16% working population depends on construction. And more than 50 million are create assets worth 200 billion and 5% over nations GDP. And more than 74 million workers working under construction industry. As per Nasso (2016-17).

The construction sector is labour intensive. There are labour who migrate to the city for work. They are poor and not educated and not enough skills. After reaches to new city they faces many problems. And poor performance of labour in construction due to many factors can affects time, expenses & construction quality.

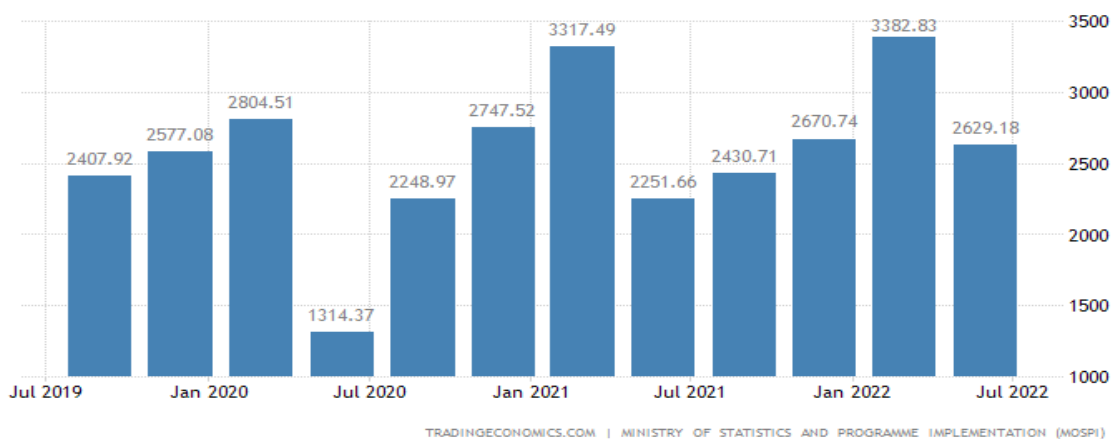


Fig: 1 GDP from Construction in India(Source: Tradingeconomics.com)

Labour Productivity

Construction industry is mainly relay on the labour and productivity. And 33-50% of the total project cost accounted to labour cost. Non value adding activities from around 50-70% of total work time. So this is more important for investigating aspects effecting productivity.

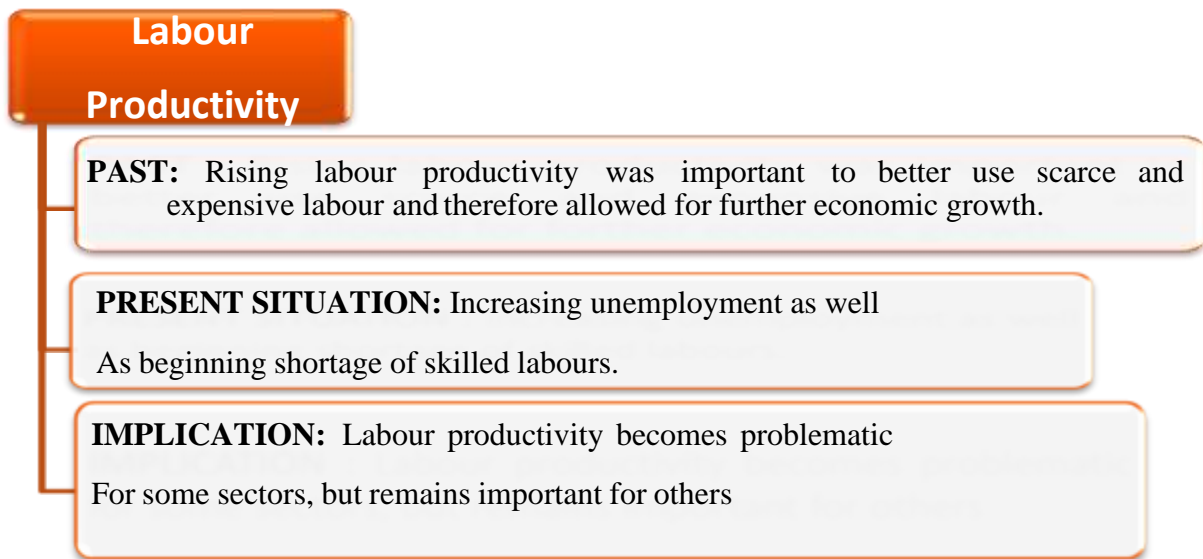


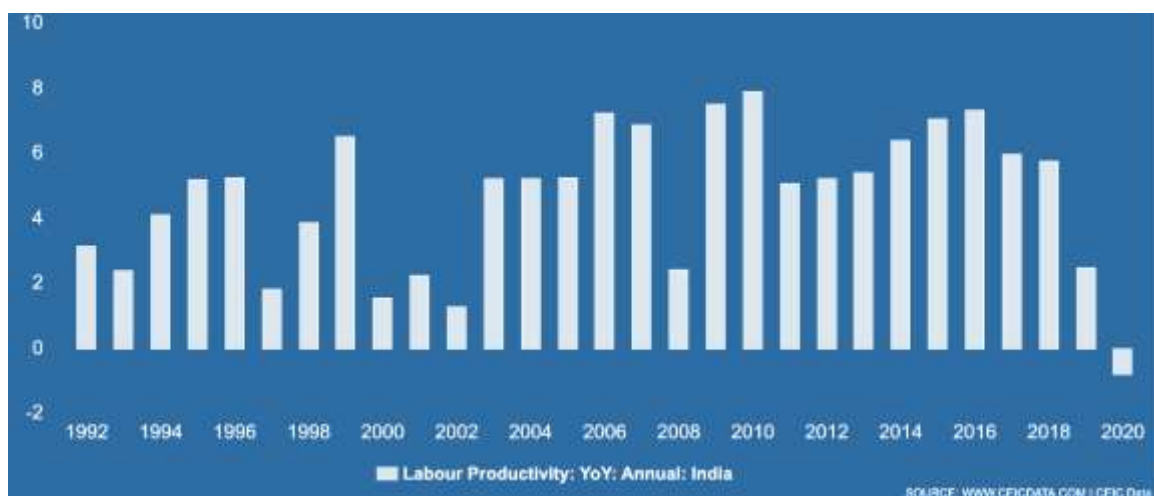
Fig: 2 Labour productivity as drivers of growth (Source: Sustainable Europe Research Institute (SERI))

India Labour Productivity Growth

In comparison to the previous year's growth rate of 1.41%, India's labor productivity increased by 2.91% in December of 2021.

Information on India's labor productivity growth, which is updated annually from December 1992 to December 2021, shows a 5-year average of 5.24%.

In December 2016, the numbers hit a record high of 9.15%, while in December 2002, they hit a record lowest of 1.20%.



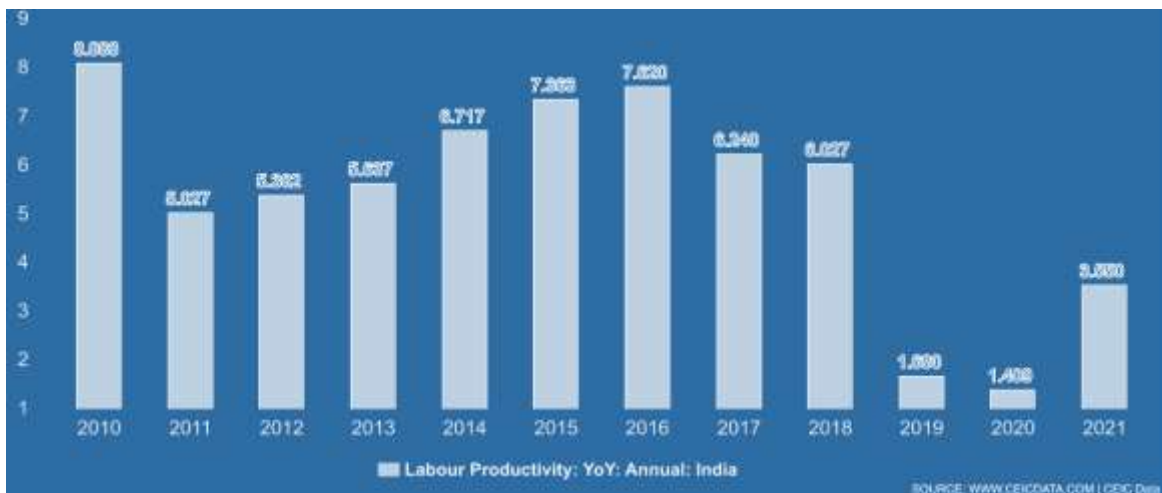


Fig: 3 Labour productivity growth

Source: CEIC DATA OF LABOUR PRODUCTIVITY

Aim & Objective

1.1.1. Aim of study

Aim of this research to study and elaborate project success through optimization of labour productivity.

1.1.2. Objectives of study

1. Studying various factors affecting labour productivity
2. Evaluation of impact of various variables on worker output
3. To design a model consist improvement strategies of CLP

1.2. *Significance of the study*

Construction is a field where productivity is crucial. A large portion of the production input for building projects is labour productivity. Numerous internal and external factors are never consistent in the building sector and are challenging to predict. The labour productivity is continuously variable as a result of this component. It's essential for ensuring as decline into productivity doesn't impact work's planning & scheduling or result in delays. These delays could have negative financial repercussions. Additionally, significant cost savings are possible if productivity is increased because less manpower is needed to do the same amount of work, which lowers the cost of labour as a whole.

(Source: Kazaz Aynur et al. (2016), Reference number (6))

2. Labour Productivity

2.1 Labour Productivity

One component of a production component during a certain time period yields a certain quantity of output, or productivity. Unfortunately, this term lacks specificity and requires more clarification. What exactly are productive variables, and how can they impact productivity? Capital, machinery, materials, land, and labor are all examples of productive elements. Each manufacturing aspect relies on the others for its success. It is clear that determining how each affects productivity is a formidable challenge.

Do we assume that doubling the worker's salary would result in a corresponding increase in productivity? Would his output improve if we provide him with higher-quality inputs, such as tools or resources? An employee may claim greater productivity if his production grows steadily over time. Yet, the unit price of the product may increase due to the higher price of the superior materials or equipment. Depending on how output/time is calculated, the company may subsequently declare a rise or loss in productivity.

Productivity is frequently defined as efficiency with which something is produced, or the ratio of its output to its input. Here again, the definition falls short since it ignores contextual aspects such as manufacturing methods. Which variables are used as input, and how much weight do they carry? Over time, a company may improve its output by 10%, yet the extra money spent may lead to a decline in productivity. So, it appears that this description is, once again, quite vague and broad. Production rate / time period or other metric is a third way of looking at productivity. Productivity may be evaluated in terms of product units, service dollars, or any other metric. Yet, if labor is valued at \$2 per hour, a 100% rise in labor costs would result in a 0% productivity improvement. Thus, this definition remains inadequate.

While it has been used before, a productivity definition that includes all of the components of production in a singular output ratio has two key drawbacks: (1) measurement inconsistencies and (2) excluding important inputs. One potential solution to the first issue is to quantify all inputs and outputs monetarily. In certain circumstances, this may be enough, but in others, it may lead to misunderstandings. A shift in the cost of a key input, such as a raw material, would have an effect on output whether the shift was intentional or not. To decide which inputs should be used is a considerably harder second challenge. Cost of labor is one input, to be sure, but what about the others? The expense of labor itself might be an issue. If we take as an example

two employees with varying levels of experience and the resulting salary gaps between them. Is the worker with more experience less productive since he or she has to put in more time and effort to get the same result? The more experienced worker will be seen as less productive based on the above general criteria, although this might not be situation whatsoever.

2. Research Methodology

3.1 Research approach

The primary goals of our study are to classify & rank most important elements persuading labor productivity in construction projects or to evaluate current state of labor productivity measurement in construction industry. The accompanying research approach is used to study of building construction procedures, & relevant literatures are evaluated. As a result, real data is gathered & analyzed to discover actual practices regarding labour productivity in construction works & essential aspects impacting labour productivity in construction projects.

There' s several ways to gather information. Important ones include observing and interviewing people and using questionnaires and timetables. Information for this study was gathered via questionnaires. Especially for large-scale queries, this technique for gathering information has gained widespread popularity. With this technique, questionnaires are sent out to those in question, who are then asked to fill them out and send them back. An questionnaire is a form or collection of forms with questions preprinted or written on them in a certain sequence.

Primary and secondary data were used to compile this study's findings. The major source of information was a questionnaire given to construction contractors. This secondary information came from many previously conducted studies, internet, scholarly publications, & books. The main data was developed and examined by means of secondary data, which was utilized to help identify problems. A questionnaire will be used to collect information for the study.

3.2 Survey Questionnaires

The questionnaire employed in this study was carefully crafted to ensure that each of its sections was dedicated to investigating a specific subset of what was set out to discover in the study's overarching research topic. In the first section of questionnaire, you will find questions designed to elicit data about the respondent's & company's profile. These questions will probe for details like respondent's job title, the company's industry, & contact details of any ongoing projects.

Second section of survey is designed to collect information regarding contractors' levels of knowledge and understanding with regards to productivity in building projects. In the last section, you'll find a rating scale for the main elements influencing productivity, as well as summaries of general experiences used to boost productivity and offered solutions for increasing productivity in building projects. The findings from past studies will be used as a starting point for developing a questionnaire to examine the impact on construction sector productivity of the characteristics highlighted.

This questionnaire was created with the idea of being easy to fill out by respondents while also providing sufficient information for researcher to draw meaningful conclusions.

3.3 Research Population and Sampling

Every kind and size of contractor is feeling the effects of low labor productivity right now. The construction industry employs a wide variety of workers in specialized roles, but this study focuses mostly on constructing construction firms and projects. Nonetheless, contractors of grade 3 & higher are chosen because of their greater familiarity with the subject matter of research.

Domestic contractors of Grade 3 or above & construction projects they undertake make up target demographics for this study.

3.4 Data Analysis

Analysis of questionnaire data has been completed, and this procedure includes a basic statistical method of inquiry, examination, tabulation, and categorization according to the preferred metric. Most results were shown graphically, such as in tables, pie charts, & bar graphs, to make the data more understandable and accessible.

3.5 Ranking Method

Ordinal scales were employed for this study's data collection and analysis. A ranking system, with values assigned as illustrated in the accompanying table (satty, 1970) Mark how much of an impact each aspect has on your project's output. In every column, please indicate the level of significance, from 1 (very low) to 9 (very high).

Table:-4.1 Ordinal Scale Utilised to Measure impact level

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extremely strong importance
2,4,6,8	Intermediate value

Create an AHP structure to describe the issues with each component first. Thomas Saaty is credited with introducing AHP methods (saaty1990). These methods compare two options in a pairwise fashion, taking into account the respondents' prior knowledge, opinion, and experience with the building project. In this study, we create a comparison matrix of size PP, wherein P is total number of components used by both comparison groups..

- As solution to the issue of establishing a purpose.
- With aim of accomplishing purpose.
- Identify the standards by which each criterion may be judged.

Next, using the nominal scale of 1–9 indicated in table, generate a pairwise comparison matrix for every criterion and level.

4. Data Collection & Analysis

4.1 Stakeholder Particulars

3 kinds of stakeholders have been focused:

1. Project managers
2. Contractors
3. Engineers

Towns where survey is performed

1. Gandhidham
2. Adipur

4.2 Sample Size Calculation

Following formula is employed to determine what size sample would be statistically comparable to general population.

$$n = \frac{M}{1 + [m-1N]}$$

Here, n, m & N signifies sample size of limited, unlimited & available population correspondingly. And m is deliberated as.

$$m = \frac{z^2 * p * (1-p)}{e^2}$$

Here,

z = statistic value for confidence level used, i.e. 1.96 & 1.645 for 95% & 90% confidence level correspondingly;

p = population value estimated &

e = estimation of sampling error. Since we don't know what p really is. Proportional to a 0.5-valued sample

Table 4.1: Population by Academic Field.

Table 4.1: Population Distribution amongst Study Area

City	Construction Firms
Gandhidham (a)	340
Adipur (b)	142
Total (a+b)	482

$$M = \frac{1.645^2 * 0.50 * (1-0.50)}{0.1^2}$$

$$M = 67.65 \sim 70$$

$$n = \frac{482}{67.65 \left(1 + \frac{67.65 - 1}{482} \right)}$$

$$N = 59.79$$

$$N = 60$$

Because of this, it will be necessary to get in touch with at least sixty construction company respondents for the research. The sampling of 70 construction businesses is being evaluated, and if feasible, additional respondents should be contacted, to counteract the danger of nonresponse from respondents & represent stronger reliability and advantages for research.

4.3 Questionnaire distribution & collection

Questionnaire was sent out to interested parties after they were briefed upon study's goals & invited to indicate whether or not they were ready to take part in study's survey. Respondents were given a questionnaire when they shown an initial desire to participate. Stakeholders were given questionnaires explaining the study's goals and inviting them to rate their level of interest in taking part in the study. Respondents were given a questionnaire when they showed initial interest.

Various participants in Ahmadabad & Vadodara were each given one of 126 questionnaires. Ninety-five people total filled out the survey for this study. There were 95 interested parties represented on this list. The results from the whole research region are portrayed into Table 5.2.

Table 4.2: Distribution of Responder

Stakeholders	City		Total
	Gandhidham	Adipur	
Project Manager / Consultant	19	10	29
Contractor	24	12	36
Engineer	20	10	30
Total	63	32	95



Figure 4.1: Percentage of Response Received in Gandhidham and Adipur

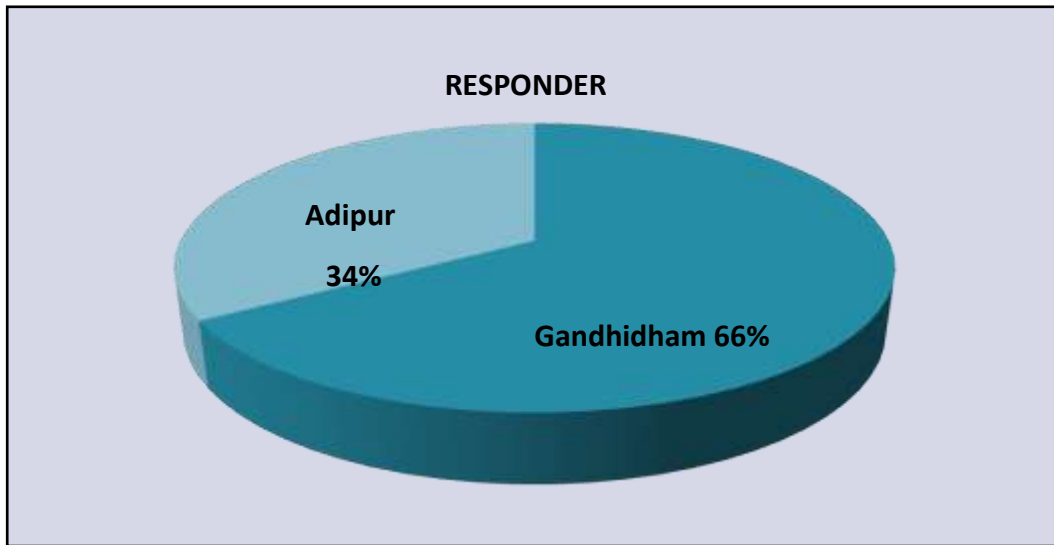


Figure 4.2: Percentage of Response Received Stakeholder Wise

Figure 5.1 and 5.2 represents the percentage wise distribution of responses city wise and stakeholder wise respectively

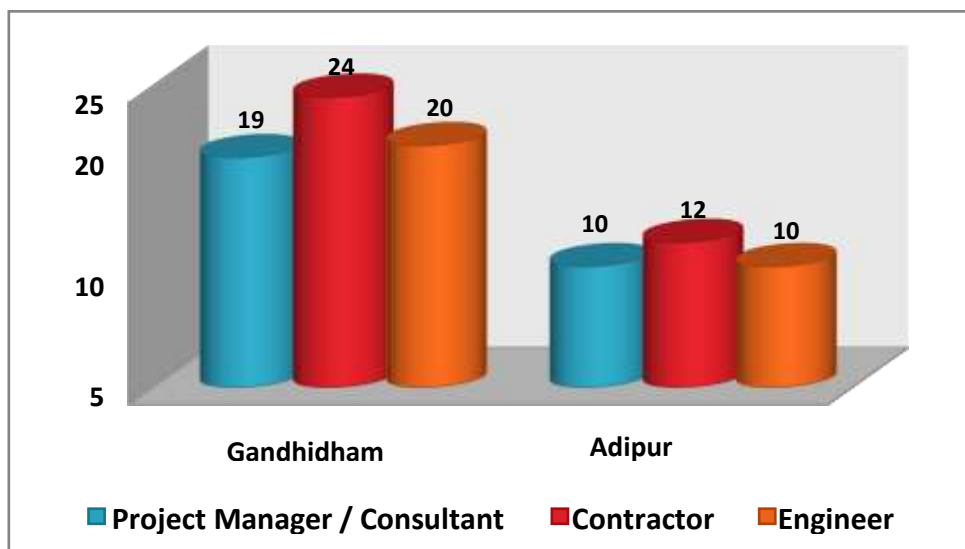


Figure 4.3: City Wise Distribution of Respondent

Figure 5.5 represents the city wise distribution of respondents. Table 5.3 represents city wise summary of questionnaire distribution and response rate. The percentage of respondents is

determined by the distribution and return of surveys. A total of 126 surveys were planned for collection, & 95 were returned (or 75.39 percent), which should be sufficient for this research.

Table 4.3: City Wise Summary of Questionnaire Distribution and Response Rate

City	Number of Questionnaires Distributed	Successfully Responded	No Response	Response Rate (%)
Gandhidham	84	63	21	75 %
Adipur	42	32	10	76.19 %
Total	126	95	31	75.39 %

5.0 Final local and global weight

SUBFACTOR	LOCAL WEIGHT	GLOBAL WEIGHT
ABSENTEEISM OF LABOUR	0.25	0.0407
LACK OF TRAINING	0.53	0.0844
INCREASED LABOUR AGE	0.09	0.0146
PERSONAL PROBLEM	0.13	0.0206
FREQUENT CHANGES IN DESIGN	0.096	0.0093
INCOMPLETE SPECIFICATION	0.160	0.0154
INACCURATE DESIGN	0.292	0.0282
DELAY IN SUBMISSION OF DRG.	0.376	0.0362
POOR RESOURCE MANAGEMENT	0.21	0.0614
TOO MUCH WORK LOAD	0.21	0.0611
LACK OF MOTIVATION	0.07	0.0203
REWORK	0.27	0.0782
LOWER WAGES OF LABOUR	0.06	0.0183
LACK OF SAFETY/ACCIDENT	0.18	0.0532
SHORTAGE OF MATERIAL	0.16	0.0462
POOR QUALITY OF MATERIAL	0.51	0.1490
ACCESSIBILITY OF STORAGE LOCATION	0.07	0.0216
LACK OF STORAGE SPACE	0.26	0.0757
EFFECT OF BAD WEATHER	0.23	0.0870
UNFORSEEN CONDITION	0.07	0.0257
HOLIDAY	0.70	0.2631
LACK OF EQUIPMENT AND TOOLS	0.25	0.0184
DAMAGE OF EQUIPMENT	0.07	0.0052
ABSENCE OF ADVANCEMENT IN MACHINE	0.69	0.0515

Fig: 5.1 factors with local and global weight

As shown in Fig 5.21 local weight and global weight for factors are analysed now local weight is if we are confined to the main criteria or main factor and within this category we want to say which one of these more important than the other so we are localize here and only confined to this particular category are local weight and now global weight is taking all of them together means all factors together which one is more important and less important than that is global weight. In aggregate sheet the find out weight of each factors are the local weight and for global weight we have to multiple the local weight with is criteria. And through global weight we set the ranks for the weight.

5.1 Final ranking and weights

After the combined weight of each subfactor has been calculated, the factors may be sorted by the greatest to the smallest. Based on this ranking, we may ascertain what element has the greatest impact on labor productivity. Outcomes of this ranking is show into table based in result the respondent voted for holiday, effect of bad weather, lack of training, lower wages of labour and rework.

FACTORS	FACTOR WEIGHT	SUBFACTOR	LOCAL WEIGHT	GLOBAL WEIGHT	RANK
HUMAN/ LABOUR	0.160	ABSENTEEISM OF LABOUR	0.25	0.0407	12
		LACK OF TRAINING	0.53	0.0844	4
		INCREASED LABOUR AGE	0.09	0.0146	22
		PERSONAL PROBLEM	0.13	0.0206	17
TECHNOLOGICAL	0.096	FREQUENT CHANGES IN DESIGN	0.096	0.0093	23
		INCOMPLETE SPECIFICATION	0.160	0.0154	21
		INACCURATE DESIGN	0.292	0.0282	14
		DELAY IN SUBMISSION OF DRG.	0.376	0.0362	13
LABOUR MANAGEMENT	0.292	POOR RESOURCE MANAGEMENT	0.21	0.0614	7
		TOO MUCH WORK LOAD	0.21	0.0611	8
		LACK OF MOTIVATION	0.07	0.0203	18
		REWORK	0.27	0.0782	5
		LOWER WAGES OF LABOUR	0.06	0.0183	20
		LACK OF SAFETY/ACCIDENT	0.18	0.0532	9
MATERIAL MANAGEMENT	0.292	SHORTAGE OF MATERIAL	0.16	0.0462	11
		POOR QUALITY OF MATERIAL	0.51	0.1490	2
		ACCESSIBILITY OF STORAGE LOCATION	0.07	0.0216	16
		LACK OF STORAGE SPACE	0.26	0.0757	6
EXTERNAL	0.376	EFFECT OF BAD WEATHER	0.23	0.0870	3
		UNFORSEEN CONDITION	0.07	0.0257	15
		HOLIDAY	0.70	0.2631	1
EQUIPMENT&TECHNOLOGY	0.075	LACK OF EQUIPMENT AND TOOLS	0.25	0.0184	19
		DAMAGE OF EQUIPMENT	0.07	0.0052	24
		ABSENCE OF ADVANCEMENT IN MACHINE	0.69	0.0515	10

Fig: 5.2 final ranking of factors affecting CLP

NO	FACTORS
1	HOLIDAY
2	POOR QUALITY OF MATERIAL
3	EFFECT OF BAD WEATHER
4	LACK OF TRAINING
5	REWORK
6	LACK OF STORAGE SPACE
7	POOR RESOURCE MANAGEMENT
8	TOO MUCH WORK LOAD
9	LACK OF SAFETY/ACCIDENT
10	ABSENCE OF ADVANCEMENT IN MACHINE

Fig: 5.3 Top ten factors affecting CLP

Top ten variables affecting labor productivity, ranked by impact.. Holidays, lack of training, too much workload, safety and accident, effect of bad weather are most affect the labour productivity.

5.2 FISH BONE DIAGRAM OF LOW PRODUCTIVITY OF LABOUR

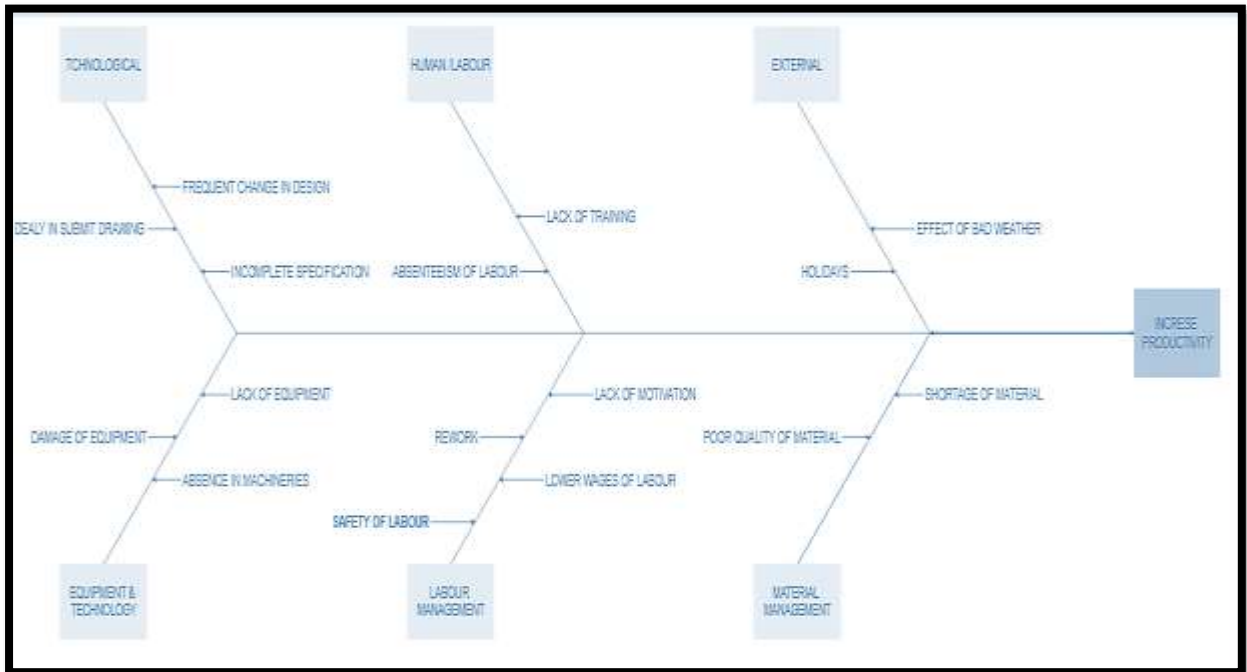


Fig. 5.4 fishbone of lower productivity of labour

Here we see a fishbone diagram, determine cause and effect a tool frequently employed in constant improvement to help pinpoint the precise origin of issue and then implement a solution. Here it' s showed the possible root cause of a low labour productivity rate. By solving the issue. can be increase in labour productivity.

4. Conclusion

The survey and analysis of questionnaire responses were provided before. Research results are analyzed, and suggestions for further study and application are presented together with ensuing conclusions.

The goal of this study is to determine whether aspects of construction work environment effect labor productivity. With a standardized questionnaire administered in the two cities of

Kutch (gandhidham and adipur), this research explores all potential variables impacting labor productivity. After analyzing the survey data, we rank the variables using AHP formula (Analytical hierarchy process)

Twenty-four elements were investigated for the research and were divided into five primary groups: technical, human labor, Administration, external, apparatus, & technologies. There was a total of 126 surveys sent out, with a response rate of 75.39 percent.

What are the top 10 variables affecting labor productivity, and how do they rank? To examine how many aspects interact with one another, the Analytical Hierarchy Method was demonstrated to be very helpful. Subgroup results showed that holidays, low-quality materials, bad weather, an inadequate training,, lower salaries, overtime, & rework all had a major influence on worker productivity. However, the most productive onsite groups were the management team outside consultants.

The important elements impacting labor productivity were compared and contrasted among two cities. It's no secret that boosting efficiency in workplace is a top priority for any construction company, and this AHP model provides a key area for doing so. AHP approach may be implemented quickly and provides room for expansion in terms of criterion & sub-criteria.

6.1 Recommendation

1. The construction industry might benefit from more management training for both foremen and forewomen. Timely payment of progress invoices is essential for effective site management.
2. There has to be more interaction and collaboration between the many construction partners. Storage spaces of material and quality of material should be improve.
3. Safety should be increase on site for improve productivity of labour. Proper training to be provide to the labours for improve their skills.
4. As a lack of instruction was shown to be a major element impacting efficiency in construction work, contractors are encouraged to devote considerable time to monitoring labour productivity and also to motivate labours to engage in workshops and training sessions to develop their knowledge and skill.
5. The contractors should pay particular attention to the problems of insufficient

materials, excessive workload, & inadequate tools and equipment in order to lessen the negative effects on worker output.

6. Stakeholders should use this study's rankings to inform their own planning for addressing the highlighted essential criteria.

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