Factors Influencing Labour Productivity in Building Projects: A Case Study of Saurashtra Region

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Abstract: Construction industry is fast growing industry in all over the world. Unique design brings complexity in construction. Today's scenario depicts that there are numerous stakeholders are associated on single project. Completion of project on time and cost with best quality is the primary base of project management. Major construction onsite is done by the labour. Without them, completion of construction work is quite hard and if done then it consumes more cost than estimated cost. Labour management is as important as other parameters consider on site, because labours cost is about 30% to 50% of estimated project cost. So, it requires quite detailed management on site. Paper show study of various factors affecting labour productivity in building projects in various four cities: Rajkot, Bhavnagar, Jamnagar and Junagadh of Saurashtra region. Factors were divided into five main categories and each of them divided into two sub categories. Result of paper included top ten factors affected labour productivity.

Keywords: **Construction, Construction Labour Productivity (CLP), Labour, Labour Productivity Factors, Productivity, Management**

I. INTRODUCTION

Construction industry is fast growing industry in all over the world. Unique design brings complexity in construction. Today's scenario depicts that there are numerous stakeholders are associated on single project. **Vaishant Gupta et al. (2014)** observed that construction industry is depending on 3-M resources. There are means of 3-M is manpower, machine and materials. 3-M are basic input in construction industry. **[6]** The construction industry faces difficulties concerning issues related with effective productivity and good labour management. Insufficient labour management on construction to result in low productivity. Proper labour management can help with effective productivity. Most construction industry 30% to 50% of the total cost the of project is spent on labours and labour management In order to achieve significant reductions in cost and improvements to LP, a focus on site management is important. However, there are few publications that relate to site operations. If properly done, a benchmarking study should culminate in a prescription (validated practices) for productivity improvement. **[25]** Detailed Image of Cities of which are taken into study are as per below.

II. LITERATURE REVIEW

Following are some literature review form different international journals and conferences about the factors affecting to the CLP and its effect on output of project. Also, contains positive and negative impact of factors which affect CLP.

Figure 1: Physical Location of Cities in India map (Scope of work)

Abdulaziz M. Jarkas et al. (2012) worked on importance of factors perceived to affect LP on construction sites in Kuwait. They were finding out around 45 factors which were affected to the productivity of labour in construction. Paper results were used to fill the gap in knowledge of factors that could be used by industry practitioners and construction managers to affect LP. [13] Anu V. Thomas et al. (2013) illustrated the application of benchmarking techniques to understand productivity variability among the different types of labour employed for same king of work. They developed regression model to find out impact of various factors on construction LP and finding out that majority of construction productivity losses arise as a result of managerial inefficiencies. [24] Naychisoe et al. (2014) studied four categories of labour management practices effect on project. They were used taking questionnaire survey as a principal tool and analysis of result were taken by RII method and in addition, H-test or Kruskal-Wallis test were used to check the opinions of all respondents. They finding out that factors on increase LP and reducing LP were identical on other hand the opinions on manpower problems in construction were not identical. Therefore, manpower problems were not considered as improvement in the capabilities of labour. [19] Vaishant Gupta et al. (2014) worked on 55 factors that affecting the LP and then gives recommendation that details of every work were present at site in well define format. Payment were made timely and effective labour supervision helps to increase LP. Also, find out that more than 8hr/day shift efficiency on workers were less than 90% and they only physically present at site not mentally. To achieve desired goals of project regular meeting and skilled and knowledgeable labour required. [6] Dharani K (2015) identified factors which are affected to LP and also studied causes of labour problems on site and its effects on the construction projects Also, finding that small firms in India can't satisfy prerequisites of labours. They try to studied ill effects of falling LP with the productivity of others resources were material, equipment and capital. They finding that most of the construction labours were engaged with others profession therefore they not give full importance to construction work and tend to work informally. [4] S. Sivaraj et al. (2018) identified the affecting and improving productivity factors in construction through labour management. The researches were carried out in 122 samples. The data were analysed and found the top important reducing and increasing factors in construction through labour management. They concluded all reducing factors were 98.4% to 64.24% and all increasing factors were 97.86% to 73.34% importance from given responses. From that they were given recommendations to improve LP in construction through labour management. [21]

III. RESEARCH METHODOLOGY

The study aims to finding out various factors affecting to labour productivity and rank their effect on industry after gathering data through survey. Different literatures related to this research are reviewed, and the following research methodology is implemented which is shown in figure 2.

The research instrument used in this research is questionnaire which was designed in such a way that it ensures to address the objectives of the study categorized by different parts. The first part of the questionnaire is targeted to gather information about the respondents and firms' profile. The second part contains the various factors affecting to the labour productivity which is to be rated by the respondents. The factors which were distinguished from previous research will be utilised for preparing a questionnaire to investigate its influence on the construction industry. Total 45 factors were identified under 5 main groups which are further divided into two categories namely productivity increasing factors and productivity decreasing factors. A 5-point Likert scale was used for measuring of the level of impact and agreement of factors. These questionnaires were distributed to Project Managers, Architect, Contractors and Engineers of a construction firm in 4 different cities: Rajkot, Bhavnagar, Jamnagar and Junagadh in Saurashtra region of Gujarat, India.

The data collected from the questionnaire survey was analysed using Microsoft Excel. The perspective of the respondent for factors influencing labour productivity has been analysed to rank the factors based on their Relative Important Index and Spearman Rank Correlation. Higher the value of index, more important is the factor labour productivity in construction industry.

To obtain statistically representative sample size of the population following equation was used:

$$n = \frac{m}{1+[\frac{m-1}{N}]} \quad (1)$$

Where n, m and N = the sample size of limited, unlimited available population, respectively. m is estimated by following Equation:

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

Where z=the statistic value for the confidence level used, i.e, 1.96, and 1.645 for 95% and 90% confidence level respectively; p=the value of the population that estimated and e=the sampling error to be estimated. Because the value of p is unknown sincich et al. (2002) suggest the value 0.50 to be used in sample size.

$$m = \frac{1.645^2 * 0.5 * (1-0.5)}{0.1^2} \quad (3)$$

$$m = 67.65$$

Here confidence level is taken as 90%.Accordingly, for the total number of classified contractors, the sample size is 63.

$$n = \frac{67.65}{1+[\frac{67.65-1}{825}]} \quad (4)$$

$$n \approx 63$$

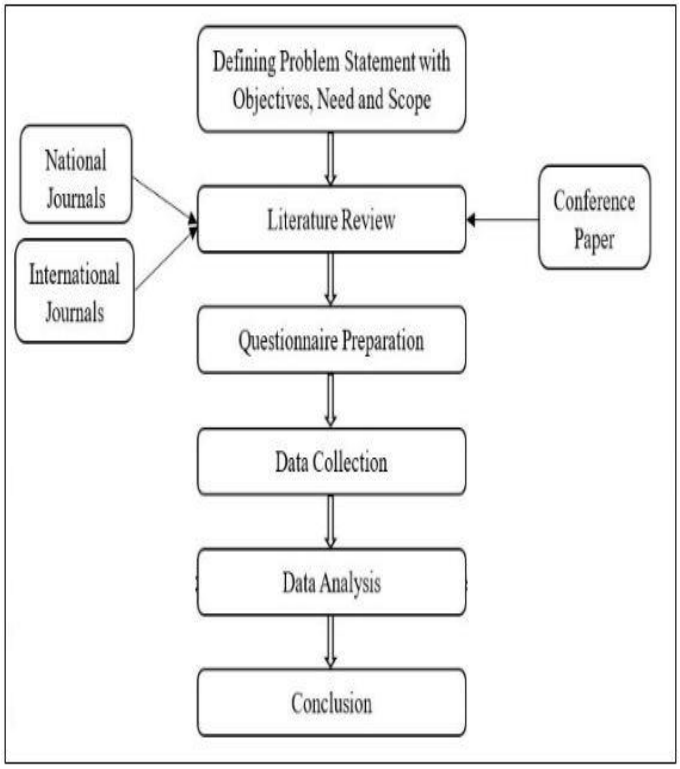

Figure 2: Methodology flow diagram

IV. DATA ANALYSIS AND RESULT

Project Managers, Architect, Contractors and Engineers of Rajkot, Bhavnagar, Jamnagar and Junagadh cities registered with Gujarat R&B authority or working with firm registered with same authority were targeted for the survey. Normally response rate is very low so the questionnaire was distributed to the various stakeholders more than the sample size requirement. A total of 198 questionnaires were distributed to different stakeholders in different cities. This study received 113 responses.

4.1 Relative Important Index (RII)

The primary data collected from the questionnaire survey were analysed utilizing Relative Importance Index method for ranking each factor from the point of view of project managers, architect, contractors and engineers. A Five-point Likert scale was used for rating of the level of impact and agreement of factors, where 5 means critical impact and 1 means no impact and for agreement 5 means strongly agree and 1 means strongly disagree. This was transformed to important indices for each factor as follows:

$$RII = \frac{\Sigma W}{A \times N} \quad (5)$$

Where, W is the weighting given to each factor by the respondents (ranging from 1 to 5), A is the highest weight (i.e., 5 in this case), and N is the total number of respondents. Higher the value of RII, more important was the factor affecting labour productivity.

Table 1: Top most productivity increasing factor of impacting building projects by RII method

Sr. No	Factors by Level of Impact	RII	Rank
AI 1	Bonus and incentives	0.858	1
BI 1	Safety programs	0.841	2
DI 2	Easy access to information	0.804	3
DI 1	Advantage of technology	0.786	4
AI 2	High amount of payment	0.777	5
AI 5	Motivation of labour	0.766	6
CI 1	Use of latest materials available	0.761	7
BI 2	Construction method	0.759	8
AI 3	Facility at workplace	0.738	9
AI 6	Age of labour	0.727	10

Table 2: Top most productivity decreasing factor of impacting building projects by RII method

Sr. No	Factors by Level of Agreement	RII	Rank
CD 1	Materials shortage	0.878	1
BD 2	Lack of supervision	0.835	2
AD 1	Poor skill of labour	0.827	3
BD 6	Lack of training session	0.811	4
DD 3	Delay in responding to Request For Information (RFI)	0.811	4
CD 4	Tools and equipment shortage	0.809	6
ED 1	Weather changes	0.798	7
AD 3	Less experience	0.793	8
ED 4	Working at high place	0.791	9
BD 7	Strict inspection by engineer	0.789	10

4.2 Spearman Rank Correlation

Spearman Rank Correlation is done for identification of the way of occurrence of factors based on the response given from various stakeholders. The Spearman correlation coefficient, r_s, can take values from +1 to -1. A r_s of +1 shows an ideal association of ranks, a r_s of zero indicates no association between ranks and a r_s of -1 indicates a perfect negative association of ranks. The closer r_s is to zero, the more fragile the relationship between the ranks. Spearman rank correlation is calculated using formula 6.

$$r_s = 1 - \frac{6\sum_{i=1}^{n} d_i^2}{n(n^2-1)} \quad (6)$$

Where,
r_s = Spearman's rank correlation coefficient
ΣDi^2 = Sum of squared differences between paired value of individual factor
n = Total number of factors (10 and 22 factors respectively in this study)

As there are 4 different designated persons, it makes 6 different pairs as shown in Table 3 with the value of r_s.

Table 3: Spearman Rank Correlation Value between Stakeholders in Decreasing Order for factors by Level of Impact

Sr. No.	Stakeholder	Value of r_s	Stakeholder
1	Project Manager	0.438801054	Architect
2	Project Manager	0.627997365	Contractor
3	Project Manager	0.788932806	Engineer
4	Architect	0.613306983	Contractor
5	Architect	0.486100132	Engineer
6	Contractor	0.8243083	Engineer

As shown in table 3, highest value of spearman rank correlation is between Contractor and Engineer that means level of thinking and giving answer to particular issues is very similar. There is a highest level of agreement between Contractor and Engineer. Likewise, lowest value of spearman rank correlation is between Project-Manager and Architect it means that there is lowest level of agreement between Project Manager and Architect.

V. CONCLUSION

Based on the results of this study some conclusions are to be found as discussed below,

- This research paper is intended to identify the factors affecting labour productivity in building construction.
- This study investigates all possible factors affecting labour productivity through a structured questionnaire distributed in four cities of Saurashtra: Rajkot, Bhavnagar, Jamnagar, and Junagadh.
- The survey results are subjected to analysis, and the ranking of factors is calculated using the Relative Important Index (RII) Method.
- Forty-five factors were considered for the study, which were categorized in five main groups as Human or labour, Management, Resource, Technology and External Factors and each of main group further categories as two parts increasing and decreasing.
- A grand total of 198 questionnaires were distributed, and 57.05% was the response rate.
- In addition, the agreement/disagreement among respondents was checked using Spearman's rank correlation coefficient, which states that there is strong agreement among respondents regarding ranking of factors affecting labour productivity in building construction.

VI. FUTURE SCOPE

In this study, residential and commercial types of projects are considered for research purpose. So work can be extended for other different types of construction projects like industrial project, infrastructural project etc. Here only factor affecting labour productivity in building construction are identified and analysed. In case researchers can also measure productivity on construction site by taking case study and then analyse it for different types of project.

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REFERENCES

1. Abdul Kadir, M. R., Lee, W. P., Jaafar, M. S., Sapuan, S. M., & Ali, A. A. A. (2005). Factors affecting CLP for Malaysian residential projects. Structural Survey, 23(1), 42–54. https://doi.org/10.1108/02630800510586907
2. Alinaitwe, H. (n.d.). Labour Productivity in the building industry. 210–220.
3. Alinaitwe, H. M., Mwakali, J. A., Hansson, B., Alinaitwe, H. M., Mwakali, J. A., & Hansson, B. (2010). Factors affecting the productivity of building craftsmen - studies of Uganda CRAFTSMEN – STUDIES OF UGANDA. 3730.
4. Dharani K. (2015). Study on Labours Productivity Management in Construction Industry. 6(1), 278–284.
5. Enshassi, A., Mohamed, S., Mustafa, Z. A., & Mayer, P. E. (2007). Factors affecting labour productivity in building projects in the Gaza strip. Journal of Civil Engineering and Management, 13(4), 245–254.
6. Gupta, V., & Kansal, R. (2014). Improvement of construction labor productivity in chambal region. (3), 2319–2322.
7. Hanna, A. S., Chang, C. K., Sullivan, K. T., & Lackney, J. A. (2008). Impact of shift work on labor productivity for labor intensive contractor. Journal of Construction Engineering and Management, 134(3), 197–204.
8. Hickson, B. G., & Ellis, L. A. (2014). Factors affecting Construction Labour Productivity in Trinidad and Tobago. The Journal of the Association of Professional Engineers of Trinidad and Tobago, 42(1), 4–11.
9. Hiyassat, M. A., Hiyari, M. A., & Sweis, G. J. (2016). Factors affecting construction labour productivity: a case study of Jordan. International Journal of Construction Management, 16(2), 138–149.
10. Jarkas, A. M., & Bitar, C. G. (2014). Factors affecting construction labour productivity in Kuwait. Journal of Construction Engineering and Management, 138(7), 811–820.
11. Jarkas, A. M., Kadri, C. Y., & Younes, J. H. (n.d.). A Survey of Factors Influencing the Productivity of Construction Operatives in the State of Qatar Productivity of Construction Operatives. (December 2014), 37–41.
12. Kazaz, A., & Ac, T. (2015). Comparison of Labour Productivity Perspectives of Project Managers and Craft Workers in Turkish Construction Industry. Procedia - Procedia Computer Science, 64, 491–496.
13. Kazaz, A., & Acikara, T. (2015). Comparison of Labour Productivity Perspectives of Project Managers and Craft Workers in Turkish Construction Industry. Procedia Computer Science, 64, 491–496.
14. Kazaz, A., Manisali, E., & Ulubeyli, S. (2008). Effect of basic motivational factors on construction workforce productivity in. (July 2014), 94–106.
15. Kazaz, A., Ulubeyli, S., Acikara, T., & Er, B. (2016). Factors Affecting Labor Productivity: Perspectives of Craft Workers. Procedia Engineering, 164(June), 28–34.
16. Li, X., Chow, K. H., Zhu, Y., & Lin, Y. (2016). Evaluating the impacts of high-temperature outdoor working environments on construction labor productivity in China: A case study of rebar workers. Building and Environment, 95, 42–52.
17. Mahamid I. Contractors perspective toward factors affecting labor productivity in building construction Journal of Engineering, Construction and Architectural Management 2013.p. 446-460.
18. Menon, M. A., Varghese, P. S., Engineering, C., Athanasius, M., & Kothamangalam, E. (2018). Labour Productivity Measurement method using 3D BIM of a Commercial Project.
19. Minde, P. (2016). Importance of Measurement of Labour Productivity in Construction. (July).
20. Nay Chi Soe & Aye Mya Cho (2017). Current Practices on Labour Management in Building Construction Projects. 03(10), 2017–2021.
21. Nurhendi, R. N., Khoiry, M. A., & Hamzah, N. (2019). Review on Factors Influencing Labour Productivity in Construction Project. (6), 837–844.
22. Online, I., Sivaraj, S., & Vidivelli, B. (2018). Effective Productivity in Construction through Labour Management. 7(4), 46–55.
23. Soekiman, A., Pribadi, K. S., Soemardi, B. W., & Wirahadikusumah, R. D. (2011). Factors relating to labor productivity affecting the project schedule performance in Indonesia. Procedia Engineering, 14, 865–873.
24. Sparsha B.P., Mahadev Gowda S.K. (2016). A Study on Labour Productivity In Construction Sites of Kodagu Region. 4(3), 183–188.
25. Thomas, A. V, & Sudhakumar, J. (2013). Labour Productivity Variability Among Labour Force – A Case. (1), 57–65.
26. Thomas, B. H. R. (1994). Forecasting labor productivity using Work Environment Input Work to be done. 120(1), 228–239.

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