

# Study of Factors Affecting Labour Efficiency at Construction Sites

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**Abstract:** Construction is a labour intensive industry and the labour productivity is considered as a direct measure of their efficiency. A higher productivity can help to ensure better competitiveness in the industry which in turn may help to meet the project goals and values. The study aims at identifying and analyzing the key factors which are likely to affect the labour efficiency at construction sites and also analyzing their impact. The study also aims at providing suggestions in order to reduce the variation in labour productivity. A questionnaire survey approach has been used for data collection and multi variate regression has been used to analyze the major factors affecting labour productivity and the results indicate six main factors which significantly impact on the labour efficiency at construction sites.

**Keywords:** Construction sites, Labour Productivity, Multiple variate regression, efficiency.

## Introduction

Productivity is an average measure of the efficiency of production. It can be expressed as the ratio of output to inputs used in the production process

The Construction industry is labour intensive and labour is one of the major and the most complex of all resources need at the Construction sites for execution of the work. Labour costs account for almost 30 % to 55 % of overall project cost. In general labour productivity is usually expressed as output per hour.

Among the various factors affecting productivity at construction sites. Hence it becomes extremely important to study the factors that are likely to affect the labour productivity at site and further there is also a need to quantify the affect of these factors so that inefficiencies can be reduced and productivity can be maximized. The study aims at quantifying these factors and to generate a model for predicting labour productivity and efficiency.

## Objectives of The Study

The study is focused on identifying the key attributes affecting labour productivity at construction site and their affect on the labour efficiency and further model the impact of these factors through multi variate regression so that appropriate recommendations can be made in to reduce the variations of labour productivity in construction projects.

## Literature Review

Labour is one of the most important resources in the construction industry and accounts for majority of the cost. The quantity and quality of labour available for performing a task in construction is much more susceptible to the influence of management than materials or capital. However, it is extremely important to note that the labour productivity is a measure of the overall effectiveness of the system in effectively utilizing labour, equipment and capital so as to convert the labour efforts into useful output.

25 critical factors were identified by Homyun Jang et al (2009) which were grouped into 4 main heads, mainly management of work at sitet, work technique, characteristics of work and worker component. A similar study carried out by Durdyev and Mbachu (2011) identified 56 variables which affected the labour productivity, and further categorized them into 8 factor heads.

Enshassi (2007) classified the attributes affecting labour productivity and efficiency in the construction into 10 main groups, namely: characteristics of internal workforce, leadership, work motivation time, materials and equipment, supervision, project characteristic, site security, quality and external factors. 113 variables were identified by Soekiman et al (2011) which effect the labour productivity sites these were grouped under 15 heads according to their characteristics, namely:, execution ,

design, equipment & material, health and safety, supervision, working times, project factors, quality of work and environment, financial factors, leadership and coordination, organization structure, and many external factors.

Nabil Ailabouni et al (2007) highlighted 32 significant factors affecting the productivity in the construction industry and were then grouped into 4 groups based on their common characteristic, namely: environmental factors, organization related factors, dynamics of the group and personal factors.

On the basis of Literature review, 34 factors have been selected and further based on their characteristics these have been grouped into 8 heads namely: Manpower, Managerial, Environmental, safety, Material/Equipment, Schedule, motivation, and Quality

The **first** Factor considered is MANPOWER characteristics and the variables studied under this are lack of skills, increase in the age, labour absenteeism, lack of training and personal problems of the labour. The **Second** Factor under consideration is MANAGERIAL factors this includes poor site management, poor communication at site, misunderstanding and misrepresentation of information between labour and supervisors, and lack of periodic meetings with labour. Further the **third** factor is ENVIRONMENTAL FACTORS, these include variables like weather conditions, location of project, working in confined places, and size of the project site. The **fourth** factor is MOTIVATION which includes the study of variables like delays in payments, facilities of transportation to and from site, financial motivation system, availability of appropriate spaces for eating at relaxing at site. Etc.

Further the fifth and a very important factor was that of MATERIAL AND EQUIPMENT which mainly and discussion on variables like material shortages at site, lack of proper storage facilities, old and inefficient machines and shortages of tools and equipments.

The last three factors are very important namely SCHEDULE, QUALITY AND SAFETY which include parameters like Working days and hours, holidays, schedule, safety precautions, first aid, accidents at site, availability of safety engineer at site, sufficient lighting, quality of raw materials, quality of food available, quality of work required, and quality inspections etc

### Hypothetical Model

The hypothetical model consists of eight hypotheses from H1 to H8, the factors are the independent variables which affect labour productivity directly, a dependent variable here is the labour productivity whereas the independent variables under this study are Manpower related factors, managerial factors, environmental factors, motivational factors, materials and equipments used, safety parameters and quality issues.

### Research Methodology

The study proposes to use a questionnaire survey approach to identify the key factors affecting the labour productivity at construction sites. The questionnaire consisted of 56 questions which were circulated to different construction sites and the panel consisted of respondents from various levels of the organization from project managers, site supervisors, labour, quality inspectors, etc. A reliability analysis was then carried out in order to test the reliability of the survey data collected

Cronbach's alpha is used as the most common method to measure reliability. It is most commonly used when we have multiple likert scale type of questions in a survey/questionnaire. As the number of variables is large we need to narrow down our data for the multivariate regression, hence a factor analysis has been carried out on the 56 variables and which were ultimately grouped into 8 main factors. Then a multivariate regression is carried out on the 8 factors which are believed to have a direct impact on the labour productivity

A questionnaire shall be developed to identify the major factors affecting the productivity of labour at construction site. The questions formed would be to produce responses for the factors identified from literature survey and expert interviews. Some questions would also be included on the Initiation, Monitoring & Controlling and Closing process areas of these projects. Obtaining "high-quality" responses with adequate disclosures would be a key task and the researcher would work in collaboration with project stakeholders to achieve this. The target is to obtain at least 30% responses would be targeted with reasonable number of responses from three identified Organizations.

Factor analysis is carried out in order to reduce the number of variables under common factors and make the data handling a easier process. The initial classification was done purely on the basis of literature review (and expert opinion from industry experts.

A reliability analysis was then conducted on the factors for each classified component so as to verify the reliability of the components. A multi variate regression analysis was then carried out on the 8 factors This was the last stage of the statistical analysis in which the factors that were found to be significant in affecting the labour productivity at construction sites were identified and modelled.

**Results of Data Analysis and Discussion**

60 questionnaires were distributed to different construction firms in the population. Out of these, 53 questionnaires were successfully filled and returned. The response rate obtained was 88.33%.

**Reliability Analysis**

Cronbach’s alpha approach has been used for carrying out reliability analysis on the responses obtained through the questionnaire survey. This method is used to assess the basic consistency on the basis of the average correlation between the data that was measured in an identical manner.

The value of cronbach’s alpha and total correlation must lie between 0.6 and 0.3 respectively. Three factors were deleted due to low correlation after considering the result of the first reliability analysis,

Table 1. Results for Reliability Studies

Sr No	GROUP	CRONBACH’S ALPHA VALUE
1	Manpower issues	0.6935
2	Managerial issues	0.663
3	Environmental concerns	0.626
4	Motivation factors	0.665
5	Material & equipment	0.747
6	Schedule aspects	0.778
7	Safety issues	0.672
8	Quality concerns	0.645

**Factor Analysis**

The aim behind carrying out a factor analysis is to group larger number of related variables into factor heads and also for data reduction Factor analysis is one of the most commonly used statistical technique which explains the common dimension that compose variables (called components) by analyzing the existing correlation between them.

In this study 34 independent variables were identified which affect the labour productivity on construction sites. After the reliability analysis three factors were eliminated due to low total correlation.

The Kaiser Meyer Olkin value obtained was 0.59 which is greater than 0.5, which indicates that the data will factor well and in the Bartlett’s test the significant value obtained is lower than 0.05, which clearly indicated that the correlation matrix is different from an identity matrix.

Further the eigen value which is an index that represents the explanatory power of the components, and is extracted from the number of the components that have a value of 1 or more. From the analysis there are seven components whose initial eigen values are found to be greater than one and these components were extracted during analysis. These seven components were able to explain 65.822% of the information contained in the original factors.

**Multi Variate Regression Analysis**

The coefficient of determination denoted by R<sup>2</sup> came out to be to 0.822. This indicates that factors considered under the study are able to explain 82.2 percent of the total variations in labour productivity at sites. The P value obtained of 0.000 implies that the labour productivity is significant at the 5 percent level of significance.

Table V indicates that about 82.2% of the total variation in the labour productivity can be explained by the seven independent variables considered under this study. This indicates that the model is adequate in the prediction.

A F value of 35.38 in the table VII below indicates that the overall regression model is significant and has some explanatory value (P- value p=0.00<0.05). This also indicates that there exists a significant relationship between the predictor variables.

$$LPF = -3.104 + 0.233F1 + 0.199F2 + 0.344F4 + 0.225F5 + 0.124F6 + 0.218F7 + 0.168F8$$

(F1: manpower related group, F2: managerial factors group, F4: motivational factors group, F5: material/equipment group, F6: schedule group, F7: safety group, F8: quality group)

Table 2. Total Variance

**Total Variance Explained**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.615	21.597	21.597	5.615	21.597	21.597	3.058	11.762	11.762
2	2.751	10.583	32.180	2.751	10.583	32.180	2.856	10.984	22.746
3	2.125	8.173	40.352	2.125	8.173	40.352	2.752	10.583	33.329
4	1.977	7.604	47.956	1.977	7.604	47.956	2.223	8.551	41.881
5	1.803	6.935	54.892	1.803	6.935	54.892	2.152	8.278	50.159
6	1.550	5.961	60.853	1.550	5.961	60.853	2.151	8.275	58.434
7	1.292	4.970	65.822	1.292	4.970	65.822	1.921	7.389	65.822
8	.970	3.730	69.553						
9	.902	3.469	73.021						
10	.811	3.121	76.143						
11	.757	2.911	79.054						
12	.710	2.732	81.786						
13	.625	2.406	84.192						
14	.585	2.248	86.440						
15	.528	2.032	88.472						
16	.473	1.818	90.290						
17	.449	1.726	92.016						
18	.377	1.451	93.467						
19	.354	1.362	94.830						
20	.339	1.305	96.135						
21	.292	1.125	97.260						
22	.203	.780	98.040						
23	.186	.715	98.755						
24	.149	.571	99.326						
25	.105	.405	99.731						
26	.070	.269	100.000						

Extraction Method: Principal Component Analysis.

Table 3. Summary for Multivariate Linear Regression Analysis

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.920 <sup>a</sup>	.846	.822	.415	.846	35.380	7	45	.000

a. Predictors: (Constant), Quality, Material, Managerial, Safety, Manpower, Motivation, Schedule

Table 4. Anova Table for Multivariate Linear Regression Analysis

**ANOVA<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	42.567	7	6.081	35.380	.000 <sup>b</sup>
	Residual	7.734	45	.172		
	Total	50.302	52			

a. Dependent Variable: LPV

b. Predictors: (Constant), Quality, Material, Managerial, Safety, Manpower, Motivation, Schedule

Table 5. Coefficient of Multiple Linear Regression Analysis

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-3.105	.455		-6.826	.000
	Manpower	.328	.102	.233	3.205	.002
	Managerial	.291	.094	.199	3.111	.003
	Motivation	.489	.101	.344	4.825	.000
	Material	.305	.094	.225	3.263	.002
	Schedule	.169	.104	.124	1.631	.110
	Safety	.275	.081	.218	3.398	.001
	Quality	.312	.116	.168	2.693	.010

a. Dependent Variable: LPV

Table 6. Model Summary

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.920 <sup>a</sup>	.846	.822	.415	.846	35.380	7	45	.000

a. Predictors: (Constant), Quality, Material, Managerial, Safety, Manpower, Motivation, Schedule

Table 7. Hypothesis Summary

HYPOTHESIS	GROUP	T	Sig	Decision
H1	Manpower	3.205	.002	Reject hypothesis H0
H2	Managerial	3.111	.003	Reject hypothesis H0
H4	Motivation	4.825	.000	Reject hypothesis H0
H5	Material/Equipment	3.263	.002	Reject hypothesis H0
H6	Schedule	1.631	.110	Accept Hypothesis H0
H7	Safety	3.398	.001	Reject hypothesis H0
H8	Quality	2.693	.010	Reject hypothesis H0

### Conclusion and Recommendations

The results obtained for the multivariate regression analysis resulted in six independent groups, which have a positive impact on labour productivity and efficiency, and one group, which had no significant impact. The Multiple linear regression analysis indicated that the model generated explains 82.2% of the variance in labour productivity and efficiency.

Among the six independent groups, the motivational factors group has obtained the highest score indicating maximum impact on labour productivity.

Hence through this study it be concluded that the motivational factors have the highest impact on labour productivity which has the highest standardized beta value of 0.344. It can also be seen from the study that the low labour satisfaction possibly has a negative impact on labour productivity and morale. Hence it is important that the construction companies increase labour satisfaction by incorporating different factors in their policy like paying a reasonable salary, and developing financial reward programs and also by improving the living condition at construction site.

Also it is highlighted through the study that the issues related to manpower play an important role during the project execution. A bad workforce is a major problem and affects the schedule of the project. Hence it is important to improve the labour commitment and the relationship among workers by increasing labour benefit and also by team building programs. Lastly in order to reduce the variations in labour productivity, the construction companies must take steps to improve supervision conduct periodic meetings at site and ensure proper selection procedure for supervisors.

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