International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 02 Issue: 03 | June-2015 www.irjet.net p-ISSN: 2395-0072

LABOR PRODUCTIVITY-ANALYSIS AND RANKING

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Abstract – ***This paper studies about daily labor productivity and the factors attributing to the same. In construction industry, productivity is an important aspect that can be used as an index for measuring the efficiency of production. In some cases it also helps in analyzing the economic growth of a company. This study helps in analyzing different factors affecting labor productivity. Some of the tests used for this study are reliability test, factor analysis, regression analysis. It was concluded that planning is a very significant factor followed by material availability.***

Key Words: *labor productivity, reliability test, factor analysis, regression analysis and hypothesis*

1. INTRODUCTION

Construction productivity and labor productivity are two important words that determine the profit and loss of construction business. Labor productivity is a sub domain of the overall construction productivity at the same time construction productivity is highly dependent on labor productivity as construction is a labor intensive industry. In most countries , experience and literature showed that the labor cost alone will account for 40-65% of the total cost of the project. Since labor productivity determines the economy of a project, having a control over labor productivity and the related factors will increase the overall productivity. In construction industry numerous activities are involved which relies only on human resource , so an effective use and proper management of labor for each activity is very important. In spite of all the technological advancements and education , improved construction materials , advanced tools and equipment, most of the projects are outrunning the planned budget and time.

1.1 Definition

Productivity can be defined in many ways. In construction, productivity is usually taken to mean labor productivity, that is, units of work placed or produced per man-hour. The inverse of labor productivity, man-hours per unit (unit rate), is also commonly used.

Productivity is the ratio of output to all or some of the resources used to produce that output. Output can be homogenous or heterogeneous. Resources comprise: labor, capital, energy, raw materials, etc.

$$\textbf{Productivity} = \frac{Output}{Labour\ cost}.$$

Or

$$\textbf{Labor Productivity} = \frac{Output}{Work\ hour}$$

There is no standard definition of productivity and some contractors use the inverse of above,

$$\textbf{Labor Productivity} \frac{= Labour\ cost}{work\ hour\ Output}$$

In general, productivity signifies the measurement of how well an individual entity uses its resources to produce outputs from inputs. Moving beyond this general notion, a glance at the productivity literature and its various applications quickly reveals that there is neither a consensus as to the meaning nor a universally accepted measure of productivity. Attempts at productivity measurement have focused on the individual, the firm, selected industrial sectors, and even entire economies. The intensity of debate over appropriate measurement methods appears to increase with the complexity of the economic organization under analysis. There are however, a number of different productivity measures that are commonly used. Choosing between them usually depends on the purpose of the productivity measurement and the availability of data. Productivity measures can broadly be placed into two categories. Single factor, or partial, productivity measures relate a particular measure of output to a single measure of input, such as labour or capital. Multi-factor or total productivity measures (MFP) relate a particular measure of output to a group of inputs, or total inputs used. Productivity measures can also be distinguished by whether they rely on a particular measure of gross output or on a value-added concept that attempts to capture the movement of output. Of the most frequently used MFP measures, capital-labor MFP relies on a value-added concept of output while capital labor-energy-materials MFP relies on a particular measure of gross output.

2. LITERATURE REVIEW

Lim and Alum (1995)[1] identified 17 factors that affect labor productivity in Singapore in which difficulty in recruiting the supervisors and labor turnover topped the list. Zakeri et al (1996) [2] identified 13 major factors in Iran, material shortage and site / weather condition was ranked first and second respectively. Enshassi et al (2007)[3] made a study and identified 45 factors affecting labor productivity in Gaza strip and was distributed under the following heads Materials/tools, supervision, leadership, quality, time, man power, project, external , motivation and safety. Materials shortage and lack of labor experience were found to be highly significant.

Abdul Kadir et al (2005)[4] found out that material shortage at site and nonpayment to the suppliers topped the list of 50 factors that affected labor productivity in Malaysia.

Alinaitwe et al (2007)[5] identified 36 factors affecting labor productivity in Uganda .incompetent supervision and lack of skills among workers were the most significant ones.

Durdyev and Mbachu (2011) [6] identified 56 factors affecting labor productivity in new Zealand and the important factors found out were re-work and skill and experience of the labor force. El gohary and aziz (2014)[7] identified 30 factors and classified them into 3 categories 1) human/ labor 2)industrial 3) management in Egypt. Homyun Jung et at (2009)[8] identified 25 variable and they were characterized into 4 groups 1) work management 2) work technique 3) work characteristics 4) worker component. Jarkas and Bitar(2012)[9] identified 45 factors and RII was carried out, clarity of technical specifications had the highest RII followed by extent of variation/ change orders during execution. There is no consensus in the literature on the identification of factors that affect the construction times of buildings, i.e., the length of time between a building being started and being completed.

One reason for this is that researchers have largely viewed the subject from diverse perspectives. The poor productivity of construction labor is agreed to be one of the factors that cause construction delay. Therefore, studying factors affecting construction labor productivity is crucial to improve productivity, and thus, to help manage construction to achieve a competitive level of quality and cost-effective projects in a timely manner.

3. RESEARCH METHODOLOGY

3.1 Identification of factors

The methodology used is questionnaire survey which is designed to receive the necessary information regarding labor productivity. Based on the previous literature reviews maximum number of factors were identified and listed.

3.2 Formulation of the questionnaire

All the sixty one identified factors were classified into 6 heads 1)labor 2)management 3)Design / build-ability 4)Tools and equipment 5)Natural 6)Miscellaneous. These six categories are further classified into client and contractor factors. The questionnaire has three parts:

I . Personal information of the respondent

II. Questions with 1-5 ratings

III. Suggestions by the respondent on improving labor- the respondents were asked to give their suggestions with respect to their project scenario.

3.3 Pilot study and validation

To ensure the validity of the questionnaire a pilot study was done to validate the questionnaire, It was done to

A. Check the clarity, comprehensiveness, and appropriateness of the questions.
B. To check the range of responses.
C. To check the efficiency with which the questionnaire is completed by the respondents.

3.4 Sampling design

Random sampling techniques is used to ensure the sample size by using the equation,

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

“m” is estimated by

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

$$m=\frac{(1.6452)\times 0.2\times(1-0.2)}{0.1^2} \sim 45$$

Minimum 45 responses were collected

3.5 Data collection

The primary data were collected through questionnaire survey. The secondary data were collected through journal papers, articles, books and conference papers.

3.6 Data analysis and Ranking

The data collected are analyzed using different tests in SPSS software.

1. Reliability

2. Factor analysis
3. Correlation test
4. Regression analysis
5. Descriptive Statistics

4. RESULTS AND DISCUSSIONS

4.1 Reliability analysis

The method used for reliability analysis is Cronbach's Alpha . This method assesses the basic internal consistency on the basis of the average correlation between the data that were measured in an identical manner. It is considered reliable if the α value is greater than 0.7.

Table 1 Cronbach's alpha

SL NO	CATEGORY	CRONBACH'S ALPHA VALUE
1	Labor	0.938
2	Design factors/ build-ability	0.860
3	Natural factors	0.810
4	Management factors	0.900
5	Miscellaneous	0.910
6	Tools and equipment	0.772

4.2 Factor analysis

Factor analysis is used to describe the larger number of variables by the smaller set of component variables. It is applicable when there is a systematic interdependence among a set of observed or manifest variables and wants to find the fundamental or latent commonality.

Table 2: KMO and Bartlett's test for contractor related factors

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.555
	Approx. Chi-Square	1389.976
Bartlett's Test of Sphericity	Df	703
	Sig.	.000

KMO is a measure of sampling adequacy and its value should be greater than 0.6 for the sample to be adequate for undertaking factor analysis. In this case (0.55<0.6), hence factor analysis cannot be done for this data set.

Table 3: KMO and Bartlett's test for client related factors

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.792
	Approx. Chi-Square	764.506
Bartlett's Test of Sphericity	Df	253
	Sig.	.000

The value of KMO Measure of Sampling Adequacy is 0.792, which is greater than 0.6.hence factor analysis can be undertaken using this dataset.

After the factor analysis for client's factors, it can be concluded that they were divided into five components with Eigen values greater than 1. The first component consist of political influence on the industry, economic slowdown or recession, government regulation, accidents during construction, Health and safety factors, and poor coordination between different departments. Based on literature review they were classified under miscellaneous factors. Factor analysis also classified them into a group. From the interpretation of the result, it can be observed that these five components can explain 73.559% contained in the original factors.

4.3 Correlation analysis

Correlation is a measure of linear relationship between two variables. It expresses the extent to which two variables vary together. The observation is given in the table

Table 4: Correlation coefficient for contractors' factors

SL. NO	SPEARMAN'S CORRELATION CO-EFFICIENT	FACTORS CORRELATED
1	0.640	Q27 – Q32
2	0.629	Q15 – Q9
3	0.626	Q18 – Q10
4	0.617	Q23 – Q11
5	0.616	Q35 – Q18

Table 5: Correlation coefficient for clients' factors

Table 4: Correlation coefficient for contractors' factors

SL. NO	SPEARMAN'S CORRELATION CO-EFFICIENT	FACTORS CORRELATED
1	0.683	Q21,Q2
2	0.670	Q2,Q19
3	0.646	Q2,Q18
4	0.630	Q2,Q9
5	0.630	Q22,Q6

Correlation test for contractor's factor shows that design changes and drawing error. That is, design changes are dependent on the drawing errors. Similarly, correlation test for client's factors indicates that the competence and skills possessed by the technical team would enable them to opt for the most suitable equipment or tool pertaining to a specific job. Also, the professionalism showcased by the technical team would better equip them to manage and mitigate accidents in construction.

4.4 Regression Analysis

Regression analysis is done to find the degree of dependency. It is done for those factors with highest correlation.

4.4.1 For clients

The result shows that R= 0.691, it indicates that model is reliable. R value between 0.6-0.8 is considered to be moderately reliable. R^2 = 0.477 that is the dependent factor gets 47.7% dependent on the independent factor.
The best fit equation is given by $y = 1.48 + 0.71 * x + (-0.02) * x^2$.

Where 'x' is the dependent variable and 'y' is the independent variable. Equipment selection specific to job is a dependent variable .professionalism of technical team is taken as the independent variable.

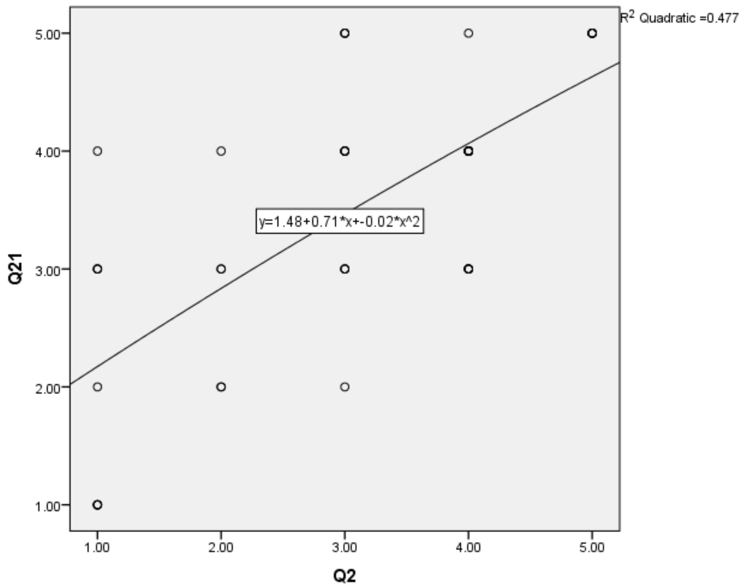

Fig 1. Best fit curve for professionalism of design team and equipment selection specific to job.

4.4.1 For contractors

The R value obtained is 0.629 and it indicates that the model is reliable. R^2=0.392. ie, there is a dependency of 39.2% between the variables.The best fit curve is given by $y = 0.29 + 1.29 * x + (-0.09) * x^2$

Where 'x' is the dependent variable and 'y' is the independent variable. That is design change is dependent on drawing errors.

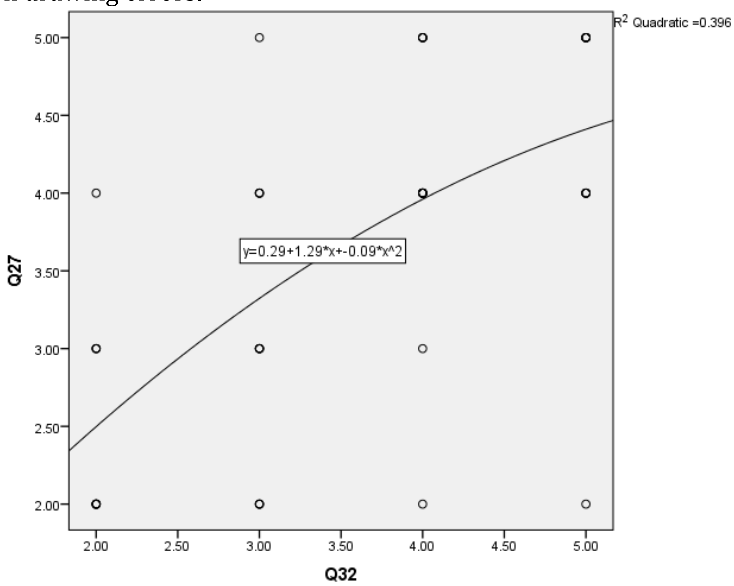

Fig 2. Best fit curve for design changes and drawing errors

4.5 Suggestions By The Respondents

The frequency of response of suggestions has been recorded.

SL NO	FACTORS SUGGESTED	FREQUENCY
1	Proper planning and scheduling.	30
2	Proper logistic plan.	22
3	Regular technical supervision which will reduce frequent mistakes and rework and provide maximum threshold for errors and mistakes. .	16

5. CONCLUSIONS

Reliability analysis test results showed five factors that had to be discarded. This was due to the following reasons 1) Unclear questions 2) Lack of experience of the respondents.3) Factors which were irrelevant to their projects.

Factor analysis for the client's factors, divided the factors into five components and factor Q13- untimely approvals or responses was deleted. Political influence on the industry, economic slowdown/Recession, government regulations, accidents during construction, health and safety factors and poor co-ordination between different departments was classified in the first component. In factor analysis similar components were classified based on some commonality.

Correlation test showed that design changes is dependent on drawing errors and also equipment selection specific to job is related to professionalism of the technical team.

Nonlinear regression analysis, indicates the degree of dependency of two factors. It is found that Design changes has a dependency of 47.7% on drawing errors. Similarly equipment selection specific to job is dependent on professionalism of technical team by 39.7%.

- From the suggestions by the respondents, it can be observed that most of them think that planning and scheduling has to be improved at site followed by proper logistic plan and availability of materials at site before the start of the work. It is also observed that regular safety trainings, issuing drawings on time and efficient cash flow also has to be improved as per the respondents.

REFERENCES

[1] Lim, E. C., and Alum, J. (1995). "Construction productivity: Issues encounteredby contractors in Singapore." Int. J. Proj. Management., 13(1), pp. 51–58.

[2]Zakeri, M., Olomolaiye, P. O., Holt, G. D., and Harris, F. C. (1996)."A survey of constraints on Iranian construction operatives' productivity."J. Constr. Manage. Econ., 14(5),pp. 417–426.

[3] Enshassi, A., Mohamed, S., Abu Mustafa, Z., Mayer, P. E. (2007). "Factors affecting labour productivity in building projects in the Gaza Strip."J. Civ. Eng. Manage., 13(4),pp. 245–254

[4] Abdul Kadir, M. R., Lee,W. P., Jaafar, M. S., Sapuan, S. M., and Ali, A. A.A. (2005). "Factors affecting construction labour productivity for Malaysian residential projects." J. Struct. Surv., 23(1), 42–54.

[5]Alinaitwe, H. M., Mwakali, J. A., and Hansson, B. (2007). "Factors affecting the productivity of building craftsmen—Studies of Uganda." J. Civ. Eng. Manage., 13(3), pp169–176.

[6] Durdyev, S., and Mbachu, J. (2011). "On-site labour productivity of New Zealand construction industry: Key constraints and improvement measures." Aus. J. Constr. Econ. Build., 11(3), pp 18–33.

[7] Khaled Mahmoud El Gohary and rRemon Fayek Aziz (2014) "factors influencing construction labor productivity in egypt". J. management in engineering ,vol 30, no.1,1-9

[8]Homyun Jang, Kyonghoom Kim, Juhyung Kim, and Jaejun Kim. (2011). "Labour productivity model for reinforced concrete construction projects." Construction Innovationm Process, Management, 11(1), 92-113.

[9]Jarkas, A. M., and Bitar, C. G. (2012). "Factors affecting construction labor productivity in Kuwait." J. Constr. Eng. Manage., pp. 811–820.

