Labour Productivity Analysis Using Multi-variable Linear Regression Technique

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Abstract - *Labour productivity is a very important element in the process of construction project management especially with regard to the estimation of the duration of the construction activities. The primary goal of this research is to conduct an accurate measurement of labour productivity in selected sites. The data required for the study are to be collected through questionnaire survey. The data analysis are to be conducted by using the statistical software package, SPSS 19.0, for determining the labour productivity. Based on the data analysis results, prepare a Multiple Linear Regression model to predict productivity of the selected work.*

Key Words: Homoscedastic, linear regression model, F statistics , statistical software package, inspection frequency

1.INTRODUCTION

Productivity rates of construction trades are the basis for accurately estimating time and costs required to complete a project. Most of the construction agencies focus on material and equipment management to reduce cost and increase efficiency. However, the construction labours are the most dynamic element in the construction industry and their cost represents 30 to 50% of the overall construction cost. The term labour productivity is generally defined as "the ratio of physical amount of output achieved in a given period to the corresponding amount of labour expended.

The primary goal of this research is to conduct an accurate measurement of on-site labour productivity in selected sites through developing Multi variable linear regression models for predicting the productivity of a particular work. It is widely accepted that productivity measurement plays an important role in the construction management process. Productivity measurement provides the necessary data to analyse factors for project owners, constructors, and management professionals to control construction progress, estimate the cost of future construction projects, and determine its competitiveness in the global market. This study will help to develop guidelines for maximizing the labour productivity under different construction conditions.

1.1 Methodology

- Literature review was conducted to provide the previous research studies related to the construction productivity and to understand the current construction industry.
- Identification of factors influencing labour productivity
- Selection of area of study
- Data collection through questionnaire survey
- Data analysis using the statistical software package, SPSS 19.0
- Development of Multiple Linear Regression model to predict productivity of a particular work

1.2 Labour Productivity

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

The labour productivity for this study is estimated using work done in m3, no. of hours worked and no. of labourers using equation 1.

$$\text{Labour productivity} = \frac{WD}{LxH} \qquad (1)$$

Where,   WD = Work done in m³
           L = No. of labourers

1.2 Factors affecting Labour Productivity

A questionnaire survey was conducted among 76 respondents to identify the major factors which will affect the productivity of labour. The collected data were analysed using SPSS software which is is capable of handling large amounts of data and can perform all of the analyses covered in the text and much more. The main 10 factors which affect labour productivity are listed below.

- Availability of tools and equipments
- Availability of experienced labours

- Availability of materials
- Working location
- Performance based pay
- Payment delays
- Leadership quality
- Labour supervision quality
- Frequency of inspection
- Site layout

2. MULTIPLE LINEAR REGRESSION MODEL

In this study labour productivity of column concreting was modelled using multiple linear regression as shown in equation (II). The assumptions of linear regression includes:

- Expected value of Y is a linear function of X
- The error term is homoscedastic i.e., uniform variance
- Error is normally distributed
- Error terms are random

The relationship between dependent and independent variable can be modelled in a multiple regression analysis using the following equation:

$$y = \beta_O + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n + \varepsilon \qquad \text{(II)}$$

Where,

$$
\begin{aligned}
y &= \text{Dependent variable} \\
x_1, x_2 ..... x_n &= \text{Independent variable} \\
n &= \text{No. of predictors} \\
\beta_1, \beta_2, \beta_{3....} \beta_n &= \text{Estimated coefficients}
\end{aligned}
$$

A total of 12 variables were considered for the analysis. The labour productivity of different sites were considered as the dependent variable and all others are considered as independent variables. The sample size for column concreting analysis was 80 and the model was developed using SPSS software.

Table -1: Statistics of variable

Variables	Coefficient	Standard error	t	Significance
Constatnt	-	0.018	0.421	0.675
Age	0.086	0.002	1.878	0.065
Gender	0.001	0.006	0.024	0.981
Availability of tools and equipments	0.005	0.002	0.082	0.935
Availability of experienced labours	-0.050	0.002	-.0.627	0.533

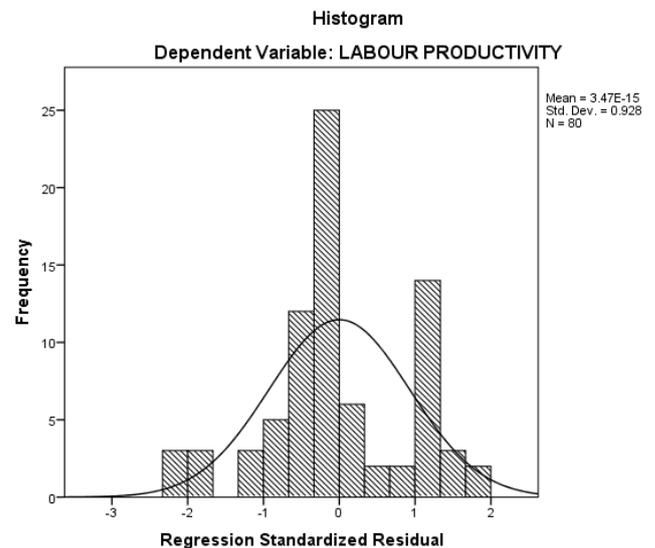|				
Availability of materials	0.032	0.003	0.494	0.623
Working Location	-0.675	0.002	-0.526	0.025
Performance based pay	0.298	0.004	5.356	0.124
Leadership quality	0.037	0.001	0.744	0.459
Labour supervision quality	0.101	0.002	1.862	0.067
Inspection frequency	-0.058	0.002	-1.097	0.276
Site layout	0.281	0.003	5.189	0.256

Chart -1: Histogram

The regression model developed has an R^2 value of 0.914. The corresponding F statistics was 65.303.

3. CONCLUSIONS

In this thesis, various factors affecting construction labour productivity were studied through questionnaire survey and the major 10 factors were identified which includes tools and equipments availability ,availability of experienced labours, material availability, working location, payment delays, use of performance based pay etc. A multivariable linear regression model was developed by using these 10 factors as variables. It is concluded that the model will help to predict the productivity of column concreting with high level of accuracy

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