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Using logistic and Multilinear Regression Technique for Modeling Productivity finish work Construction in Ramadi City

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ABSTRACT

An essential part of managing construction projects is productivity estimation. The accuracy of the construction productivity estimate determines the management quality. This research established a multi-variable linear regression and another mathematical model for the same variables to assess the productivity of building projects using the logistic regression approach. Data from residential, commercial, and educational projects in various regions of Anbar was utilized in the research. Numerous dependent variables were chosen with care. These independent factors, which include age, experience, the quantity of work, level of execution, and security circumstances, may be divided into objective and subjective variables. The person-hour/unit and the cost/unit are two inputs to the system that are used to measure input/output, the parameter known as productivity. The first is used for procedures that need a large amount of labour and is focused only on labour. All impacts are combined in the second cost/unit. The researcher came up with an equation that contains the following factors (Health condition, equipment available, Security, labor, Quality work, morale, the material available, site condition, Experience, Weather, Height, and Age).

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1. Introduction

The basis for accurately estimating the time and costs required to complete a project is the productivity rates of the construction trades. In the construction industry, productivity is referred to as "work production per man-hours worked." (Donald N.Stengel 2012)But for a particular manufacturing situation, it might be defined as "the ratio of input of requisite quality to the outputs". Contractors benefit from increased productivity in terms of efficiency and profitability, precise estimation, and increased competitiveness when submitting bids for projects)Gerges, M., Ahiakwo,2016)The primary goal of this research was to develop regression models for predicting the productivity of polishing marble floors in Iraq in response to industry expectations for accuracy in evaluating on-site productivity) Al-Zwainy, Abdulmajeed M.H, Aljumaily H.S(2013).

The following are the two most crucial indicators of labor productivity:

1- How efficiently labor is utilized throughout the building process;

2-The relative effectiveness of labor doing the necessary tasks at a certain time and location.

Employees with physical or mental health issues are more likely to be away from work often and less productive when they do show up for work. They are slower to return to work and more prone to seek

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compensation claims. Managers spend more time addressing the complicated health concerns of employees and prospective staff replacement costs, which also influences indirect expenses (Nabil Ailabouni, Kassim Gidado 2009)

If left unchecked, employees' low engagement and health expenses may escalate. Disengaged employees, in particular, exert less effort and operate their discretionary resources.

2. THE OBJECTIVE

The main objective of this study was to create regression models for predicting brickwork production to accurately quantify construction productivity in Iraq. Multiple linear regression and logistic regression are the two estimating approaches that are the focus of this research, which the following process may support:

- investigating the use of regression analysis techniques to increase building productivity and define the level of precision for the mathematical models.

-Productivity of finished work may be calculated using mathematical models and numerical formulae.

- Determine the elements that have an impact on the productivity in building projects.

3. Research Methodology

The following steps were used to fulfill the research objectives:

1- Literature review: A thorough review of the literature was undertaken to provide earlier research studies on construction productivity and to comprehend the state of the Iraqi construction sector now. The review consolidated the results from earlier literature published in textbooks, journal articles, research reports, dissertations, conference proceedings, Internet publications, theses as well as techniques of productivity data analysis. With the review's aid, the researcher could better comprehend the fieldwork state and carry out accurate and valuable investigations.

2- Data collection: In Iraq, the researcher measured construction productivity on the job site.

3- Data analysis and comparison: For estimating the productivity rate features and labor productivity, the data were analyzed using the statistical software program SPSS 25. Throughout the study, several statistical analytic approaches such as correlation, descriptive statistics, and nonparametric tests were employed for modeling.

4- Developed Model: Based on the data analysis findings, a multiple linear regression model will be presented and discussed to forecast the output of marble finishing tasks for floors.

5- Validation Model: In this step, the MLR was shown to be a reliable prediction model.

6- Conclusions, suggestions, and future research: Based on the data analysis outcomes used to create the model and validate it, conclusions and recommendations for this study were offered. The results included aspects of worker productivity and manufacturing efficiency.

The literature research identifies several factors that have affected the site's labor output rates. Twelve independent variables specified correctly for each building project were carefully chosen. Objective and subjective variables are two categories into which these independent variables might be divided. The security circumstances may be divided into security and non-security, with values of 1 and 2, respectively. Additionally, the health state of the work team is listed as excellent, moderate, and terrible and is given the numbers 1, 2, and 3 accordingly. At the same time, the climate was bright (1), and rainy (2). The site conditions may be divided into simple and complicated categories, with values of 1 and 2, respectively. The availability of building supplies is represented on a scale of 1 to 2, with 1 representing close by and 2, respectively. Researchers have discovered that choosing the right data-gathering strategy impacts the precision of the production rate figures. Although questionnaires are the most popular data collecting technique used by researchers to gather information on variables and production rates cost-effectively, the findings' correctness and dependability cannot be confirmed. As a result, the research's data collection technique of choice is direct observation. A pilot study has been conducted by choosing four building projects in various Iraq regions. The production rates at the facility were measured using a work sampling technique, and stopwatches were utilized to determine the daily activity duration at particular intervals. The researcher collected fifteen observations during four separate studies at various intervals. There are five residential, two commercial, two educational projects, and one Government Institution Building, in Ramadi, Thus, a total of 57 data samples were gathered.

Table 1- Factors affecting productivity

variables	Description	Units
X1	Age	year
X2	Experience	year
X3	labor	number
X4	Site condition	Category
X5	Security	Category
X6	Weather	Category
X7	morale	Category
X8	Height	meter
X9	Material available	Category
X10	Quality work	Category
X11	Equipment available	Category
X12	Health condition	Category

4. Multiple linear regression model development for productivity

The model is created using SPSS Version.25, a statistical package for social sciences solutions services. Regression analysis was carried out using the SPSS statistical program in the manner described below:

1- Steps one: Editing of Data To acquire the constants for this phase, the researcher utilized the statistical program SPSS:

a) Input data: all variables (dependent and independents

b) Choosing regression analysis using the menu bar, the researcher first selects "analyses," then "regression," and last "linear."

c) The researcher chooses which variables will be dependent and independent.

d) The researcher selects statistics, then models, R squared, descriptive statistics, part, and partial correlations, and click continues.

2- Steps two: Results

In this step, the Regression analysis's concluding findings are available to the researcher; the first table displays the mean, standard deviation, and quantity for each of the variables shown in table 2, as well as the correlation of all the variables.

Table 2- Descriptive Statistics

	Mean	Std. Deviation	N
productivity	4.7500	.85049	76
Age	38.5263	9.60899	76
Experience	15.5526	8.24038	76
labor	5.1447	1.07955	76
Site condition	1.3684	.48558	76
Security	1.1447	.35417	76
Weather	1.3289	.71904	76
morale	1.0526	.22478	76
Height	3.7632	.72789	76
Material available	1.0921	.29110	76
Quality work	1.6842	.52181	76
Equipment available	1.2632	.44327	76
Health condition	1.8816	.32525	76

Table 3 in this case, the sig. the coefficient is less than 0.05, which is acceptable. The coefficient of correlation and (coefficient determination) results indicate that the productivity of brickwork and other input factors have a somewhat positive association. This shows an acknowledgment of the link between the dependent and independent variables.

Table 3- Model Summary

Model	R	R Square	Adjusted R Square	Std. The error in the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.554a	.307	.175	.77239	.307	2.328	12	63	.015

The model helps estimate the productivity of the stone finishing job. All of the identified possible independent variables were included in this model. We derived this regression equation from the previous table.

$$y = 7.624 + .002x_1 + .024x_2 + .054x_3 - .158x_4 + .127x_5 + .243x_6 - .226x_7 - .347x_8 - .918x_9 - .315x_{10} - .497x_{11} - .085x_{12}$$

Some factors can be neglected, especially. Health condition

Table4- ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.665	12	1.389	2.328	.015b
	Residual	37.585	63	.597		
	Total	54.250	75			

a. Dependent Variable: Productivity

b. Predictors: (Constant), Health condition, equipment available, Security, labor, Quality work, morale, the material available, site condition, Experience, Weather, Height, Age

5. Logistic Regression. model development for productivity

A distinct set of statistical tests must be used when the dependent (response) variable is categorical since many statistical tests need a continuous dependent variable. As one of the most often used tests for categorical variables, the Chi-squared test examines whether the two categorical variables have a statistically significant association or not. Persistent outcome variables may be used in multiple regression.

a- Considering additional explanatory factors when analyzing correlations between a dependent variable and multiple independent variables

b- Employing a linear combination of explanatory (independent) factors to predict the results of a dependent variable

c- The researcher chooses the dependent and independent variable, the researcher chooses Enter method,

d- Researcher click options and choose Hosmer-Lemeshow goodness-of-fit, correlations of estimates then click continue and click ok,

The logistic regression equation can be written as :

$$p = \frac{\exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 \quad \dots\dots\dots + \beta_q X_q\right)}{1 + \exp\left(\beta_0 + \beta_1 X_1 + \beta_2 X_2 \quad \dots\dots\dots + \beta_q X_q\right)} \qquad 0 < \rho < 1$$

1) Steps one: Changing or adding to the Data To acquire the constants, the researcher made use of SPSS statistical software.

a) Input data

b) Regression analysis should be selected. The researcher selects Analyze from the menu bar, then Regression, and finally Binary Logistic from the drop-down menu.

Table 5- Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	25.996	12	.011
	Block	25.996	12	.011
	Model	25.996	12	.011

Table 6- Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	78.042a	.490	.589

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 7- Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	9.641	8	.291

Table 8 - Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1a	Age	.067	.036	3.502	1	.061	1.069
	Experience	.038	.041	.845	1	.358	1.038
	labor	.176	.289	.371	1	.543	1.192
	Site condition	-.370-	.660	.313	1	.576	.691
	Security	.404	.912	.196	1	.658	1.498
	Weather	.157	.473	.110	1	.740	1.170
	morale	-.935-	1.282	.531	1	.466	.393
		-1.446-	.496	8.481	1	.004	.236
	Material	-2.597-	1.076	5.830	1	.016	.074
	Quality work	.261	.631	.171	1	.679	1.298
	equipment	-1.626-	.693	5.500	1	.019	.197
	Health	-.125-	.955	.017	1	.896	.883
	Constant	7.246	3.714	3.806	1	.051	1402.974

a. Variable(s) entered in step 1: Age, Experience, labor, site condition, Security, Weather, morale, Height, the material available, Quality work, equipment available, and Health condition.

$$\log\frac{p}{1-p} = 7.264 + .067x1 + 0.038x_2 + 0.176x_3 - 0.37x_4 + 0.404x_5 + 0.157x_6 - 0.935x_7 - 1.446x_8 - 2.597x_9 + .261x_{10} - 1.626x_{11} - 1.25x_{12}$$

Where p: represent the probability of success of the model.

The result of (cox & snell R square) =0.49 and (nagelkerke R square)= .589 this result show that there is an acceptable correlation between finish stonework and the input variables.

6. Validation regression models:

This research takes a basic approach (Collection of new data to check the model and its predictive ability). There were five new observations for each variable in Tables 9 and 10. Model calibration techniques did not incorporate these data, which were used as an independent verification check to compare results with actual stone finish productivity and projected productivity values.

Table 9- number of observations for each variable for multi–regression.

Project no.	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12
P1	30	6	4	1	2	1	1	4	1	2	2	1
P2	45	15	6	2	1	1	1	3	1	1	1	2
P3	50	5	7	2	2	1	1	4	1	2	1	1
P4	45	10	4	2	2	1	1	5	1	1	2	1
P9	55	7	5	2	2	1	1	4	1	1	2	2

Table 10- number of observations for each variable for logistic regression.

Project no.	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12
P1	35	6	5	1	1	1	1	4	1	2	1	1
P2	45	4	6	1	2	1	1	4	1	2	2	2
P3	45	20	5	1	1	1	1	5	1	2	1	2
P4	42	30	5	1	2	1	1	5	1	2	1	2
P5	40	21	4	1	2	1	1	3	1	2	1	2

Table11-finish work productivity computed by linear regression

No of project	Actual productivity	Estimated productivity	(Actual-estimated) /actual
Project 1	5.5	4.582	0.166
Project2	5	4.624	0.156
Project3	5	4.551	0.0898
Project4	4	4.078	0.0195
Project5	4	4.342	0.0855

Table 12 shows an overview of MLR's finish work productivity computations for model verification. Where the second column represents real productivity and the third column represents estimated productivity for five repeating observations after using the regression equation obtained by the SSPS algorithm.

Table 12: finish work productivity computed by logistic regression

No of project	Actual productivity	Estimated productivity	Probability success
Project1	4.5	4.103	89.7%
Project2	4	4.048	98.2%
Project3	4	3.892	96.3%
Project4	5	4.894	99.29%
Project5	5	4.761	94.9%

an overview of how LMLR computes brickwork productivity for model verification. Where column two displays actual Productivity, column three shows estimated Productivity, and column four displays the chance of success for five repeating observations after using the regression equation obtained by the SSPS algorithm.

a comparison between predicted Productivity and actual Productivity for the finished job. Predicting the Productivity of marble finishing works for floors using multivariable linear regression for every data set within the used range of data is demonstrated in this picture. Developing the multivariable linear regression method for MLR and LMR, respectively. MLR model correlation (85.88%) and LMR model correlation (94.337%).

7. CONCLUSIONS

1-This research used multiple regression and logistic approaches to construct a productivity estimation model for marble floor finishing operations. The model was using 76 sets of data that were gathered in Iraq.

2-Several dependent variables were chosen with attention. Age, Number of Labor, Experiences, Level of Execution, and Security Conditions are two types of independent variables that may be categorized as objective and subjective.

3-Multivariable linear regression to look at several variables simultaneously and their correlations with one another. Additionally, MLR has a high degree of accuracy when forecasting the output of stone finishing projects for floors.

4-Using the linear regression technique gives the coefficient of determination equal to 72.85. While the logistic regression technique gives the coefficient of determination of 88.92%.

5-The most important factors affecting the productivity of stone finishing work for flooring are age, experience, and the quantity of assistive labor. The productivity is only a little impacted by the other input variables.

6-The coefficient of determination (R2) number reflects how much of the variation in y can be accounted for by the model. The "Model Summary" table shows the findings for two fictional R2 values that aim to quantify an equal object, although logistic regression cannot measure this.

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