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DEVELOPMENT OF COST PREDICTION MODEL FOR ROAD CONSTRUCTION PROJECTS IN NIGER STATE, NIGERIA

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ABSTRACT
The lack of cost data base and standard for which cost of road could be determined in developing countries like Nigeria have negative effect on the estimation of road construction cost. The successful completion of road construction projects depends solely on the accuracy of cost estimate at the inception phase of the projects. Especially in Niger State, where most of the roads are in the state of dilapidation and some of the projects abandoned as a result of lack of proper model for predicting accurately the cost of road construction at initial stage of a project. Therefore, the paper aims at developing cost prediction model for road construction projects in Niger State with a view of improving the road construction projects delivery. The archival data was collected from Niger State Ministry of Work, Housing and Transport. The data obtained from the ministry are Bill of Engineering Measurement and Evaluation (BEME), financial statement, financial reports of the road construction projects within the period of 2007 to 2017 in Niger State. The method of analysis adopted for this study was simple regression analysis. The result shows that followings elements of road construction projects (site clearance, sub base, base course, asphalt course, and excavation works) tested with total cost of road construction projects have the probability value of >0.05 with the followings R^2 value of 45.1%; 56.9%; 45% 82.9% & 47.4%. This imply that there is strong statistical significant relationship between the two variables. The paper therefore, recommended that the top management of the construction firms should be encouraged to adopt this cost prediction model to reduce cost escalation, conflicts, disputes and abandonment of road projects.
Keyword: *Cost Prediction Model; Cost Estimation; Construction Industry; Project Delivery and Road Construction.*

INTRODUCTION

Poor road infrastructure development causes difficulties in moving goods and services from rural area to urban area which has great impact on loss of labour productive hours and in turn lead to high increase in the cost of goods and services. The cost of cumulative loss due to bad roads in Nigeria was estimated about one hundred and thirty-four (134) million Naira in 2010 (Nworji and Oluwalaiye, 2012). However, Okonjo (2007) asserted that Nigeria would require not less than 5 billion USD annually for a period of 10 years to expand and maintain all types of infrastructure. The huge financial requirement for infrastructure would need private partnership to be involved in order to reduce the rate of bad road in Nigeria. Moreover, Sodicov (2005) observed that the estimation of construction cost in developing countries are always a problem due to the lack of cost-data base and standards for which costs of road could be determined. The successful completion of road construction projects solely depends on the accuracy of cost estimate at the inception phase of the projects (Mahamid, 2011; Chandanshive and Kambekar, 2014). Therefore, model development for accurate prediction of cost of road construction projects is extremely essential for the successful completion of the projects. Sodicov (2005) expressed that both advanced and developing nations are faced with the problems of accurate cost estimations at early stages of project development, and therefore, noted that it is important to develop better techniques for cost estimation at the conceptual stage. At the beginning of a road project, the professionals are always in need of information as regard to the cost of the project despite the limited available data (Vinayak *et al.*, 2017).

However, inaccurate prediction of estimated cost of the projects and incomplete design at the early stage of road projects were

identified as the root causes of variation order, time & cost overruns and abandonment of construction projects (Tijani and Ajagbe, 2016; Ojo and Aroge 2016). Therefore, the main problem of this research is that road construction projects are hardly completed within the budget, and in most cases causes projects abandonment as a result of shortage of funds, mostly attributed to lack of a reliable cost model that accurately predicts the likely costs of road construction. These are motivating factors for this research with a view of investigate the major components of road construction to serve as variables for developing a model that will accurately predicts the construction cost of road facilities in Niger state.

As explained above, that some research works have been conducted on developing models for building construction projects across various geographical locations, but in the absence of known research on cost prediction model for road construction projects in Niger state. Therefore, this serves as the research gap for this study to develop a cost prediction model for road construction projects with a view to minimizing the rate of abandonment of roads construction projects in Niger State. This was in line with recommendation of the Aje, *et al.* (2014) and Kadir (2015) that further research should be conducted on the others areas of infrastructure development like road, railways, airport etc. In addition, Ogungbile and Oke (2018) conducted a similar study in Akure and recommended that further research should be conducted in other part of country on the subject matter with a view of mitigating inaccurate estimate in road construction projects in Nigeria.

LITERATURE REVIEW

The construction industry remains one of the driving forces behind the socio-economic development of any nation. This is

evident in the provision of employment and physical infrastructural facilities, including bridges, dams and roads (Ashebir *et al.*, 2016). Roads represent the wealth and asset, which support social development and economic growth of any nation (Pinard *et al.*, 2016). Roads contribute immensely to the rating standards of a nation, by bringing about growth in industries, commerce, trade and improving the standard of living of people (Ashebir *et al.*, 2017 and Markow 2012). Cities can only grow bigger when there are good road networks that can enable people to go about their normal businesses; and goods and services can be moved and distributed without much hindrance (Asiyanbola *et al.*, 2012).

In Nigeria, roads play important roles in every aspect of development. For instance, people travel to villages with their goods for social purposes. Before the advent of the British rule in Nigeria, most roads were in the form of communal foot paths, but later developed into standard roads for trading and commercial activities (Idris, 2017). Oribuyaku (2010) asserted that footpaths are the genesis of road development in Nigeria. A total of three hundred and forty-four (344) billion Naira was budgeted for construction of road and rehabilitation projects across Nigeria in the year 2018, representing approximately 3.77 percent of the Federal Government annual approved total budget (Budget, 2018). In developing countries like Nigeria, in spite the effort of government by allocating huge sum of money for road construction projects in the budget, the sector suffers cost and time over run due to variation order (Ismail *et al.*, 2012; Ubani and Nwokonkwo, 2010). Ndihokubwayo (2008) asserted that 63% of site instructions are due to variation while 14% are accompanied by waste as a result of modification to the already completed works. According to Halwatura and Ranasinghe (2013), the more the variation orders on a project the greater the

likelihood that they become time consuming and abandoned. However, Mohammed (2001) stated that occurrence of variation order cannot be completely avoided but can be reduced to the lowest limit if their origin and causes were clearly known. Thus the study carried out by Halwatura and Ranasinghe (2013) revealed that complete design and accurate prediction of estimated cost of project reduce the causes of variation and abandonment. There is always a wider discrepancy between the estimated cost and final cost of projects, and hardly ever a road construction is completed without cost overrun as a result of variation order (Ashebir *et al.*, 2016). Moreover, similar road projects with common characteristics do experience a very wide range of discrepancy in terms of cost (Aljohani *et al.*, 2017).

Specifically, the roads that link the Niger State capital are in the state of physical dilapidation, almost deserted, filled with countless potholes and hotspot for criminals. Practical examples of such roads include: Minna, Sarkin Pawa, Kaduna Road; Bida, Minna Road and Suleja, Lambata, Bida Road, to mention but few (Idris, 2017). Passengers that plied these roads travelled through thick cloud of dust, the plantation and roofs by the road side have all being coated with brown dust, which cause frequent occurrence of accidents on the roads (Idris, 2017). Most of these roads experience variation order, cost overrun and mostly abandoned before completion. Therefore, there is the need to know the probable cost for providing these facilities to minimise the rate of road project abandonment (Idris, 2017). Murtala (2012) and Koo *et al.* (2011) attributed these problems to lack of existing model to predict the cost of road construction projects and improper decision-making at the conceptual stage of road construction which pose a great effect on a project. Gould (2005) and Murtala (2012) highlighted that a cost model is a statistical method or technique for determining and forecasting the

probable cost of a proposed project. However, most of the roads in Niger state are in the state of dilapidation and some of the projects abandoned are as a result of lack of proper model for predicting accurately the cost at initial stage of a project. Therefore, it is essential to develop a model that is capable of predicting the probable cost of road construction project with a view of minimizing the rate of abandonment of road construction projects in Niger state.

METHODOLOGY

The quantitative research approach was adopted for the development of cost prediction model for road construction projects in Niger State. The archival data was collected from Niger State Ministry of Works, Housing and Transport. The data obtained from the ministry are Bill of Engineering Measurement Evaluations (BEMEs), valuation reports, final account of the road construction projects within the period of 2007 to 2017 in Niger State. The population of this study are road construction projects awarded and executed within the period of 2007-2017 by the Niger state Government through the Ministry of Works, Housing and Transport. This period was selected because Government allocate huge sum of money on road construction projects during this period. The sampling frame for this study constituted the total number of 60 road construction projects awarded and executed in the three senatorial zones of Niger State (A, B and C) within the period of 2007 -2017. Out of 60 numbers of road construction projects, Zone 'A' had a total number of 17 projects; Zone 'B' had 24 projects; while Zone 'C' had 19 projects, making a total of 60 projects awarded and executed in Niger State within the period of 2007 – 2017. Out of these projects, a total of 52 Bill of Engineering Measurement Evaluations (BEMEs) were collected, 15 projects in Zone A, 20 projects in Zone 'B', and 17 projects in Zone 'C' However the

remaining (8 BEMEs) could not be accessed due to unavailability of the data in the data base. The sample size of 52 road construction projects awarded and executed in Niger State was selected to represent the total number of road construction projects awarded in Niger State within the period of 2007 and 2017. This is because only 52 projects have complete BEMEs and other necessary documents, which were deemed fit for this study.

The method of analysis adopted for this study was simple linear regression model to establish the relationship between variables. The aggregate score or total cost is referred to as the dependent variables and is denoted by Y, while other variables represent independent variable which is the factor from which this estimate is made is called the independent variables and is denoted by X. (Azmi *et al.*, 2018).

Simple linear regression equation is given as $Y = a + bx$.....1

Where, Y is the dependent variable,

'a' is the constant, and 'x' is independent variable and b is the coefficient of the independent variable (Olasanmoye, 2016).

Furthermore, the result of the models was evaluated based on the following:

i- The correlation coefficient (r)

ii- The coefficient of determination (r^2)

iii- The significance of the regression equation (f- ratio)

i- The correlation coefficient (r) measures the strength of the relationship between the dependent and independent variables. The statistical techniques measure the degree of closeness or relationship between the variables, mathematically expressed as

$$R = \frac{\sum x_1 y_1 - nxy}{\sqrt{[(\sum x^2 - nx^2)](\sum y^2 - ny^2)}} \text{ ----------2}$$

Determinant R= -1< r +1

R = + 1 (direct correlation)

R = 0.00 no relationship

R = -1.00 inverse relationship

The nearer R approaches 1, the greater the degree of relationship; and the more it approaches zero, the less the degree of relationship (Olasanmoye, 2016).

ii- The coefficient of determination (r^2) the coefficient of determination is useful because it gives the proportion of variance (fluctuation) of one variable that is predict from others. It is a measure that allows us to determine how certain one can be in making predictions from a certain model or graph. Mathematically it is expressed as

$$R^2 = \frac{\text{Regression sum of squre (SSR)}}{\text{Total sum of square (SST)}} \quad \text{----------3}$$

R^2 is always between 0 & 1 and can be expressed in percentage. R^2 must be very high for the equation to be acceptable the larger the R^2 is, and then the more accurate a predictor is the equation is based on the input data upon which it was built

iii- The significance of the regression (F – ratio). T was used to ascertain the significance of a regression equation by testing the following hypothesis:

H0 = The regression is not significant

Hi = The regression is significant

The f- ratio is an indication of whether or not the model is an acceptable prediction model in order to test the hypothesis, F-calculated which expressed as:

$$F = \frac{MSR}{MSE} \quad \text{---------- 4}$$

Where MSR = Regression Mean Square and

MSE = Regression Mean Square Error is compared with the critical value of f (F – tab) at 5% level of significance.

Where F Cal is greater than F-Tab H0 is rejected, and hence the equation is suitable to establish a relationship where the model

should be significant for it to be acceptable and valid for estimation (Olasanmoye, 2016).

The below hypothesis was formulated to aid the decision making from the analysis.
Ho: The cost of road components (site clearance, earth work, sub-grade, sub- base, base course, road surfacing, kerbs, excavation for culverts and bridges, concrete drain, concrete culverts and bridges, preliminary items) are not related to the total cost of road construction.

Findings and Discussion of Results

The results of components of road construction with the total cost of road construction projects were summarised in tabular form for clear understanding and interpretation.

The Results of Simple Linear Regression

In order to gain full insight into the linear regression models developed in this research, Table 1 shows the summary of all linear regression analyses between total cost (dependent variable and all the independent variables.

Table 1. Results of Simple Linear Regression

S/N	Variables		Type of model	Observation			Inference		
	X	Y		Regression equation (y= a +bx)	R Square	Probability value	Strength of relationship	Remarks	Action on Hypothesis
1	Cost of Site Clearance	Total cost of road construction Project	Linear regression	Total cost (₦) = 176,599,667 + 18.253(X1)	45.1 %	0.000	Strong	S.S	Accept Hi and Reject Ho

2	Cost of Earth work	Total cost of road construction Project	Linear regression	Total cost (₦) = 153,039,237.6 +3.745(X1)	32 %	0.000	Week	S. S	Accept Hi and Reject Ho
3	Cost of Sub base	Total cost of road construction Project	Linear regression	Total cost (₦) =173,367,615.9 + 9.168(X1)	56.9 %	0.000	Strong	S. S	Accept Hi and Reject Ho
4	Cost of Base course	Total cost of road construction Project	Linear regression	Total cost (₦) =189,871,697.8 + 5.138(X1)	45 %	0.000	Strong	S. S	Accept Hi and Reject Ho
5	Cost of Asphalt course	Total cost of road construction Project	Linear regression	Total cost (₦) = 76,651,308.80 + 2.197(X1)	82.9 %	0.000	Strong	S. S	Accept Hi and Reject Ho
6	Cost of Kerb works	Total cost of road construction Project	Linear regression	Total cost (₦) = 252,993,565.8 + 15.476 (X1)	4%	0.153	Weak	N. S	Accept Ho and Reject Hi
7	Cost of Excavation works	Total cost of road construction Project	Linear regression	Total cost (₦) = 134,075,806.9 + 44.057(X1)	47.4 %	0.000	Strong	S. S	Accept Hi and Reject Ho
8	Cost of Concrete drainage	Total cost of road construction Project	Linear regression	Total cost (₦) = 183,707,804.6 + 1.524(X1)	24.6 %	0.000	Week	S. S	Accept Hi and Reject Ho
9	Cost of Concrete culverts/ bridge	Total cost of road construction Project	Linear regression	Total cost (₦) = 187,097,307.2 + 5.576(X1)	31%	0.000	Week	S. S	Accept Hi and Reject Ho

10	Cost of Preliminary items	Total cost of road construction Project	Linear regression	Total cost (₦) = 213,286,475.3 + 3.802(X1)	11.8 %	0.006	Week	S. S	Accept Hi and Reject Ho

Key SS- Statistical Significant NS – Not Significant

Table 1 shows the followings elements of road construction projects (site clearance, sub base, base course, asphalt course, and excavation works) tested with total cost of road construction projects have the probability value of >0.05 with the followings R^2 value of 45.1%; 56.9%; 45% 82.9% & 47.4%. This imply that there is strong statistical significant relationship between the two variables. This signifies that the model explains all the variability of the response data around its mean. This shows that the aforementioned five elements of road construction project have impact on the total cost of road construction projects. This result was in agreement with Koo *et al.* (2011) and Ogungbile *et al.* (2018) that the cost of road construction projects have effects on total cost of road construction projects.

In addition, the result also shows the followings elements of road construction projects (earth work, concrete drainage, concrete culverts/bridge and preliminaries) tested with total cost of road construction projects have probability value of >0.05 with the followings R^2 value of 32%; 24.6%; 31% & 11.8%. This signifies that there is week statistical significant relationship between the two variables. This shows that the model explains none of the variability of the response data around its mean this indicates that the aforementioned four elements of road construction project have little impact on the total cost of road construction projects. Furthermore, the kerb works element of road construction project tested have probability value of 0.153 < 0.05 with R^2 value of 4%. This indicates that there is no statistical

significant relationship between the two variables. This reveal that kerb work element has no impact on the total cost of road construction projects.

Relationship between the Cost of Road Components and the Total Cost of Road Construction Project

The result of the simple linear regression analysis performed show that a statistically significant relationship existed between the road components and total cost of road construction project. The following are the models used for determining the total cost of road construction project using cost of various components of proposed road construction project.

1. Total cost of road (₦) = 176,599,667 + 18.253(cost of site clearance) -(MODEL 1)
2. Total cost of road (₦) = 153,039,237.6 +3.745(Cost of road earthwork) (MODEL2).
3. Total cost of road (₦) = 173,367,615.9 + 9.168(Cost of sub base) - (MODEL 3)
4. Total cost of road (₦) = 189,871,697.8 + 5.138(Cost of base course) -(MODEL 4)
5. Total cost of road (₦) 76,651,308.80 + 2.197(cost of asphalt course) ----(MODEL 5)
6. Total cost of road (₦) 252,993,565.8 + 15.476 (cost of kerbs) --------(MODEL 6)
7. Total cost of road (₦) 134,075,806.9 + 44.057(cost of excavation for drainages/bridges). (MODEL 7)
8. Total cost of road (₦) 183,707,804.6 + 1.524(cost of concrete drainages) (MODEL 8)
9. Total cost (₦) 187,097,307.2 + 5.576(cost of concrete culvert/bridges) --(MODEL 9)

10. Total cost (₦) 213,286,475.3 + 3.802(cost of preliminary items) ------ (MODEL 10)

These results were contrary to the studies carried out by Ogungbile *et al.* (2018) on cost prediction model for the following components: asphalt, earthwork, concrete drain, site clearance and base course for asphalt wearing course Y_1= 1.034E7 +518.879 X_1 and asphalt binding course Y_1 = 1.236E7 + 2947.730 X_2; earthwork Y_3 = 2.622E7 + 300.49X_3; concrete drain Y_4 = 2.701E6 + 37349.88X_4 + 545863.166X_5; site clearanceY_5 = 3.991E5 + 543810.61 X_6; and base course Y_9 = 3.28E6 + 6117.112X_9. However, these results are in line with the findings of the studies conducted by Mahamid & Bruland (2010) and Mahamid (2011) on the following components site clearance, earth work, base course, asphalt works concrete drain, and excavation but argued on kerbs, concrete culvert and preliminary items. Ogungbile *et al.* (2018) expressed that the success of adoption of cost prediction model depend on commitment of key stakeholders.

CONCLUSION

The research concludes that only five elements of road construction project tested have strong statistical significant relationship between the two variables. This indicates that the five elements have direct impact on the total cost of road construction projects. Moreover, four elements of road construction projects tested have week statistical significant relationship between the two variables. This mean that the four elements have little impact on the total cost of road construction projects. In addition, a positive correlation was established between the cost of road construction projects and the total cost of roads construction projects from which the model for predicting the cost of roads construction were developed. The paper concludes that application of cost prediction model will

mitigate the inaccurate estimate of cost of road construction projects and also improve road construction projects delivery in Niger State. Therefore, applications of these models are recommended to be use by Niger State Government and other key stakeholders for effective budget planning and efficient road construction project delivery. Secondly, the top management of the construction firms should be encouraged to adopt this cost prediction model to reduce cost escalation, conflicts, disputes and abandonment of road projects.

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