MODELS FOR PREDICTING TIME AND COST OVERRUNS FOR HIGHWAY PROJECTS IN NIGERIA

BY

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A PROJECT SUBMITTED TO THE DEPARTMENT OF QUANTITY SURVEYING

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DECLARATION

I declare that this research work titled **"Models for Predicting Time and Cost Overruns for Highway Projects in Nigeria"** is an original work carried out by me, Osazeme Felix Enodolomwanyi with Matriculation Number ENV1604575 in the Department of Quantity Surveying, University of Benin.

Osazeme Felix Enodolomwanyi Signature: ………………….

ENV1604575 Date: ………………………

CERTIFICATION

We certify that this project with the title: **Models for Predicting Time and Cost Overruns for Highway Projects in Nigeria** submitted by **Enodolomwanyi Osazeme Felix**, with Matriculation Number, ENV1604575 has satisfied the regulations governing the award of Bachelor's Degree in Quantity Surveying from the University of Benin, Benin City, Edo State. of the Department of Quantity Surveying, Faculty of Environmental Sciences, University of Benin, Benin City, Edo State, Nigeria.

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Date: ………………………

External Examiner: PROF. H. A ODEYINKA Signature: ………………….

Date: ………………………

DEDICATION

This project is dedicated to GOD ALMIGHTY for being my strength and my provider and to my parents Reverend and Deaconess Enodolomwanyi.

ACKNOWLEDGEMENTS

I want to thank God Almighty for His protection and sustenance all through the period of my stay and studies at the University of Benin. My profound gratitude and appreciation goes to the Head of department DR T. S. FAWALE, for his guidance and direction throughout my study at the University of Benin. To my supervisor, DR C.P. OGBU, thank you so much for your guidance, support, constructive criticisms and patience through this project.

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Abstract

The Nigerian construction industry is expanding at a rapid rate both in terms of complexity and volume, with that comes a host of issues with project cost and time overruns being at the top. As a result of this, it has become important to conduct this study with the aim of developing cost and time models that can be used by stakeholders in the construction industry. The objectives of this study are to: determine the relationship between cost per kilometer and cost overrun in Nigeria, ascertain the relationship between cost per kilometer and time overrun in Nigeria, analyze the relationship between initial cost and cost overrun in Nigeria and determine the relationship between initial time and time overrun in Nigeria. Secondary data of a population size of 229 extracted from a document released by the Federal Ministry of Works and Housing in 2017 on the ongoing highway projects in Nigeria was the source of data for this study. Linear regression was the form of analysis performed in order to develop the models in this study. The models obtained in this study are as follows:

$C_1 = -4.681 \times 10^{10} + (5.946 \times 10^9) \text{ Log } C_{km} + \varepsilon_{i,}$

$T_1 = -322.174 + (58.454) \text{ Log } C_{km} + \varepsilon_i,$

$C_1 = -4.336 \times 10^9 + (1.088) C_0 + \varepsilon_{i,}$

$T_1 = -15.463 + (1.333) T_0 + \varepsilon_{i.}$

The four models developed posted R^2 values, ranging from ≥10% to ≤30%. In conclusion, the relationship between the initial cost of highway projects and its corresponding cost overrun posted the highest R^2 value of **30.2%** with an adjusted R^2 value of **29.1%**. This study recommends that reliable cost and time models should more often than not be utilized in predicting the actual time and cost it would take to complete a highway project in Nigeria.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Over the last few decades, the Nigerian Construction Industry is one that is getting more and more intricate. With Industrial development having a stronger effect on the Industry. Structures are only getting more complex, making it even more difficult to complete the projects within quality standards, budgeted cost limits and on time. These complex structures often result in equally complex risk situations which can if not handled properly, easily lead to cost and time overruns.

Unfortunately, this has been the case when it comes to the Nigerian Construction Industry, with most of the Federal Highway projects in the last two decades experiencing either cost overruns, time overruns or both. According to the Federal Ministry of Works and Housing, (2017), the Nigerian Construction Industry has experienced severe cost and time overruns which has led to drastic time delays and hundreds of billions over the original contract agreement. To improve upon this situation, it is necessary to begin cost management early on in the project. This is where the concept of modeling comes into play.

A basic definition of a model is a procedure developed to reflect, by means of derived processes, adequately acceptable output for an established series of input data. Ideally a model should be simple enough for manipulation and understanding by those who use it, representative enough in the total range of the implications it may have, and complex enough to accurately represent the system. It is also advantageous for models to be able to react and adapt to changes and maintain its accuracy (Seeley1996). The purpose of modeling is to create an algorithm or parametric equation that can be used to predict within a reasonable margin, the cost or time to execute a new project. Developing these models has been very crucial to estimators as it allows an estimator to promptly provide a reasonable estimate for a new project, in terms of the cost of the project and when the project is likely to be completed. It is highly unlikely that the output of the models will be exactly correct. However, the process of forecasting through models should not be mistaken for *guessing* as it involves analyzing the data from similar historical projects and extrapolating probable outcomes.

Cost modeling may be defined as a symbolic formation of a system and the content of it is defined with the factors affecting the cost [Holm, 2005]. Essentially, cost modeling is the development of the anticipated costs with very little project specific information (Chapman, 2012). The cost estimation models can also be classified according to their characteristics. In general, the first one is the traditional cost estimation models based on quantities; e.g. mono-priced cost estimation models used in the schematic design phase (such as unit, square, cube and building envelope models), resource-based models used in the construction phase, models based on functional elements and building operational units. The second one is the untraditional models that is to say, models comprising new techniques and practices; e.g. the experimental models, regression models and simulation models. The untraditional cost models are considered to be more accurate due to their ability to capture a lot more features than that of the traditional models (Akintoye and Fitzgerald, 2000).

Time for the performance of a construction project is usually a particularly important consideration for the parties involved. However, it is very common that projects are seldom completed on time (Nassa *et al*, 2005). The need for developing efficient time models is fast rising, this is due to the fact that for the more complex projects, the financers are less focused on the cost of the executing the project and are now more focused on time it would take to complete the project. Thus, there is more dissatisfaction among clients when the project is no longer progressing at the proposed pace. However, with efficient time models the client is provided with realistic projections on how long construction is expected to take depending on the scale and complexity of the project.

1.2 Statement of the Research Problem

It is all too common for projects in the Nigerian construction industry to experience both cost and time overruns. This is due to a host of factors such as optimism bias, inaccurate measurements and estimates, corruption, delayed payments to contractors, variation and so on Gbahabo and Ajuwon(2017). Projects that experience either one or both of these forms of overruns could have their success completely undermined and could potentially result in billions wasted if the project becomes too costly to complete. In this case, the Nigerian construction industry has not been spared as it reports billions in overruns on highway projects alone each year.

Highway construction duration estimates are often prepared very early in the design phase and are usually based on individual experiences on similar projects (William et al, 2008). These estimates are often biased, unrealistic or just simply inaccurate. It is for this reason that the need for pragmatic and robust models for the efficient prediction of construction duration at the design phase is needed.

There have been cost and time models developed by scholars in Nigeria in the past, however there is limited literature of cost and time models in northern and southern Nigeria.

1.3 Research Questions

This study will attempt to answer the following questions.

1. What is the relationship between cost per kilometer and cost overrun of highway projects Nigeria?
2. What is the relationship between cost per kilometer and time overrun of highway projects Nigeria?
3. What is the relationship between initial cost and cost overrun of highway projects Nigeria?
4. What is the relationship between initial time and cost overrun of highway projects Nigeria?

1.4 Aim and Objectives of the Study

The aim of this study is to develop a functional model based on historical data for the prediction of highway project duration and cost with a view to minimizing overruns in Nigeria. To achieve this aim, the following objectives are to be accomplished:

1. To determine the relationship between cost per kilometer and cost overrun of highway projects in Nigeria.
2. To ascertain the relationship between cost per kilometer and time overrun of highway projects in Nigeria.
3. To analyze the relationship between initial cost and cost overrun of highway projects in Nigeria.
4. To determine the relationship between initial time and time overrun of highway projects in Nigeria.

1.5 Scope of the study

The data used for this study was obtained from the Federal Ministry of Works and Housing and covered highway projects across Nigeria from 2002 to 2015. Other public sector projects outside this data base were not covered by the study particularly due to the cost of obtaining the required data, and the timeline for the submission of this project.

1.6 Significance of the study

The benefits of developing reliable models for determining cost and time estimates cannot be over emphasized as it could drastically reduce the rate at which cost and time overruns occur and also significantly reduce the effect that these overruns have on the construction industry when they do occur. These overruns have plagued the Nigerian construction for decades and as such, if the industry is looking to improve on its efficiency, productivity and output, then it is necessary to develop these models. The significance of this study is to empower construction professional and to have an easy access to a functional model for predicting the degree of cost and time overruns in the Nigerian construction industry.

CHAPTER TWO

LITERATURE REVIEW

The topic of cost and time modelling is one that has certainly been explored by professionals and scholars in the construction industry, this is due to its effectiveness and also the unique functionality it can bring to a project. Several scholars have done extensive work on cost and time models on construction projects, each focusing on diverse methods, locations and types. The main reason why so much research has been done on the topic is to develop more effective methods on curbing cost and time overruns.

Construction project time overrun can be defined as an extension of time beyond the contractual time agree during the tender and cost overrun as an extra cost beyond the contractual cost agreed during the tender. Literature by notable scholars in the industry were reviewed in order to get a grasp on what scholars have contributed on the topic of cost and time models in the construction industry. Delays in the industry generally do not benefit either party on a construction project, they usually have a negative effect on clients, contractors, and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems, and a general feeling of trepidation toward one other (Ahmed et al. 2003). A project may not be regarded as a successful endeavor until it satisfies the cost, time, and quality limitations applied to it. However, it is not uncommon to see a construction project failing to achieve its goal within the specified cost, time, and quality (Nega 2008).

2.1 Cost Overruns

Cost overrun is considered as one of the most important problems that encumber projects progress, since it reduces the contractor's profit and can lead to enormous losses and also potential undermine the success of the project Sindhu et al(2018). Lambert (2020) described cost overrun as any unexpected incurred cost that causes a project exceed the budget of a contract in order to successfully carry out the objectives agreed with the client. Ideally projects should not experience any overruns. However, Omoregie and Radford (2006) reported that the cost of projects in Nigeria escalated by 14% by the time the project was coming to completion. The issue of cost overrun is not one that is solely associated with Nigeria as it is a phenomenon that can be found globally. Al-hazim et al (2017) illustrated the extent of cost overruns in Jordan and similarly Samarghandi et al (2016) studied the reasons for delays and cost overruns in Iran. Venkateswaran and Murugasan (2017) study the extent of cost overruns in India.

2.1.1 Factors Causing Cost Overruns

There are so many factors that could lead to cost overruns during the life cycle to a project. Ameh et al (2010) found that mode of financing, bonds and payment where the most likely factor to cause cost overruns in projects. On the other hand, Omoregie and Radford (2006) showed that price fluctuation was the most sever cause of project cost escalation in Nigeria. Susanti and Nurdiana (2020) concluded that rework was the most influential factor in causing cost escalation. Mahmud et al, (2021) concluded from their research findings that the triggers of cost overrun in highway projects are contextually driven by the complex nature of the project management, societal, macroeconomic and leadership triggers specific to the Nigerian context. Kamaruddeen et al (2020) found that shortage of material was the most influential factor leading to cost overruns in Malaysia.

2.2 Time Overrun

Time overruns or delays is a very serious problem in both developed and developing countries (Soomro et al, 2019). However, the situation is worse in developing nations and Mobbs (1982) found that developed nations are better at completing construction projects in time. Time overruns have the potential to significantly undermine the success of a project based on the fact that project duration or time is one of the main criteria for a successful project (Silva et al, 2016). There are no benefits of time overruns in a construction projects as it often causes disorder in workflow and is costly to all the stakeholders involved (Hamzal et al, 2011). In Nigeria, overruns are given as the most important factor for project abandonment or contractor failure (Elinwa and Buba 2001). According to Elinwa and Buba (1993), Nigerian construction projects typically experience time overruns between 50 and 420% of the initial durations of the projects. This situation can potentially get even worse than it is currently due to the increasing level of complexity of projects these days (Hassan et al. 2022).

Contractors are constantly being put under pressure to maintain project prices as low as feasibly possibly due to the competitive nature of the industry. Contractors are unable to spend considerable amounts of time or money on project cost and duration estimation in order to avoid excessive overheads associated with abortive bidding. Many contractors simply assume that the client's contract period is reasonable and prepare bids accordingly (Pauline, 2018). This practice has been shown to be detrimental to the overall success of any road construction project, Okosun et al, (2021) conducted a study on time and cost models in Ondo and Ekiti state, the results revealed that the average rate of time overruns or delay is 26.32% and 19.92% for Ondo and Ekiti states respectively.

2.2.1 Factors Causing Time Overrun

Avoiding time overruns in construction projects is ideal however, there are so many factors that can trigger the occurrence of time overrun in a construction project. Odeh and Battaineh (2002) found that contractors and consultants agreed that owner interference, inadequate contractor experience, financing and payments, labor productivity, slow decision making, improper planning, and subcontractors are among the top 10 most important causes of construction delay. Al-Momani (2000) investigated causes of delay in 130 public projects in Jordan. The main causes of delay were related to the designer, user changes, weather, site conditions, late deliveries, economic conditions, and increase in quantity. Egila et al (2019) concluded that the factors influencing delays and cost overruns in road construction projects are; man related, money-related, machine-related, material related, environmental-related, and method related factors. Analysis using RII and MV ranked man and money related as the highest factors for delay and cost overrun respectively. Shanmugapriya and Subramanian (2013) found that that the major cause for time overruns are material market rate, contract modification, and high level of quality requirement.

Mezher et al. (2006) conducted a survey of the causes of delays in the construction industry in Lebanon from the viewpoint of owners, contractors, and architectural/engineering firms. It was found that owners had more concerns with regard to financial issues; and contractors regarded contractual relationships the most important, whereas consultants considered project management issues to be the most important causes of delays. Omoregie and Radford (2006) reported that the minimum average percentage escalation period of projects in Nigeria was found to be 18.8%. Oluyemi and Omolayo (2021) found that inaccurate evaluation of projects time and duration was the most critical factor in contributing to time overruns in Nigeria.

2.3 Usefulness of Time and Cost Models

Seeley (1996) provides a basic definition for a model as a procedure developed to reflect, by means of derived processes, adequately acceptable output for an established series of input data. This definition perfectly sums up the idea behind this study. Seeley (1996) also places emphasis on the need for models to be simple enough that they can be manipulated and flexible enough that it can adapt to changes and retain its accuracy.

The purpose of developing time and cost models is to create an algorithm or parametric equation that can be used to predict within a reasonable margin. It is highly unlikely that the output of the models will be exactly correct. However, the process of forecasting through models should not be mistaken for *guessing* as it involves analyzing the data from similar historical projects and extrapolating probable outcomes.

Using data from the Florida Department of Transportation, Shr and Chen (2006) built a model to illustrate the cost-time relationship of highway improvements. State transportation authorities and contractors have more control and awareness of the time value of highway development projects thanks to the model. The concept, however, was not appropriate for projects with a high degree of change order.

Martin et al. (2006) developed a regression analysis-based forecasting model based on real building construction time in the United Kingdom. The end result is a tool that clients and contractors may use to estimate or benchmark the construction duration of future projects at an early stage. By refining the parameters that affect construction length, Hoffman et al. (2007) created a multiple regression model to forecast highway construction duration. The BTC Model and regression analysis were used to analyze the study's data. With the least amount of error, the regression model outperformed the BTC Model. Assadulla (2010) used stepwise regression and an Artificial Neural Network to construct a highway time model. The study's findings demonstrated that the ANN had higher accuracy and reliability than more conventional models. Petruseva et al. (2013) used support vector machines to conduct research and develop a construction time forecasting model. The study looked at 75 artefacts from the Federation of Bosnia and Herzegovina that were structured between 1999 and 2011. The findings revealed an accurate representation of construction activities and suggested that it could be valuable for construction industry planning.

Waziri et al, (2014) conducted a study on the application of the Bromilow's Time-Cost model. The study revealed a positive correlation betweenn the variables with R and R^2 values of 0.734 and 0.549 respectively. A log-log regression was also produced in order to determine the K and β value which indicated the general level of time performance and the influence of complexity on the project respectively. The K value was 2.8 while the β was 0.53.

Lowe et al (2006), developed linear regressions models in order to most accurately predict the cost of construction of buildings. The models were based on 286 sets that were collected in the United Kingdom. In the study, raw cost was rejected as alternatives like cost/m^2, log of cost and log of cost/m^2. This was done because the raw cost is not seen as a reliable dependent variable as it removes all necessary context for preparing a proper regression model. The study concluded that the most suitable regression model was the log of cost of backward model which gave an R^2 of 0.661 and a MAPE of 19.3%.

CHAPTER THREE

RESEARCH METHOD

3.1 Research design

The research in this study was executed with a quantitative approach in order to sufficiently conduct this study. Quantitative research is defined as the process of collecting and analyzing numerical data sets. The analysis of said data can then be used to find patterns and make predictions. (Bhandari, 2022).

3.2 Regression Models

There are a host of different regression models that could be utilized, some of which include; linear regression, logistics regression, ridge regression, lasso regression, polynomial regression and bayesian linear regression. Each form of regression has different attributes and features that make them useful and unique, therefore making them more suited towards a specific assignment or task (Gogtay et al, 2017).

A linear regression is a form of analysis where the value of a variable is predicted or forecasted based on the value of another variable. The purpose of regression analysis is to use data to determine empirical relationships and to use those relationships to predict an outcome (Kahane 2001). Linear regression was preferred for developing time and cost models in this study because it expresses the relation between a dependent and an independent variable in the form of a linear model .Subsequent semi-log regressions were conducted after the untransformed independent variables were found to not be normally distributed.

A typical linear regression model is shown in equation 3.1 (Seiber and Lee, 2003).

$$Y_i = \alpha + \beta X_i + \varepsilon_i. \qquad \textit{Eq.3.1}$$

Where Y_I is the dependent variable (the predicted variable), α is the intercept (when X_1 is equal to 0), β is the slope of the line and X_I is the independent variable (the predictor variable). A lin-log model has the independent variable transformed to a logarithmic state and the dependent variable is left untransformed.

A typical lin-log regression model is shown in equation 3.2 (Seiber and Lee, 2003).

$$Y_i = \alpha + Log X_i + \varepsilon_i. \qquad \textit{Eq.3.2}$$

3.3 Data Collection

Secondary data for analysis and modelling were obtained from the documents released by Federal Ministry of Works (2017), which presented a list of highway projects in all zones of the nation, on-going or completed during the period 2002 and 2015. The sample frame contained a total of 229. The data was divided in the six zones of Nigeria. The data also revealed useful information about projects. Some of this information includes; length (Km), original contract sum, revised contract sum, commencement date, completion date, and extended completion date.

3.3.1 Data Treatment

3.3.1.1 Erroneous / Incomplete Records

It was discovered that a total of 30 projects did not have the "length" of the project stated and therefore were excluded from the study. This reduced the population size from 299 to 199.

3.3.1.2 Data Focusing

Upon analysis, it was determined that all bridges should be excluded from the population. This is because the inclusion of the bridges would skew the output of the models since bridges typically have much higher cost/m figures compared to those of typical highway (road) projects. This is due to the fact that road and bridge construction involve different operations, materials and components (Williams et al, 2008). This also meant that the population size had reduced from 199 to 175. See appendix A.

3.4 Method of Data Analysis

From the documents released by the Federal Ministry of Works and Housing (2017), several crucial variables for model development were extracted. The variables extracted are indicated in table 3.1.

Table 3.1: ***Illustrates the crucial extracted variables for analysis.***

S/N	Variable	Description	Code
1	Initial Cost	Initial cost is the original cost it would take to successfully complete the project. This value is free from any overruns.	C_0
2	Initial Time	Initial time is the original agreed upon period it would take to complete the project	T_0
3	Time Overrun	A condition where a construction project does not complete within the designed schedule. The value can be achieved by subtracting the commencement date from the completion date or the extended completion date in cases of extension.	T_1
4	Cost Overrun	Cost overrun is an unexpected change in the project budget that ends up increasing the total project cost. The value can be achieved by subtracting the original contract sum form the contract sum.	C_1
5	Cost / Km	This is the cost it will take to produce one kilometer of the highway or road project. The value can be achieved by dividing the contract sum by the length.	C_{km}

Simple linear and semi-log regression analysis were executed by establishing the linear relationship between two significant variables that affect highway construction duration with the aim of developing a functional model that considers construction duration. A functional model which considers cost was also developed in order to predict the degree of overruns to be expected in cost for a highway project.

The variables to be considered for the model were examined to determine whether or not there is a significant relationship between them. The variables were analyzed in SPSS to determine if there is any significant level of correlation between them. These variables analyzed include:

i. Time Overrun
ii. Cost Overrun
iii. Initial Time
iv. Initial Cost
v. Log C_{km}

3.5 Test of Assumptions of Linear Regression.

3.5.1 Multi Co-Linearity/Independence Assumption

The multi co-linearity/independence assumption deals with ensuring that all the observations or independent variable are independent of each other. This is vital to the development of a viable model because it shows that the individual observations do not influence each other. This assumption was confirmed by computing the Variance Inflation Factor (VIF) of the independent variable (Montgomery et al. 2006).

3.5.2 Normality

The normality assumption ensures that the independent variables or predictors variables are all normally distributed. This ensures that for any fixed value of Independent variable, the dependent variable is normally distributed. The variable is confirmed to be normally distributed if the Shapiro Wilk value is greater than 0.05 (Kumari and Yadav, 2018).

3.5.3 Homoscedasticity

Homoscedasticity, or homogeneity of variances, is an assumption of equal or similar variances in different groups being compared. This is an important assumption of parametric statistical tests because they are sensitive to any dissimilarities. Uneven variances in samples result in biased and skewed test results. The model is confirmed to have passed the requirement if after plotting the standardized residuals against the standardized predictors, produced a graph with no consistent pattern. (Kumari and Yadav, 2018).

3.5.4 Sample Size

The minimum requirement for each variable through all the models developed was 30 (Ganti, 2022). This requirement was passed by all the variables utilized in model development in this study, with the minimum number of variables being 60 and the maximum being 173.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Models Developed

A Total of 4 models were developed during the course of this study. The models were developed with respect to the area that the data was collected and the models aimed to represent the relationship between only two variables. The breakdown of the linear models developed are shown in the table 4.1

Table 4.1: ***showing breakdown of the models developed***

S/N	Location	Dependent Variable	Predictor / Independent Variable	Number of Models
1	Nigeria	Cost Overrun (C_1)	Log of C_{Km}	1
2	Nigeria	Time Overrun T_1)	Log of C_{Km}	1
3	Nigeria	Cost Overrun (C_1)	Initial Cost (C_0)	1
4	Nigeria	Time Overrun (T_1)	Initial Time (T_0)	1
	TOTAL			**4**

4.2 Assumption for Linear Regression

4.2.1 Multi Co-Linearity/Independence Assumption.

The table 4.2 shows the Variance Inflation Factor (VIF) values for all the variables that were used in model development in this study.

Table 4.2: ***Showing the Variance Inflation Factor (VIF) of the variables used for model development.***

S/N	Area	Models	Independent Variable	Variance Inflation Factor(VIF)
1	Nigeria	Cost overrun	Initial Cost (C_0)	1.00
2	Nigeria	Time overrun	Initial Time (T_0)	1.00
3	Nigeria	Cost overrun	Log C_{Km}	1.00
3	Nigeria	Time overrun	Log C_{Km}	1.00

The table 4.2 shows the Variance Inflation Factor which measures how much the variance of an independent variable is influenced by its correlation with the other independent variable. If the VIF equals 1, it means that there is no correlation between the independent variable. However, if the VIF is 5 or higher, it indicates that there is a high degree of multi-colinearity. This test was conducted to ensure that the independent variables did not possess a high degree of multi-colinearity. From the test results in the table 4.2 it clearly shows that all independent variables that were used in this study have a VIF score of 1 which indicates that the variables do not possess a high degree of multi-colinearity.

4.2.2 Normality Assumption

The table 4.3 show the Shapiro Wilk values for all the variables that were used in model development in this study. The histogram-normality graphs were developed and are shown in the appendix. See appendix B.

Table 4.3: ***Shapiro Wilk value of the independent variables used for model development.***

S/N	Location	Dependent Variable	Predictor Variable set	Shapiro-Wilk
1	Nigeria	Cost overrun	Log C_{km}	0.613
2	Nigeria	Time overrun	Log C_{km}	0.613
3	Nigeria	Cost overrun	Initial Cost(C_0)	0.013
4	Nigeria	Time overrun	Initial Time (T_0)	0.019

The test results in the table 4.3 shows that the independent variables that were utilized in this study have a Shapiro Wilk value of at least 0.005 which shows that the variables are normally distributed which is a necessary attribute for independent variables in developing regression based models.

4.2.3 Homoscedasticity Assumptions

The level of homoscedasticity was observed by plotting the regression standard residual against the standardized predicted value. The results are considered homoscedastic if the graphs do not have a consistent pattern (Kumari and Yadav, 2018). The level of homoscedasticity was graphically shown and was represented in the appendix. See appendix C

4.2.4 Sample Size

Table 4.2.4 shows the sample size of each model that was developed in this study. The minimum requirement for the models used in this study was 30. Citation

Table 4.4: Sample size of all models developed.

S/N	Location	Dependent Variable	Predictor Variable	Model sample size
1	Nigeria	Cost overrun	Initial Cost	86
2	Nigeria	Time overrun	Initial Time	60
3	Nigeria	Cost overrun	Log C_{km}	173
4	Nigeria	Time overrun	Log C_{km}	173

4.3 Cost/km-Cost Overrun Relationship

Data Refinement

In Nigeria, the total number of viable projects for model development is 175. However, that does not mean that all the projects were used in model development. The data had to be analyzed to ensure that the dependent and independent variables used met the requirements for regression based models. A predictive relationship was established between cost overrun and cost per kilometer by transforming the latter (independent variable) to its log form. After transforming the data, normality tests were conducted to confirm that the data was normally distributed. However this was not the case as the data posted a Shapiro Wilk value of less than 0.005. Due to the data not passing the normality test, the two (2) identified outliers were eliminated and the data then produced a normally distributed independent variable with a Shapiro Wilk value of **0.613.** This brought the model size to **173**. Subsequent multi-collinearity and homoscedasticity test were carried out on developed models to ensure that the models were able to meet the other requirements for regression based models.

4.3.1 Semi-Log Regression (Lin-Log)

A semi log regression model was developed to predict cost overruns in Nigeria. The variables to be considered for the model were examined to determine whether or not there is a significant relationship between them. The variables were analyzed to determine if there is a significant level of correlation between them. These variables analyzed include:

i. Cost Overrun (C_1)

ii. $LogC_{km}$

The variables were plotted in a scatterplot to give a visual representation of the level of correlation. See appendix D to see scatterplot.

Regression Model for Cost Overrun

The linear regression model that depicts the relationship between time overrun and initial time is shown in table 4.5 below:

Table 4.5a: ***Model Summary for Cost overrun in Nigeria.***

Model Summary

Model					Change Statistics				
	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.397[a]	.158	.153	5383365406.39189	.158	31.886	1	170	.000

a Predictors: (Constant), log of cost per kilometer

The model shown in table 4.5 is the model that depicts the relationship between cost overrun and the inverse of the log of cost per kilometer in southern Nigeria. From table 4.5, it is evident that the model posted an 'R" value of **0.397** and an "R^2" value of **0.158** which is the statistical measure of fit that determine the proportion of variance in cost overrun can be explained by the initial cost. The model also posted and adjusted R^2 of **0.153** which accounts for predictors that were deemed not significant. The standard error of the estimate is **5383365406.39189** which serves as the estimate of the accuracy of the prediction.

The model for predicting cost overrun is mathematically expressed in equation 4.1.

Cost overrun=C_1 = -4.681 x 10^{10} + (5.946 x 10^9) Log C_{km} + $\varepsilon_{i.}$ *eq 4.1*

4.4 Cost/km-Time Overrun Relationship

Data Refinement

The same independent variable (Log C_{km}) used in objective one was also used to develop the model for predicting time overrun. Therefore a similar process of data refinement was implemented.

4.4.1 Semi-Log Regression (Lin-Log)

A semi log regression model were developed to predict time overruns in Nigeria. The variables to be considered for the model were examined to determine whether or not there is a significant relationship between them. The variables were analyzed to determine if there is a significant level of correlation between them. These variables analyzed include:

i. Time Overrun (T_0)

ii. LogC_{km}

The variables were plotted in a scatterplot to give a visual representation of the level of correlation. See appendix D to see scatterplot.

Regression Model for Time Overrun

The linear regression model that depicts the relationship between time overrun and initial time is shown in table 4.6 below:

Table 4.6a: ***Model Summary for Time overrun in Nigeria.***

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	.208[a]	.043	.033	112.40561	.043	4.105	1	91	.046

a Predictors: (Constant), log of cost per kilometer

The model shown in table 4.6 is the model that depicts the relationship between time overrun and the initial cost in southern Nigeria. From table 4.6, it is evident that the model posted an 'R" value of **0.208** and an "R^2" value of **0.043** which is the statistical measure of fit that determines the proportion of variance in cost overrun that can be explained by the initial cost. The model also posted and adjusted R^2 of **0.033** which accounts for predictors that were deemed not significant. The standard error of the estimate is **112.41** which serves as the estimate of the accuracy of the prediction. The model for predicting cost overrun is mathematically expressed in equation 4.2.

Time overrun=$T_1 = -322.174 + (58.454) \text{ Log } C_{km} + \varepsilon_{i.}$ ***eq 4.2***

4.5 Initial Cost-Cost Overrun Relationship

Data Refinement

As previously established, the total of viable projects for model development was 175. However, that does not mean that all the projects were used in model development. The data had to be refined to ensure that the model met all the requirements for producing a regression-based model. A predictive relationship was established between cost overrun and initial cost by running a simple linear regression. Normality tests were conducted to confirm that the data was normally distributed. However, this was not the case as the data posted a Shapiro Wilk value of less than 0.005. Due to the data not passing the normality test, 89 identified outliers were eliminated and the data then produced a normally distributed independent variable with a Shapiro Wilk value of **0.613.** Subsequent multi-collinearity and homoscedasticity test were carried out on developed models to ensure that the models were able to meet the other requirements for regression based models.

4.5.1 Simple Linear Regression Model

Simple linear regression was carried out in order to develop models for predicting cost overrun in Nigeria. The regression was executed to determine if the relationship between initial cost (**C_0**) and cost overrun (**C_1**) is a good predictor for cost overrun in Nigeria.

The variables to be considered for the model were examined to determine whether or not there is a significant relationship between them. The variables analyzed include:

i. Cost Overrun (C_1)
ii. Initial Cost (C_0)

The variables were plotted in a scatterplot to give a visual representation of the level of correlation. See appendix D to see scatterplot

Regression Model for Cost Overrun

The linear regression model that depicts the relationship between cost overrun and initial cost is shown in table 4.7:

Table 4.5b: ***Model Summary for Cost overrun in Nigeria.***

Model Summary

Model					Change Statistics				
	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.549[a]	.302	.291	5214561499.03410	.302	29.380	1	68	.000

a Predictors: (Constant), Initial Cost

The model shown in table 4.7 is the model that depicts the relationship between cost overrun and the initial cost in Nigeria. From table 4.7, it is evident that the model posted an 'R" value of **0.549** and an "R^2" value of **0.302** which is the statistical measure of fit that determines the proportion of variance in cost overrun that can be explained by the initial cost. The model also posted and adjusted R^2 of **0.291** which accounts for predictors that were deemed not significant. The standard error of the estimate is **5214561499.03** which serves as the estimate of the accuracy of the prediction. The model for predicting time overrun is mathematically expressed in equation 4.3.

Cost overrun = $C_1 = -4.336 \times 10^9 + (1.088)\, C_0 + \varepsilon_{i.}$ ***eq 4.3***

4.6 Initial Time-Time Overrun Relationship

Data Refinement

The data to be utilized had to be refined to ensure that the model produced met all the requirements for producing a regression-based model. A predictive relationship was established between time overrun and initial time by running a simple linear regression. Normality tests were conducted to confirm that the data was normally distributed. However, this was not the case as the data posted a Shapiro Wilk value of less than 0.005. Due to the data not passing the normality test, 115 identified outliers were eliminated and the data then produced a normally distributed independent variable with a Shapiro Wilk value of **0.019.** Subsequent multi-collinearity and homoscedasticity test were carried out on developed models to ensure that the models were able to meet the other requirements for regression based models.

4.6.1 Simple Linear Regression Model

Simple linear regression was carried out in order to develop models for predicting time overrun in Nigeria. The regression was executed to determine if the relationship between initial time (**T_0**) and time overrun (**T_1**) is a good predictor for time overrun in Nigeria.

The variables to be considered for the model were examined to determine whether or not there is a significant relationship between them. The variables analyzed include:

i. Time Overrun (T_1)
ii. Initial Time (T_0)

The variables were plotted in a scatterplot to give a visual representation of the level of correlation. See appendix D to see scatterplot.

Regression Model for Time Overrun

The linear regression model that depicts the relationship between cost overrun and initial cost is shown in table 4.8:

Table 4.6b*; Model Summary for Time overrun in Nigeria.*

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	.381[a]	.145	.130	134.27636	.145	9.823	1	58	.003

a Predictors: (Constant), Initial time

b. Dependent Variable: Time overrun

The model shown in table 4.8 is the model that depicts the relationship between time overrun and Initial time (T_0) in northern Nigeria. It is evident that the model posted an 'R" value of **0.381** and an "R^2" value of **0.145** which is the statistical measure of fit that determine the proportion of variance in the time overrun can be explained by the log of cost per kilometer. The model also posted and adjusted R^2 of **0.130** which accounts for predictors that were deemed not significant. The standard error of the estimate is **132.28** which serves as the estimate of the accuracy of the prediction. The model for predicting time overrun is mathematically expressed in equation 4.4

Time Overrun = $T_1 = -15.463 + (1.333)\ T_0 + \varepsilon_{i.}$ ***eq 4.4***

4.7 Summary Of Findings

The results of this study are summarized in table 4.9.

Table 4.7: ***Models developed in the study.***

S/N	Location	Dependent Variable	Predictor Variable set	Model	Adjusted R^2
1	**Nigeria**	**Cost overrun**	**Log C_{km}**	$C_1 = -4.681 \times 10^{10} + (5.946 \times 10^9)\ \text{Log}\ C_{km} + \varepsilon_{i.}$	**0.153**
2	**Nigeria**	**Time overrun**	**Log C_{km}**	$T_1 = -322.174 + (58.454)\ \text{Log}\ C_{km} + \varepsilon_{i.}$	**0.033**
3	**Nigeria**	**Cost overrun**	**Initial Cost(C_0)**	$C_1 = -4.336 \times 10^9 + (1.088)\ C_0 + \varepsilon_{i.}$	**0.291**
4	**Nigeria**	**Time**	**Initial Time**	$T_1 = -15.463 + (1.333)\ T_0 + \varepsilon_{i.}$	**0.130**

	overrun	**(T_0)**

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the models developed in this study, the following conclusions have been drawn.

1. The relationship between the cost per kilometer of highway projects and its corresponding cost was able to produce decent models for predicting cost overrun with the model posting relatively decent adjusted R^2 value of 15.3% respectively.
2. The relationship between the cost per kilometer of highway projects and its corresponding cost was able to produce decent models for predicting time overrun with the model posting poor adjusted R^2 value of 3.3% respectively.
3. The relationship between the initial cost of highway projects and its corresponding cost was able to produce decent models for predicting cost overrun with the model posting relatively decent adjusted R^2 value of 29.1% respectively.
4. The relationship between the duration (time) of highway projects and its corresponding initial time was able to produce decent models for predicting cost overrun with the model posting relatively decent adjusted R^2 value of 13.0% respectively.

5.2 Recommendations

Based on the research findings, the following recommendations were made:

1. The practice of developing cost and time models would be greatly improved with better record keeping. This was observed during the process of data collection for this study as a

number of projects were missing key figures that are necessary for developing time and cost models.

2. Reliable cost and time models should more often than not be utilized in predicting the actual time and cost it would take to complete a highway project.

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APPENDIX A

S/N	CNo.	Length km	Original Contract Sum (N)	Contract Sum (N)	Comm. Date	Compl. Date	Ext Compl. Date	A	B	Time overrun	Cost overrun	Cost/km
1	5983	76	4,206,805,680.00	4,206,805,680.00	5/28/09	11/27/10	6/30/14	266	78	187	0.00	55,352,706.32
2	6100	18	1,035,824,120.10	1,035,824,120.10	10/23/12	1/22/14	6/30/17	244	65	179	0.00	57,545,784.45
3	6088	10	486,740,100.00	486,740,100.00	1/21/11	6/20/11			21		0.00	48,674,010.00
4	6156	25.8	3,296,177,230.50	6,686,554,420.40	12/13/12	12/12/13	4/30/18	281	52	229	3,390,377,189.90	259,168,775.98
5	6159	30	3,297,761,006.93	3,297,761,006.93	4/10/13	4/9/15			104		0.00	109,925,366.90
6	6259	39	9,999,171,491.93	9,999,171,491.93	1/24/15	7/23/17			130			256,389,012.61
7	6265	24	7,962,031,030.80	7,962,031,030.80	2/17/15	8/16/16	8/17/17	130	78	52	0.00	331,751,292.95
8	5862	42	11,227,571,390.41	28,666,721,831.64	8/3/06	2/2/11	2/28/17	552	235	317	17,439,150,441.23	682,540,995.99
9	6275	8	982,412,229.88	982,412,229.88	2/17/15	2/16/16			52		0.00	122,801,528.74
10	6260	51.81	7,497,172,077.78	7,497,172,077.78	1/24/15	7/23/16	9/11/17	137	78	59	0.00	144,705,116.34
11	5884	49.36	9,697,186,699.20	25,827,333,686.52	10/12/06	4/11/11	3/12/14	387	235	152	16,130,146,987.32	523,244,199.48
12	6098	10.1	974,580,320.53	974,580,320.53	2/4/11	2/3/12			52		0.00	96,493,101.04

13	5885	50	11,987,187,078.04	31,087,756,036.84	10/12/06	10/11/08	4/10/14	391	104	287	19,100,568,958.80	621,755,120.74
14	6135	58.59	11,663,957,682.30	30,569,460,059.99	12/24/12	12/23/14	10/22/17	252	104	148	##############	521,752,177.16
15	6242	42.9	5,240,000,000.00	5,240,000,000.00	12/5/16	12/4/18			104		0.00	122,144,522.14
16	6154	5	1,319,983,348.53	1,319,983,348.53	12/27/12	12/26/13	12/31/16	209	52	157	0.00	263,996,669.71
17	6210	93.6	14,587,233,292.17	14,587,233,292.17	1/30/14	1/29/16	12/28/17	204	104	100	0.00	155,846,509.53
18	6212	113.6	8,217,373,106.77	8,217,373,106.77	1/30/14	1/29/17			156		0.00	72,336,030.87
19	6231	8	1,242,977,506.00	1,242,977,506.00	3/3/14	3/2/15	3/2/17	156	52	104	0.00	155,372,188.25
20	6239	22.1	976,219,650.00	976,219,650.00	11/15/14	11/14/15	1/31/18	168	52	116	0.00	44,172,834.84
21	5805	98	4,423,639,212.30	4,423,639,212.30	11/11/05	1/10/07	12/31/10	268	61	207	0.00	45,139,175.64
22	6065	88	7,935,044,748.75	7,935,044,748.75	9/20/10	9/19/12	3/31/14	184	104	80	0.00	90,170,963.05
23	5846	82	5,402,424,859.73	15,190,821,088.10	2/10/06	8/9/07	9/20/18	658	78	580	9,788,396,228.37	185,253,915.71
24	5972	13.3	3,382,960,350.00	3,382,960,350.00	4/20/09	10/19/10	10/31/14	289	78	210	0.00	254,357,921.05
25	6274	10	999,431,244.00	999,431,244.00	2/17/15	8/16/16			78		0.00	99,943,124.40
26	6237	53.4	8,846,651,987.25	8,846,651,987.25	1/4/14	7/3/16			130		0.00	165,667,640.21
27	6077	40	9,951,051,335.18	9,951,051,335.18	12/13/10	6/12/13	7/12/16	291	130	161	0.00	248,776,283.38

28	6267	61	23,632,309,811.36	23,632,309,811.36	2/18/15	2/17/19			209		0.00	387,414,914.94
29	6254	52.3	17,563,264,407.19	17,563,264,407.19	1/24/15	1/23/16	7/31/17	131	52	79	0.00	335,817,675.09
30	6144	5.5	1,185,114,615.37	1,185,114,615.37	12/20/12	9/19/13	12/19/16	209	39	170	0.00	215,475,384.61
31	6141	24.5	3,698,014,603.34	3,698,014,603.34	12/20/12	12/19/16			209		0.00	150,939,371.56
32	6162	100	8,968,809,507.63	19,566,758,401.95	4/10/13	4/9/15	8/17/17	227	104	123	##############	195,667,584.02
33	6258	53.644	14,217,920,900.06	14,217,920,900.06	1/24/15	1/23/17			104		0.00	265,042,146.37
34	5890	24.3	2,252,998,873.30	2,252,998,873.30	11/16/06	2/16/08	5/15/10		65		0.00	92,716,003.02
35	6215	38	2,997,940,010.26	2,997,940,010.26	1/30/14	7/29/15			78		0.00	78,893,158.16
36	5879	117.776	35,841,452,834.88	65,315,458,261.59	10/12/06	2/11/10	12/5/17	582	174	408	##############	554,573,582.58
37	5880	101.84	29,100,000,000.00	45,181,695,740.22	10/12/06	4/11/10	6/3/18	607	182	425	##############	443,653,728.79
38	6152	15.5	1,215,539,325.00	1,215,539,325.00	1/21/13	1/20/14	12/20/14	100	52	48	0.00	78,421,891.94
39	6228	5	1,750,119,126.53	1,750,119,126.53	2/8/14	11/7/14			39		0.00	350,023,825.31
40	6214	15	3,076,381,622.74	3,076,381,622.74	1/30/14	7/29/15			78		0.00	205,092,108.18
41	6264	38.2	7,129,762,447.50	7,129,762,447.50	2/17/15	8/16/16			78		0.00	186,642,996.01
42	6069	51	16,683,596,891.08	16,683,596,891.08	9/20/10	9/19/12			104		0.00	327,129,350.81

43	6071	36.28	9,880,524,657.27	9,880,524,657.27	9/20/10	9/19/12	9/19/14	209	104	104	0.00	272,340,811.94
44	5869	145.109	39,998,728,481.25	67,795,690,880.01	8/3/06	12/2/09	1/10/16	492	174	319	##############	467,205,279.34
45	5975	73	5,019,848,813.60	5,019,848,813.60	5/28/09	11/27/10	2/27/12	144	78	65	0.00	68,765,052.24
46	5974	122	5,720,242,869.50	5,720,242,869.50	5/28/09	11/27/10	5/27/12	156	78	78	0.00	46,887,236.64
47	5971	20	1,240,458,276.75	1,240,458,276.75	9/30/09	12/29/10	6/30/11	91	65	26	0.00	62,022,913.84
48	6261	68	7,256,623,914.54	7,256,623,914.54	1/24/15	7/23/17			130		0.00	106,715,057.57
49	5105A	69	5,155,507,915.77	5,901,688,155.30	12/12/05	5/14/08	12/31/09	211	126	85	746,180,239.53	85,531,712.40
50	6143	3.2	1,187,795,843.85	1,187,795,843.85	12/20/12	12/19/13			52		0.00	371,186,201.20
51	6151	7	1,043,029,772.40	1,043,029,772.40	3/9/13	3/8/14			52		0.00	149,004,253.20
52	6230	32	3,978,932,819.40	3,978,932,819.40	1/30/14	1/29/15			52		0.00	124,341,650.61
53	6232	5.5	1,030,107,509.00	1,030,107,509.00	2/8/14	10/7/14			34		0.00	187,292,274.36
54	6276	6.5	983,999,619.86	983,999,619.86	2/16/15	10/15/15			34		0.00	151,384,556.90
55	5881	96.24	30,250,000,000.00	51,903,173,630.22	2/1/07	11/30/09	12/18/18	620	148	472	##############	539,309,784.19
56	6139	25	6,581,999,666.55	6,581,999,666.55	12/3/12	12/24/14	6/12/15	132	107	24	0.00	263,279,986.66
57	6256	49.13	8,193,930,303.25	8,193,930,303.25	1/24/15	2/13/18			159		0.00	166,780,588.30

58	5966	30	2,318,694,378.00	2,318,694,378.00	4/28/09	4/27/11	12/19/12	190	104	86	0.00	77,289,812.60
59	6072	32.8	7,953,487,029.18	7,953,487,029.18	9/20/10	5/19/13	5/19/15	243	139	104	0.00	242,484,360.65
60	6041	13.59	1,764,096,757.50	1,764,096,757.50	12/16/09	12/15/10	8/4/16	346	52	294	0.00	129,808,444.26
61	6129	14.08	609,840,000.00	609,840,000.00	3/7/12	3/6/13	6/2/14	117	52	65	0.00	43,312,500.00
62	6150	65	3,792,451,838.18	3,792,451,838.18	12/13/12	6/12/14			78		0.00	58,345,412.90
63	5346	64.9	16,000,000,000.00	40,159,175,692.57	11/24/02	11/23/05	7/31/12	505	156	349	##############	618,785,449.81
64	6257	109.925	15,638,377,142.86	15,638,377,142.86	1/24/15	1/23/17			104		0.00	142,264,063.16
65	6197	10.2	989,168,424.30	989,168,424.30	2/28/13	2/27/14			52		0.00	96,977,296.50
66	6271	5.67	981,617,833.98	981,617,833.98	2/17/15	2/16/16			52		0.00	173,124,838.44
67	5960	26.6	13,226,801,593.27	22,773,806,219.93	5/20/07	5/19/10	11/4/17	546	156	389	9,547,004,626.66	856,158,128.57
68	6273	21.26	936,147,167.17	936,147,167.17	2/17/15	2/16/16			52		0.00	44,033,262.80
69	5878	105	37,047,307,376.33	55,122,713,072.02	10/12/06	2/11/10	12/31/15	481	174	307	##############	524,978,219.73
70	6140	21.3	4,393,730,163.90	4,393,730,163.90	12/20/12	12/19/14			104		0.00	206,278,411.45
71	6213	74.1	14,078,252,565.88	14,078,252,565.88	1/30/14	6/29/16			126		0.00	189,989,913.17
72	5264	210	3,000,000,000.00	5,615,861,594.01	7/22/03	1/21/05	12/24/10	387	78	309	2,615,861,594.01	26,742,198.07

73	6029	104	7,941,669,771.22	7,941,669,771.22	12/16/09	6/15/12	12/31/13	211	130	81	0.00	76,362,209.34
74	6226	10.5	1,452,354,449.70	1,452,354,449.70	2/8/14	8/7/15			78		0.00	138,319,471.40
75	6118	11.4	2,256,354,874.62	2,256,354,874.62	9/26/11	9/25/13			104		0.00	197,925,866.19
76	6161	155	10,559,745,000.00	30,459,183,038.00	2/5/13	2/17/18			263		##############	196,510,858.31
77	6130	55.5	2,739,105,600.20	2,739,105,600.20	9/26/12	3/25/14			78		0.00	49,353,254.06
78	5821	46	2,093,033,385.88	2,093,033,385.88	10/3/05	2/2/07	2/6/11	279	70	209	0.00	45,500,725.78
79	6094	6	589,554,307.65	589,554,307.65	2/1/11	2/29/12			56		0.00	98,259,051.28
80	6208	59.5	39,548,900,597.79	39,548,900,597.79	9/21/13	3/20/17			182		0.00	664,687,405.00
81	6091	7	515,315,493.00	515,315,493.00	2/1/11	7/31/11			26		0.00	73,616,499.00
82	6063	10	990,673,340.00	990,673,340.00	3/10/10	9/9/10			26		0.00	99,067,334.00
83	6158	28.24	2,265,982,372.50	2,265,982,372.50	2/6/13	10/5/14	10/5/15	139	87	52	0.00	80,240,169.00
84	6160	11.7	2,293,965,030.00	2,293,965,030.00	2/12/13	2/11/15			104		0.00	196,065,387.18
85	5874	10	250,723,163.30	734,039,288.90	10/31/06	4/30/07	4/30/10	182	26	157	483,316,125.60	73,403,928.89
86	5929	49	5,092,444,641.90	7,351,344,974.40	4/20/09	10/19/11	5/14/13	212	130	82	2,258,900,332.50	150,027,448.46
87	5929A	49	4,613,734,090.35	4,613,734,090.35	12/16/09	6/15/12			130		0.00	94,157,838.58

88	6220	6.7	711,888,234.75	711,888,234.75	12/4/13	12/3/14			52		0.00	106,251,975.34
89	6218	3.73	625,690,820.37	625,690,820.37	12/4/13	2/3/15			61		0.00	167,745,528.25
90	5986	25	3,794,656,941.08	3,794,656,941.08	5/28/09	5/27/11			104		0.00	151,786,277.64
91	5986A	38	2,572,473,142.28	2,572,473,142.28	6/19/09	12/18/10			78		0.00	67,696,661.64
92	6112	13.5	1,786,546,349.60	1,786,546,349.60	9/26/11	6/25/12			39		0.00	132,336,766.64
93	6024	32	5,804,811,747.04	7,173,909,755.40	12/16/09	12/15/11			104		1,369,098,008.36	224,184,679.86
94	5904	17	1,277,214,120.00	1,872,132,617.25	4/23/07	8/22/08	8/22/10	174	70	104	594,918,497.25	110,125,448.07
95	6058	10.5	599,926,404.00	599,926,404.00	2/17/10	8/16/10	12/28/12	149	26	124	0.00	57,135,848.00
96	5989	36	2,987,774,166.30	2,987,774,166.30	5/28/09	11/27/10	3/31/15	305	78	226	0.00	82,993,726.84
97	5989A	26	3,500,000,000.00	3,500,000,000.00	5/28/09	7/27/10	12/31/13	240	61	179	0.00	134,615,384.62
98	6148	40.27	11,603,191,818.53	11,603,191,818.53	12/20/12	6/19/15			130		0.00	288,134,884.99
99	6221	6.6	850,575,495.00	850,575,495.00	12/4/13	12/3/14	12/3/15	104	52	52	0.00	128,875,075.00
100	6269	4.1	994,661,294.55	994,661,294.55	1/24/15	7/23/15			26		0.00	242,600,315.74
101	6018	75	8,964,995,597.25	9,675,130,731.00	5/28/09	5/27/11	5/31/16	366	104	262	710,135,133.75	129,001,743.08
102	6078	41	6,796,939,488.99	6,796,939,488.99	12/13/10	10/12/12	10/1/15	250	96	155	0.00	165,779,011.93

103	6251	82.8	32,317,082,596.26	32,317,082,596.26	1/24/15	1/23/17			104		0.00	390,302,929.91
104	5988	56	7,251,451,515.00	7,251,451,515.00	5/28/09	11/27/11			130		0.00	129,490,205.63
105	6037	39	3,287,120,702.25	4,805,288,034.75	12/16/09	6/15/11			78		1,518,167,332.50	123,212,513.71
106	6266	58	24,243,308,789.82	24,243,308,789.82	2/17/15	2/16/18			156		0.00	417,988,082.58
107	5962	85.6	6,446,051,729.71	6,446,051,729.71	12/16/09	1/15/12	11/30/14	259	109	150	0.00	75,304,342.64
108	6170	40.5	12,951,207,018.75	12,951,207,018.75	2/5/13	1/4/15			100		0.00	319,782,889.35
109	6169	56.049	10,370,810,187.53	10,370,810,187.53	2/5/13	8/4/15			130		0.00	185,031,136.82
110	6153	31.15	3,035,439,907.50	3,035,439,907.50	2/6/13	8/5/14			78		0.00	97,445,903.93
111	6194	5.53	995,369,082.81	995,369,082.81	1/21/13	10/20/13	10/20/15	143	39	104	0.00	179,994,409.19
112	6060	58	199,758,174.00	199,758,174.00	2/17/10	6/16/10			17		0.00	3,444,106.45
113	6126	22	4,207,774,864.51	4,207,774,864.51	6/20/12	6/19/14			104		0.00	191,262,493.84
114	6155	11.26	3,780,988,125.00	3,780,988,125.00	2/6/13	8/5/15			130		0.00	335,789,353.91
115	6234	11	1,275,747,419.10	1,275,747,419.10	1/30/14	1/29/15			52		0.00	115,977,038.10
116	6083	21	2,995,300,579.20	2,995,300,579.20	12/13/10	12/12/12	12/12/13	156	104		0.00	142,633,360.91
117	6036	43.2	2,991,389,773.68	2,991,389,773.68	12/22/09	8/15/11			86		0.00	69,245,133.65

118	**6061**	**0.82**	**249,992,011.50**	**249,992,011.50**	**2/9/10**	**8/8/10**			**26**		**0.00**	**304,868,306.71**
119	**6236**	**34.3**	**2,383,568,870.81**	**2,383,568,870.81**	**1/30/14**	**4/29/15**			**65**		**0.00**	**69,491,803.81**
120	**5990**	**33.49**	**9,998,340,780.00**	**13,287,484,879.43**	**5/28/09**	**11/27/11**	**12/27/15**	**343**	**130**	**213**	**3,289,144,099.43**	**396,759,775.44**
121	**6248**	**41.9**	**26,498,476,426.25**	**26,498,476,426.25**	**1/24/15**	**7/23/17**			**130**		**0.00**	**632,421,871.75**
122	**6011**	**25**	**4,613,197,050.00**	**7,613,176,725.00**	**5/28/09**	**11/27/11**	**4/10/15**	**306**	**130**	**176**	**2,999,979,675.00**	**304,527,069.00**
123	**5991**	**30**	**5,208,582,235.00**	**9,136,126,840.71**	**5/28/09**	**11/27/11**	**4/27/15**	**309**	**130**	**178**	**3,927,544,605.71**	**304,537,561.36**
124	**6262**	**48.5**	**7,037,990,821.31**	**7,037,990,821.31**	**1/24/15**	**7/23/16**			**78**		**0.00**	**145,113,212.81**
125	**6263**	**67.1**	**9,168,931,117.50**	**9,168,931,117.50**	**1/24/15**	**1/23/17**			**104**		**0.00**	**136,645,769.26**
126	**6084**	**22.85**	**995,505,585.00**	**995,505,585.00**	**1/31/11**	**1/30/13**	**2/28/14**	**161**	**104**	**56**	**0.00**	**43,566,984.03**
127	**6093**	**1.2**	**173,205,648.00**	**173,205,648.00**	**1/31/11**	**7/30/11**	**12/31/14**	**204**	**26**	**179**	**0.00**	**144,338,040.00**
128	**6147**	**4**	**848,061,742.50**	**848,061,742.50**	**1/15/13**	**7/14/13**	**7/14/14**	**78**	**26**	**52**	**0.00**	**212,015,435.63**
129	**6050**	**85**	**589,460,256.00**	**589,460,256.00**	**10/20/09**	**8/3/10**	**12/30/12**	**167**	**41**	**126**	**0.00**	**6,934,826.54**
130	**6227**	**9**	**2,116,007,583.00**	**2,116,007,583.00**	**2/8/14**	**2/7/16**			**104**		**0.00**	**235,111,953.67**
131	**6249**	**110.63**	**64,876,412,558.50**	**64,876,412,558.50**	**1/24/15**	**7/23/17**			**130**		**0.00**	**586,426,941.68**
132	**6250**	**150.2**	**47,948,569,920.17**	**47,948,569,920.17**	**1/24/15**	**1/23/18**			**156**		**0.00**	**319,231,490.81**

133	6044	30	403,336,375.37	403,336,375.37	10/20/09	6/19/10			35		0.00	13,444,545.85
134	6109	15	1,428,007,350.00	1,428,007,350.00	9/26/11	9/25/12	5/30/14	140	52	87	0.00	95,200,490.00
135	6106	6.4	524,708,299.50	524,708,299.50	3/2/11	9/1/11	7/31/13	126	26	100	0.00	81,985,671.80
136	6131	14	2,225,954,172.75	2,225,954,172.75	7/2/12	9/1/13	12/31/15	182	61	122	0.00	158,996,726.63
137	6136	63.7	11,086,276,140.36	21,294,096,681.78	12/24/12	6/23/16	11/4/17	254	182	71	##############	334,287,232.05
138	6137	54.2	11,659,588,909.69	34,866,400,154.56	12/24/12	4/23/16	11/4/17	254	174	80	##############	643,291,515.77
139	6138	47.4	11,679,997,440.71	35,252,343,918.24	12/24/12	12/23/15	11/25/17	257	156	100	##############	743,720,335.83
140	6163	4.6	350,467,425.00	610,412,347.50	12/5/12	5/4/13	2/4/15	113	21	92	259,944,922.50	132,698,336.41
141	6240	25.4	989,813,573.55	989,813,573.55	11/13/14	11/12/15			52		0.00	38,969,038.33
142	6279	6.6	400,352,766.00	400,352,766.00		5/11/16		0		0	0.00	60,659,510.00
143	6187	0.5	139,027,875.00	139,027,875.00		7/12/15		0		0	0.00	278,055,750.00
144	6079	54	5,117,920,728.75	5,117,920,728.75	12/13/10	6/12/12			78		0.00	94,776,309.79
145	6252	41.4	34,047,096,919.17	34,047,096,919.17	1/24/15	7/23/17			130		0.00	822,393,645.39
146	6025	6.6	3,030,865,379.63	3,030,865,379.63	12/16/09	12/15/10	12/31/13	211	52	159	0.00	459,222,027.22
147	5931	22	3,502,113,480.75	3,502,113,480.75	4/20/09	6/19/11	6/19/17	426	113	313	0.00	159,186,976.40

148	6005	7.2	8,661,352,271.00	8,661,352,271.00	12/16/09	3/15/12	2/15/15	270	117	152	0.00	#############
149	6202	10.8	14,989,647,635.65	14,989,647,635.65	9/21/13	3/20/15			78		0.00	#############
150	6204	43.6	70,753,387,798.42	70,753,387,798.42	7/4/13	7/3/17			209		0.00	#############
151	6253	1.8	1,141,025,424.00	1,141,025,424.00	1/24/15	1/23/16	11/23/17	148	52	96	0.00	633,903,013.33
152	6205	84	96,304,444,055.63	96,304,444,055.63	7/4/13	7/3/17			209		0.00	#############
153	5919	24	1,534,911,551.25	1,534,911,551.25	4/6/09	4/19/11	4/5/12	156	106	50	0.00	63,954,647.97
154	6133	166.02	65,223,155,642.34	65,223,155,642.34	10/22/12	10/21/15	6/21/17	243	156	87	0.00	392,863,243.24
155	6235	22.25	3,287,221,221.90	3,287,221,221.90	1/30/14	7/29/15	12/29/16	152	78	74	0.00	147,740,279.64
156	6115	42	1,799,786,661.75	1,799,786,661.75	9/26/11	6/25/12			39		0.00	42,852,063.38
157	6081	72.7	3,993,183,607.88	3,993,183,607.88	12/13/10	3/12/12	3/31/16	276	65	211	0.00	54,926,872.19
158	6241	98.414	71,648,176,867.38	71,648,176,867.38	10/23/14	10/22/18			209		0.00	728,028,297.47
159	3278A	20.575	10,627,577,047.26	10,627,577,047.26	7/12/11	10/11/12			65		0.00	516,528,653.57
160	6082	37	1,696,337,058.26	1,696,337,058.26	12/13/10	3/12/12	6/13/14	183	65	118	0.00	45,846,947.52
161	6113	14.2	1,381,556,046.26	1,381,556,046.26	9/26/11	12/25/12			65		0.00	97,292,679.31
162	6075	27.6	2,693,245,401.00	2,882,467,077.35	12/13/10	3/12/12	6/27/15	237	65	172	189,221,676.35	104,437,212.95

163	**6105**	**15**	**662,760,771.75**	**662,760,771.75**	**3/7/11**	**11/7/11**			**35**		**0.00**	**44,184,051.45**
164	**5856**	**60.1**	**2,118,231,651.11**	**2,118,231,651.11**	**4/5/06**	**10/4/07**	**12/31/10**	**247**	**78**	**169**	**0.00**	**35,245,118.99**
165	**6049**	**30**	**468,275,914.02**	**468,275,914.02**	**10/20/09**	**4/5/10**	**3/30/12**	**127**	**24**	**104**	**0.00**	**15,609,197.13**
166	**6080**	**22**	**6,718,498,984.54**	**6,718,498,984.54**	**12/13/10**	**12/12/13**			**156**		**0.00**	**305,386,317.48**
167	**6102**	**30.2**	**6,917,558,164.42**	**6,917,558,164.42**	**9/26/11**	**3/25/13**	**3/25/17**	**287**	**78**	**209**	**0.00**	**229,058,217.36**
168	**6270**	**4**	**631,848,724.24**	**631,848,724.24**	**1/24/15**	**1/23/16**	**6/30/17**	**127**	**52**	**75**	**0.00**	**157,962,181.06**
169	**6224**	**6.9**	**585,499,530.00**	**585,499,530.00**	**12/4/13**	**12/3/14**	**12/31/17**	**213**	**52**	**161**	**0.00**	**84,855,004.35**
170	**6222**	**5.2**	**873,067,889.93**	**873,067,889.93**	**12/4/13**	**12/3/14**	**5/31/17**	**182**	**52**	**130**	**0.00**	**167,897,671.14**
171	**1793A**	**52**	**47,504,138,344.20**	**47,504,138,344.20**	**6/28/10**	**10/27/13**	**12/31/17**	**392**	**174**	**218**	**0.00**	**913,541,122.00**
172	**6116**	**46**	**2,136,669,265.50**	**2,136,669,265.50**	**9/26/11**	**5/25/12**	**12/31/17**	**327**	**35**	**292**	**0.00**	**46,449,331.86**
173	**6047**	**30**	**998,840,017.25**	**998,840,017.25**	**10/20/09**	**4/19/10**	**12/31/16**	**376**	**26**	**350**	**0.00**	**33,294,667.24**
174	**6031**	**75**	**3,535,737,651.60**	**3,884,198,637.86**	**12/16/09**	**6/15/11**	**12/31/17**	**420**	**78**	**342**	**348,460,986.26**	**51,789,315.17**
175	**6268**	**1.75**	**349,908,867.00**	**349,908,867.00**	**1/24/15**	**1/23/16**			**52**		**0.00**	**199,947,924.00**

LEGEND

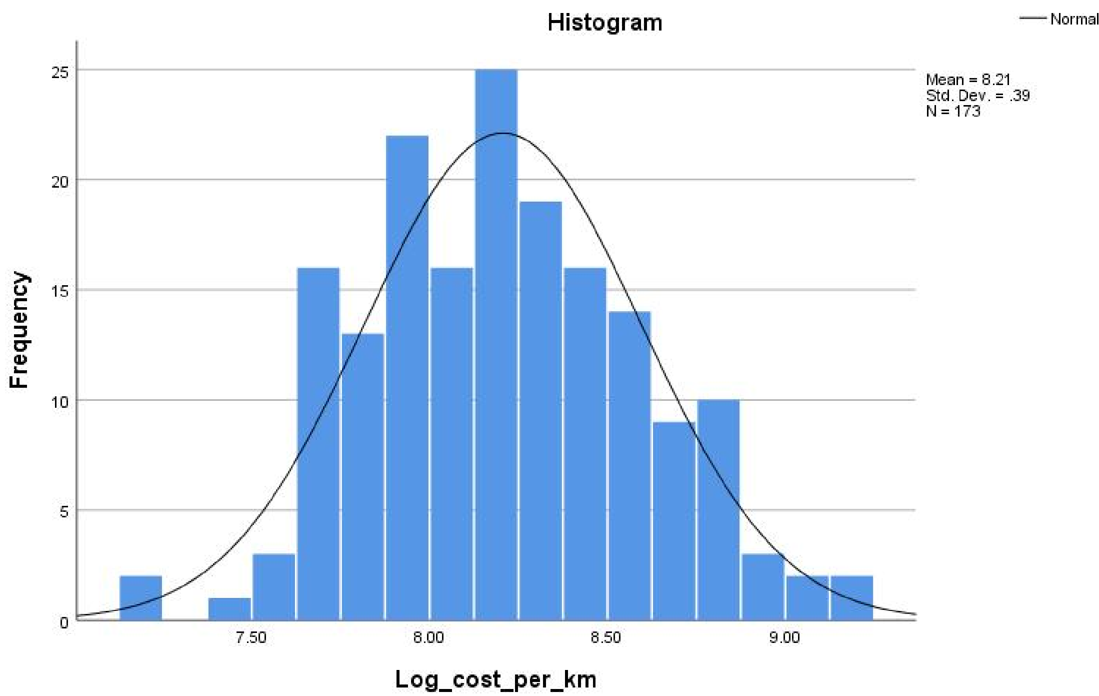
Comm.	Commencement Date

date	
Compl. Date	Completion Date
A	Exterded completion date-Commencement date (weeks).
B	Completion date - Commencement date (weeks). **Completion date - Commencement date (weeks).**

APPENDIX B

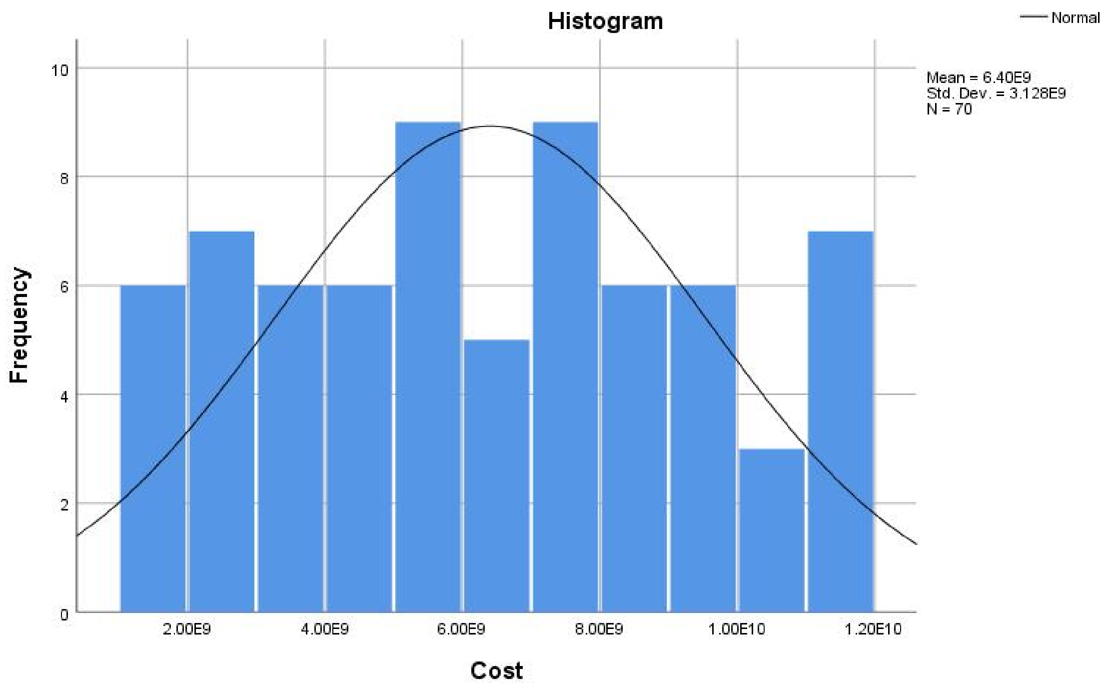
Normality Curves for Independent Variables.

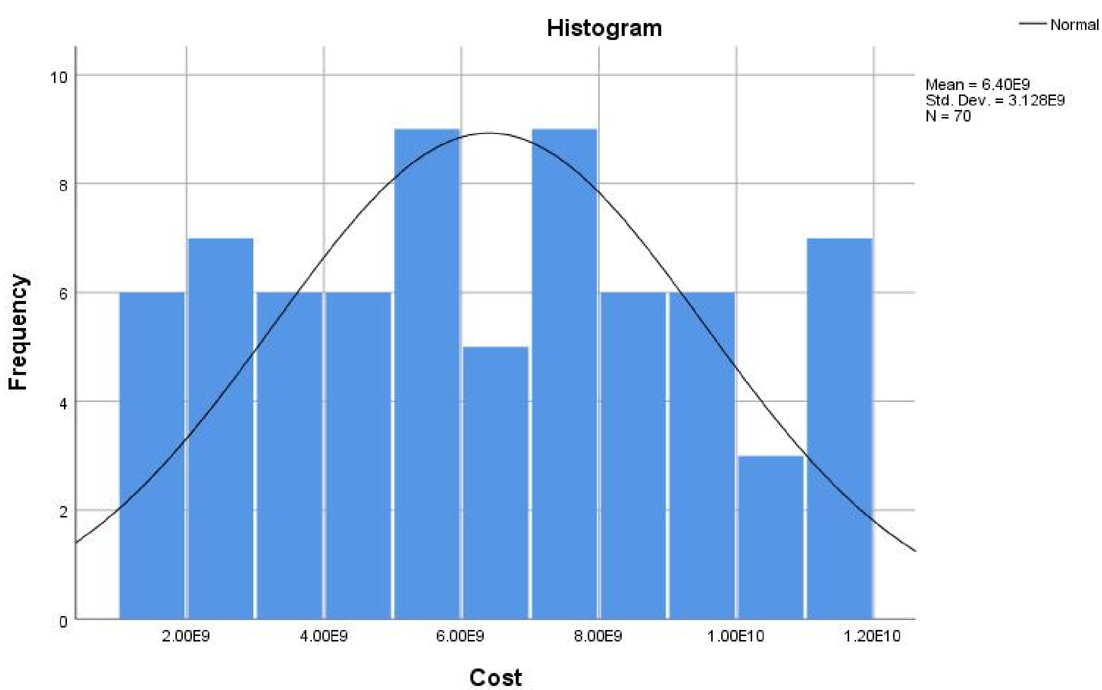
Figure 1: Normality Curve for Log Cost per kilometer in Nigeria.



Normality Curves for Independent Variables (Continued)

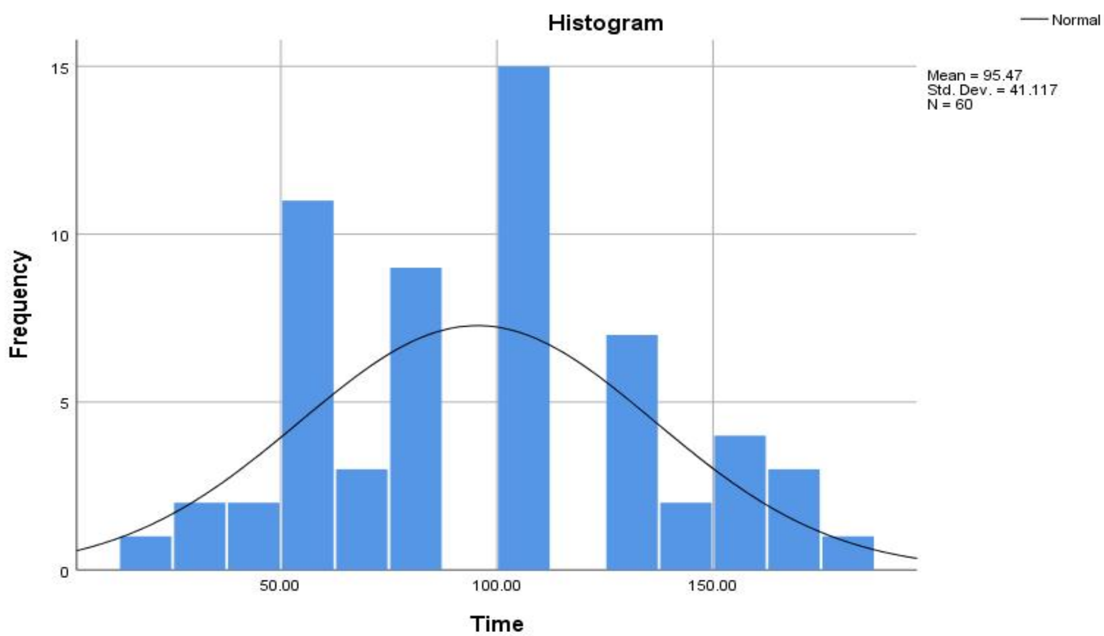
Figure 2: Normality Curve for Initial Cost in Nigeria.





Normality Curves for Independent Variables (Continued)

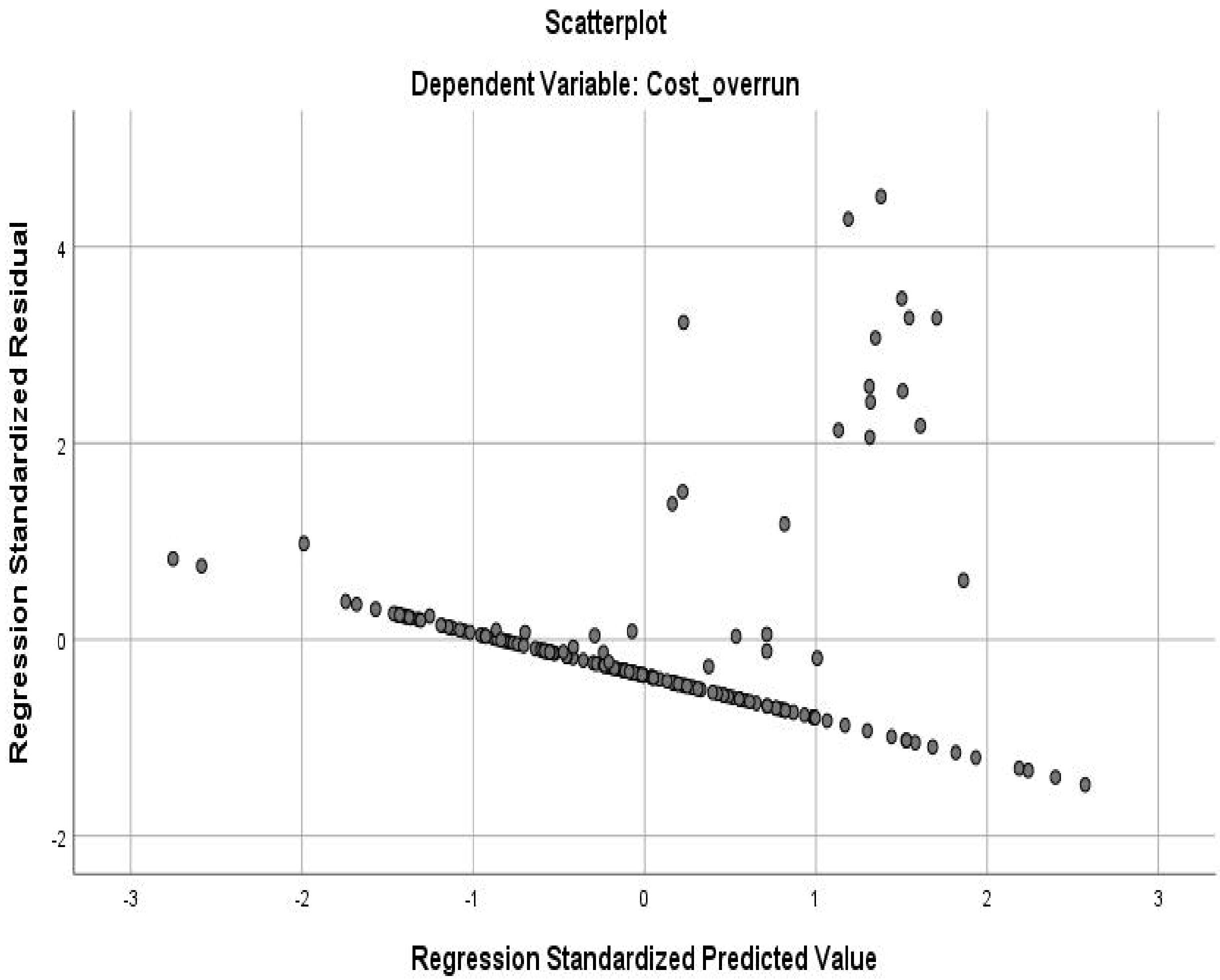
Figure 1: Normality Curve for Initial Time in Nigeria.



APPENDIX C

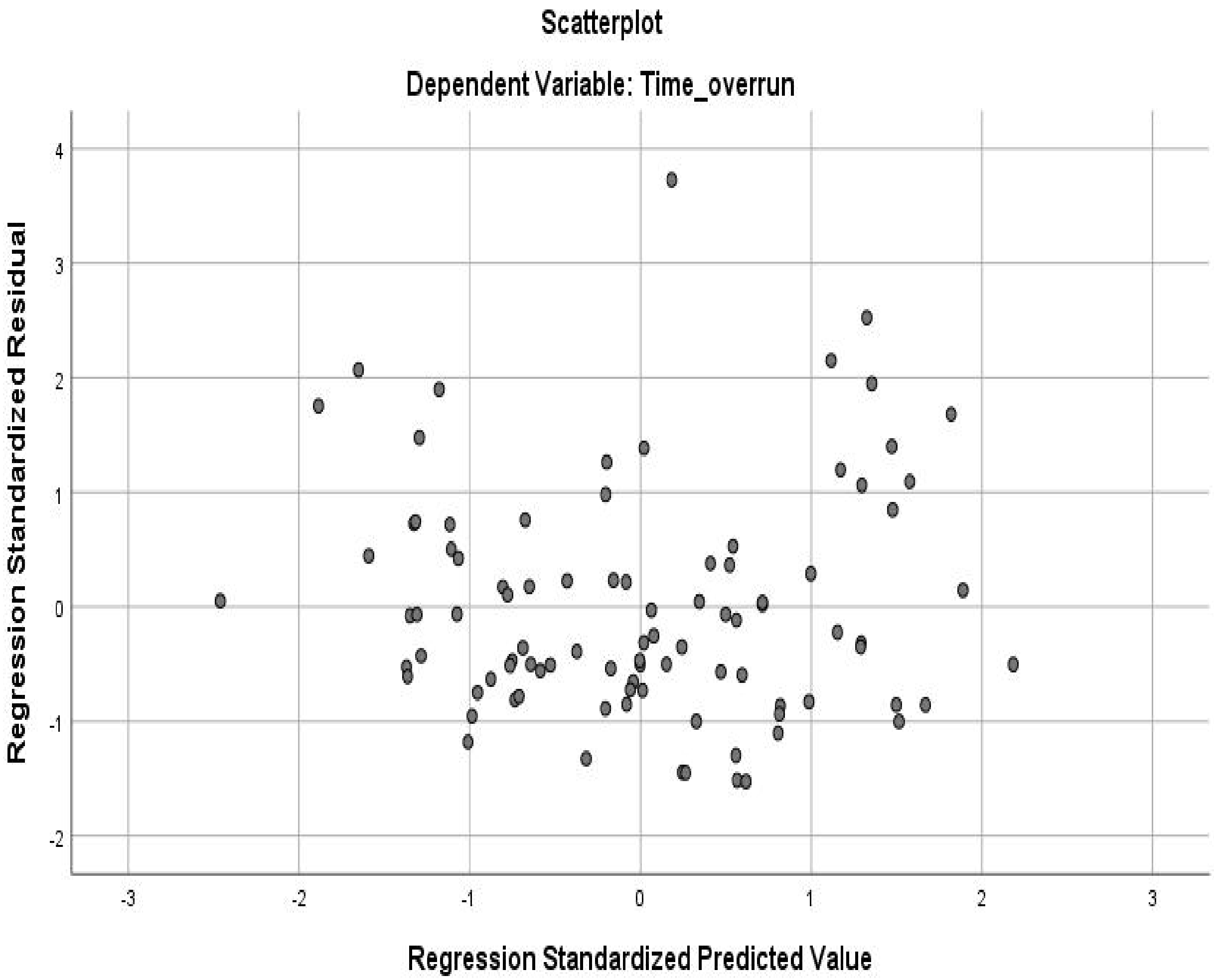
Homoescedasticity Graphs

Figure 4.1: Homoescedasticity Graphs of Cost Overrun Model Using Log Ckm in Nigeria.



Homoescedasticity Graphs (Continued)

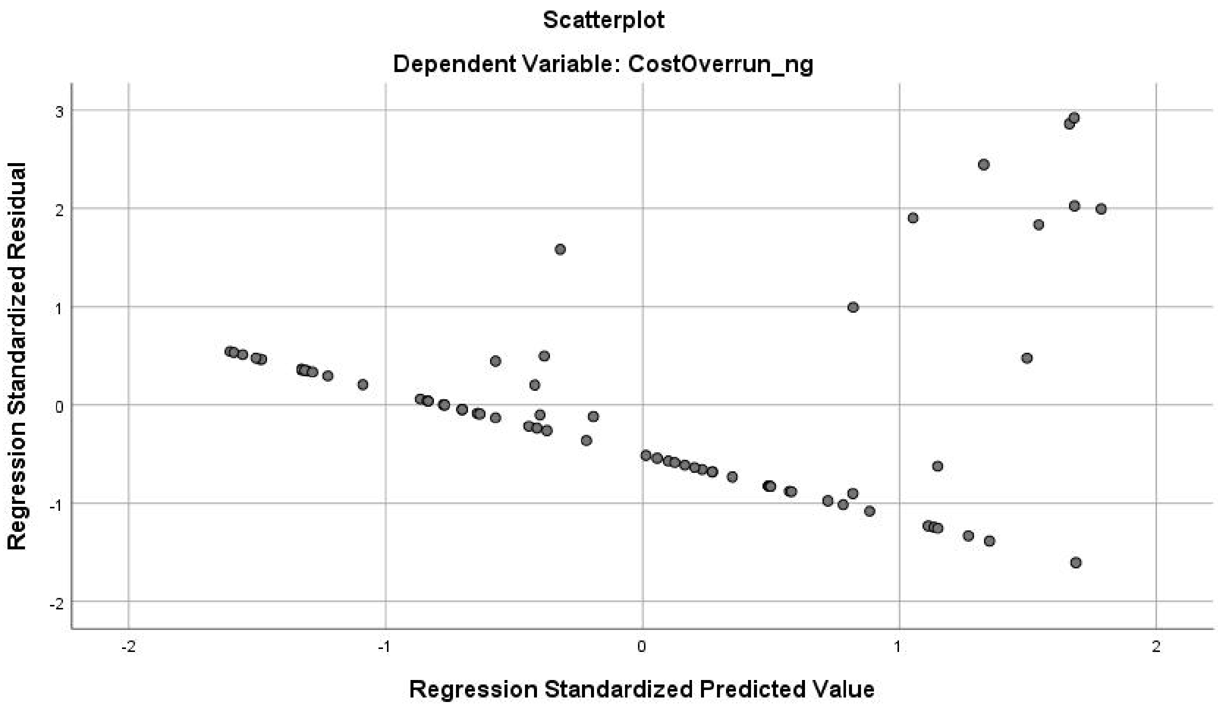
Figure 4.2: Homoescedasticity Graphs of Time Overrun Model Using Log Ckm in Nigeria.



APPENDIX D

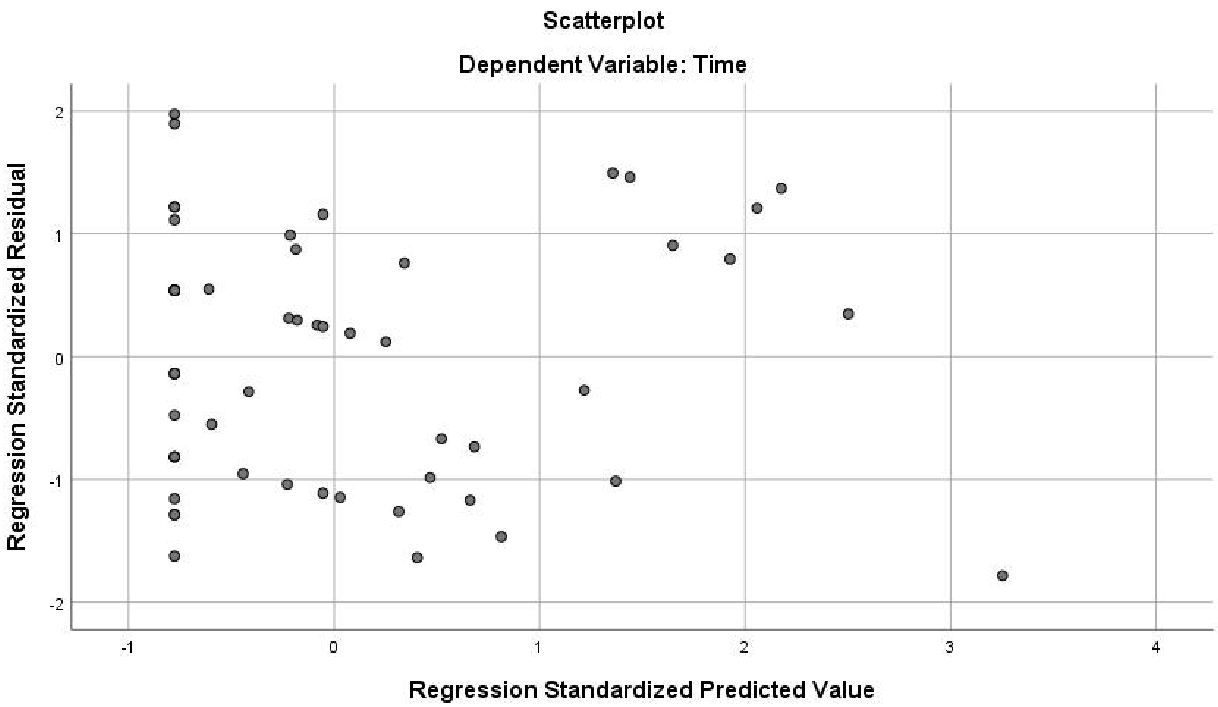
Homoescedasticity Graphs (Continued)

Figure 4.3: Homoescedasticity Graphs of Cost Overrun Model Using Initial Cost in Nigeria.



Homoescedasticity Graphs (Continued)

Figure 4.4: Homoescedasticity Graphs of Time Overrun Model Using Initial Time in Nigeria.



APPENDIX E

Correlation Scatterplots

Figure 4.5: Scatterplot illustration the relation between cost per km and cost overrun in Nigeria.

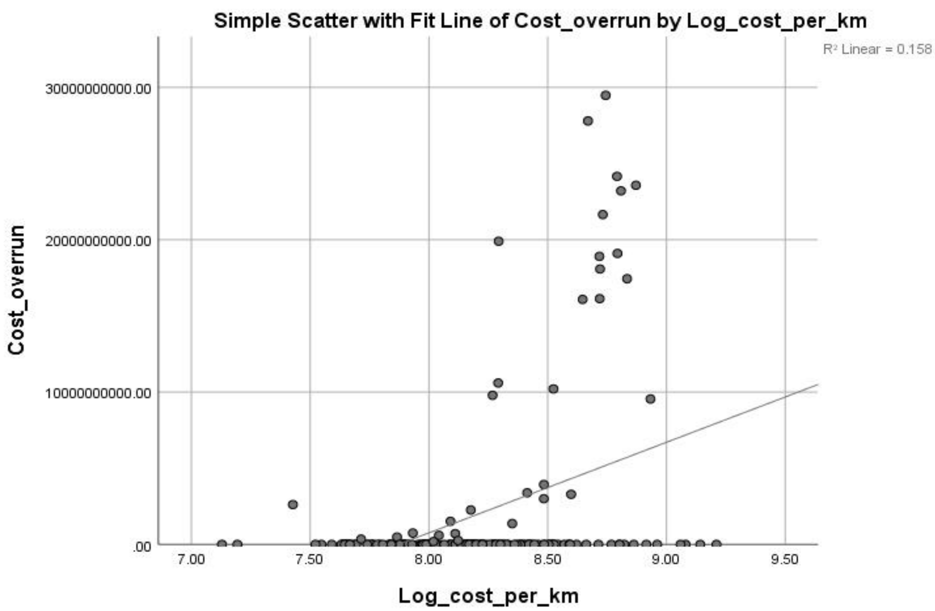
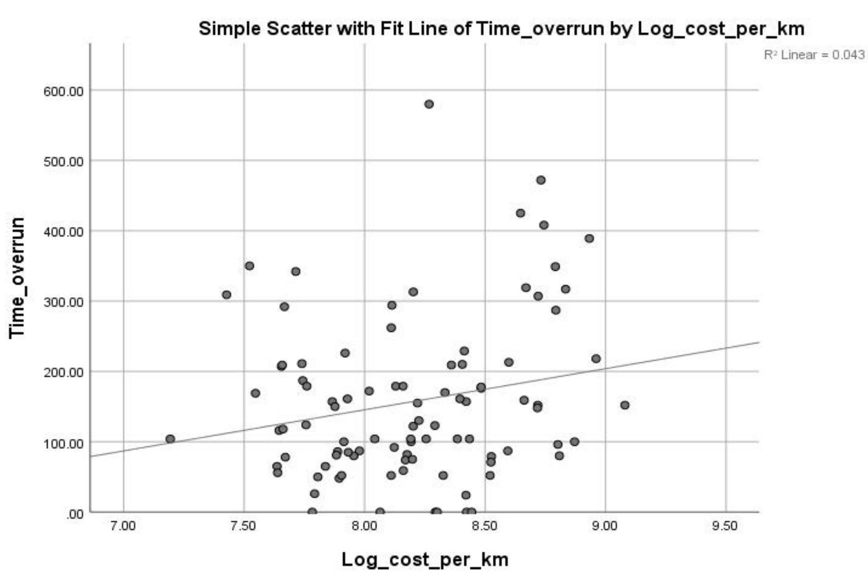


Figure 4.6: Scatterplot illustration the relation between cost per km and cost overrun in Nigeria.



Correlation Scatterplots (Continued)

Figure 4.7: Scatterplot illustration the relation between cost per km and cost overrun in Nigeria.

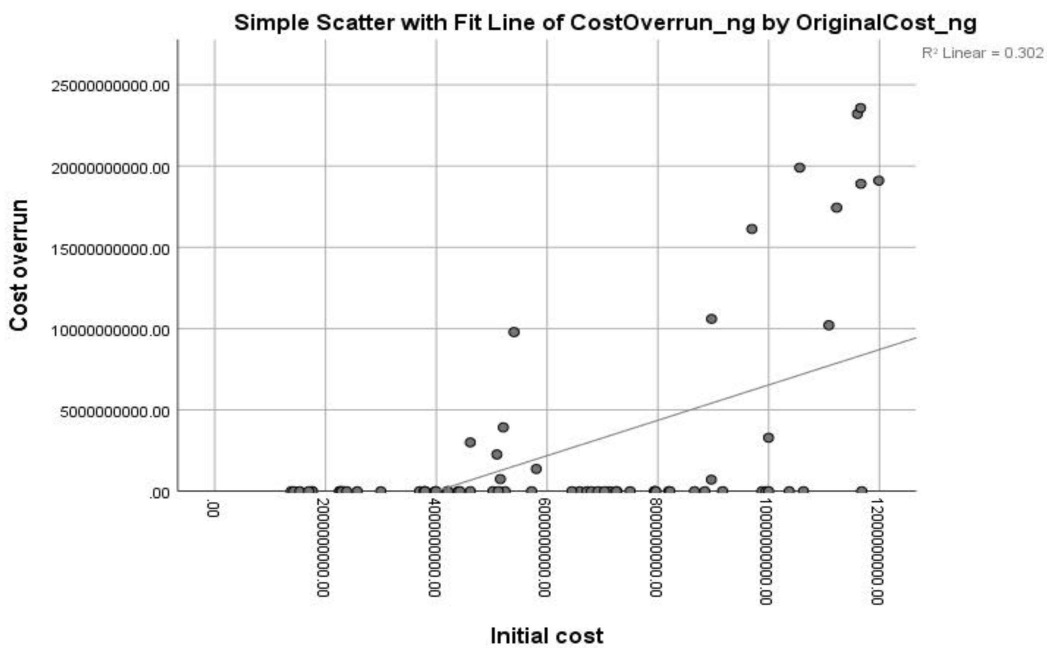


Figure 4.8: Scatterplot illustration the relation between cost per km and cost overrun in Nigeria.