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The Use of Value Engineering for Optimal Cost Performance in Efficient Road Project Delivery

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ABSTRACT
Despite the efforts of the Nigerian government at the federal, state and municipal levels to improve road networks, the country continues to suffer from bad roads due to frequent failures. The Value Engineering (VE) technique was used in this study to analyze the construction activities and management of three projects in Abuja, Nigeria. The project began with data collecting and ended with a predicting value engineering model for cost reduction while increasing road performance. All of the factors that contribute to cost overruns in road construction projects were considered in the study. The case study was conducted in Abuja, the Federal Capital Territory, with clients, consultants, contractors, subcontractors, project managers, and road users as the target respondents. One hundred fifty (150) questionnaires were distributed to randomly selected respondents, however only 123 (123) were found to be valid for use in this study. The experimental field data was collected at three different road construction sites. The Relative Importance Index (R.I.I) and the Severity Index were used in the ranking process. The value index/value engineering predictive model for long-term road project cost performance was established after the elements impacting the cost and severity of Nigerian road building project performance were uncovered. Cost overruns are mostly caused by project risk and uncertainty, a lack of financial power, indiscriminate design changes, and inadequate material inspection, selection, and testing prior to use, according to the outcomes of this study. The Value Engineering prediction model was created and tested with the goal of preventing project cost overruns as:
$\boldsymbol{\sum_{i=1}^{n} CV = 0.998 + \sum_{i=1}^{n}(1.081F_i) - \sum_{i=1}^{n}(1.792C_i) + \varepsilon}$.
KEYWORDS: *Value Engineering, Road Construction, Cost performance, overruns Index*

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I. Introduction

Poor performance of road construction projects in Nigeria, as in many other countries, has been a major source of worry. Many road construction projects are never completed on time or on budget, and those that are are of poor quality and fail before the design life is reached. Underperformance is also a concern in the construction business (Meyer *et al.*, 2010). Studies have revealed that building projects and the sector as a whole have fared poorly in both developed and developing countries, according to Takim and Akintoye, 2002. Among the factors that contribute to construction delays and subsequent performance problems, according to Faridi and El-Sayegh (2006), are a lack of skilled labor, the use of inappropriate materials, poor supervision and site management; ineffective leadership; shortage and outdated equipment; conflict, poor workmanship, and contractor incompetence (Hanson *et al.*, 2003).

This research was brought up to identify some factors affecting road construction performance in Nigeria. It assessed the most significant factors causing delays in road construction and abandonment in Nigeria and also the performance of the roads. The study also evaluated the effect of Value Engineering (VE) technique as a valid approach for highway construction performance for sustainable road development.

II. Literature Review

Measuring and tracking project performance has relied heavily on performance measurement. It is the usual approach for collecting and reporting information relating to the inputs, efficiency, and effectiveness of a construction project, according to Takim *et al.*, 2003. Furthermore, Chan, 2001; Love and Holt, 2000; believe that measurements are necessary for tracking, forecasting, and regulating essential factors in order to assure project success. According to Atkinson (1999), time, cost, and quality are the most important considerations in project performance measurements. The project manager's main objectives are to minimize time (fast); minimize the cost (cheap) and maximize the project quality (good).

systematic technique to analyzing and improving value in building that is professionally implemented. Its purpose is to achieve value for money (Shen and Liu, 2003) by lowering building costs while enhancing performance and quality.

2.1 Cost Performance Measure

The degree to which general conditions encourage the execution of a project within the estimated budget is referred to as cost performance. Cost variance is a technique used in the construction industry by Salter and Torbett to measure the design performance of a project. Furthermore, the cost variance technique does not only apply to the computation of the tender sum, but also to the total costing of a project from start to finish. Cost variance is measured in terms of unit cost, percentage of net variation over the final cost, according to Chan and Tam, 2000. Furthermore, Andi and Minato (2003) employed cost variance in their research to assess project performance in a building project with design flaws. Georgy *et al.*, 2005 also suggested using cost as a metric for evaluating engineering project performance.

Aside from cost variance, the cost performance index (CPI) has been used to assess a project's reliability and confidence in its outcomes. The following is the formula for the elements and their indication:

a) ***Cost Variance (CV):*** This can be calculated as shown in Equation 1.

$$CV = BCWP - ACWP \quad \textbf{(1)}$$

Where:

BCWP is the Budgeted Cost of Work Performed and

ACWP is the Actual Cost of Work Performed.

When the value of CV equals 0, the project is ideally on budget. When the CV value is larger than zero, the project's earnings are greater than the expected earnings, indicating that the project is under budget. When the CV value is less than zero, it signifies that the project's earnings are lower than expected, and so the project is over budget..

b) ***Cost Performance Index (CPI):*** This can be calculated as shown in Equation 2.

$$CPI = \frac{BCWP}{ACWP} \quad \textbf{(2)}$$

When the CPI number equals one, the project is ideally on budget. A CPI score of less than one indicates that the project is over budget. When the CPI value is larger than one, the project is on time and on budget. A project that is performing well must keep its CPI value as close to one as possible.

2.2 Value Engineering in Construction

Construction projects are increasing in size and breadth as a result of modern technical advancements. Construction firms are frequently under pressure to complete projects at a lower cost while retaining design quality. Engineers are increasingly seeking for solutions to cut construction costs without sacrificing quality or functionality; nevertheless, their approach is primarily based on previous experiences. To boost competitiveness, it's been normal practice to keep expenses down using traditional approaches. Everyone promotes the concept of saving money while also giving higher value. Value Engineering (VE) is a method of achieving the best possible value for money. It became comparably easier to lower construction costs as science and technology advanced, but the concept of functional utility was not given proper consideration, and reliability and durability were the least considered. Engineers have begun to consider these crucial criteria, such as reliability and durability, as well as practical utility, in order to reduce infrastructure costs.

As such, Value Engineering (VE) is the systematic application of known approaches to determine the function of a product or service, assign a monetary value to the function, and provide the required function reliably at the lowest overall cost. It is connected to the lowest cost of a project or building activity without compromising quality in civil engineering. Engineers typically design the projects, which are then built by contractors. According to Deodhar (2010), an engineer's role is to design a project in such a way that it is economical in terms of cost and output. The job of contractor thereafter is to apply his skill to construct the project at the estimated cost, or if possible even less but with the ultimate goal of having value for money

2.3 Value Engineering Process and Study

VE is an organized problem-solving approach for increasing the value of a system based on function analysis. Because value is defined as a function to cost ratio, it may be raised by either improving the function or lowering the cost. The VE study is usually carried out by a group of people with diverse backgrounds and expertise. First, the VE team uses a "how why" questioning technique to determine the functional linkages in a system. The VE team then creates a matrix that compares the system's various functions to their associated expenses.

An optimal tradeoff between the functions and their associated costs maximizes the system's value. The goal of the VE study in the context of construction is to provide the required functionality at the lowest project life cycle cost. This can be accomplished through the use of novel materials, innovative construction methods, simpler construction processes, decreased construction costs and time, enhanced construction quality and safety, and low environmental impact.

Value engineering, according to Yung and Yip (2010), focuses on the analysis of research objective functional impact and aims to achieve the required function reliably at the lowest life cycle cost in order to gain the best integrated benefits. The basic formula for it is:

$$V_i = \frac{F_i}{C_i} \quad \text{or} \quad V_i = \frac{What\ you\ get\ (want)}{What\ you\ pay} \qquad (3)$$

Where:

V_i is value index of the i scheme,

F_i is the function coefficient of the i scheme, also termed as what you get (want);

C_i is cost coefficient of the i scheme, also termed as what you pay.

The VE study is composed of six phases: Information, Function, Creativity, Evaluation, Development, and Presentation phase. A higher value or value coefficient is achieved at a lower life cycle cost. The scheme with the highest value or value index should be selected as the optimal scheme. According to Jiayou and Yanxin, 2009, the step by step general programs for applying value engineering to evaluate the schemes include identifying research objective, objective functions analysis, objective cost analysis, scheme evaluation and analysis.

2.4 Previous Reviews on Use of Value Engineering Technique

According to Boo *et al.* (2009), applying value engineering to building projects has proven to be an effective strategy to reduce project costs. In the past, various value models were developed and employed in construction projects.

According to Sungwoo *et al*. (2012), value engineering is an endeavor to increase the value of a system using a creative and systematic approach. Idea generation is the most crucial aspect of a VE task plan.

Kelly *et al*. (2004) conducted a detailed evaluation of construction briefing studies. The evaluation concluded that the current briefing guides' key flaws were that they were too generic and implicit to provide actual support to clients and designers, and that they showed what should be done without explaining how it should be done. They concluded by recommending that the briefing guide be developed using Value Engineering (VE).

Tae *et al*. (2015) in their conclusions stated that using a systematic value engineering process to produce cost-effective design alternatives can be advantageous.

III. Methodology

The Study Area

The survey will take place at three road building locations in Abuja, in the Federal Capital Territory (FCT). Commercial viability, social standing, economic factors, and geographical accessibility were used to select locations that offer potential in construction, consulting, manufacturing, agricultural, telecommunications, marketing, legal, health, and technology advancement. The research regions in Nigeria are depicted in Figure 1 as a map.

Figure 1: Map of Nigeria showing study areas (Oluyemi-Ayibiowu *et al*., 2019)

Data Source/Research Methodology

A systematic technique known as task planning is used in the value engineering study. The work plan outlines particular ways for analyzing a product or service efficiently in order to produce the greatest number of alternatives to meet the product's or service's needed functions. Following the employment plan will help to ensure that you get the most out of your job while also giving you more flexibility.

The VE task plan covers three major periods of activity: Pre-study, the Value study, and Post study as shown in Figure 2. All phases and steps were performed sequentially (The Value Society, 2007).

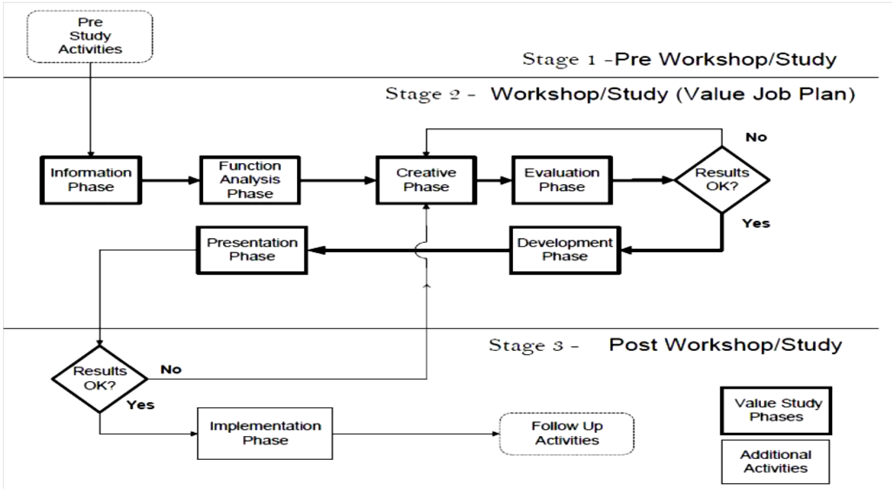

Figure 2: The Job Plan (Om and Anil, 2013)

A. Pre-Study

Pre-study tasks involved six areas: collect user/customer attitudes, complete data file, determine evaluation factors, scope the study, building physical road-models, and determine team composition.

B. Value Engineering (VE) Study

The VE for this study comprised four phases: Information, Speculation/Creativity, Evaluation and Development & Presentation phase.

C. Post-Study

The goal of post-study actions is to guarantee that the authorized value study change recommendations are followed. Individuals and management made assignments to other members of the VE study team to perform the duties connected with the approved implementation plan.

Procedure or Methodology of Value Engineering Study

A. *Information phase:*

The main importance of this phase is to identify the Basic and Secondary functions of each and individual road elements/components.

The findings in this phase were:

- elements of road that majorly cause delay (T_i) or even road project abandonment if not properly managed?
- the main or primary functional performance (F_i) required of the individual road elements mentioned above? For example: pavement section, drainage, earthwork etc.
- other functional performances (F_i)?
- the cost (C_i) implication for construction and maintenance of such road element or component?
- the value (V_i) of each road elements?

B. *Function Analysis Phase*: In the Function Analysis Phase, according to Department of defence, 2011, Amit and Belokar, 2012, the team performs the following: determination of functions, classification, building of modelled. Other duties of the team include estimation of the cost of performing each function, determination of the best opportunities for improvement, and refines of study scope.

C. *Creative Phase:* The Creative Phase's major task is to come up with new ways to fulfill each function that has been chosen for further investigation. The goal of the creativity phase is to generate a large number of ideas for executing each of the functions being studied (Om and Anil, 2013). This is a form of creative activity that is unrestricted by habit, tradition, negative attitudes, presumed limitations, or specified criteria. During this activity, no judgment or discussion is made (Department of defence, 2011).

D. *Evaluation Phase:* Ranking and rating alternative ideas is a crucial activity, according to Amit and Belokar (2012), and ideas for development are selected. The evaluation phase's goals are to synthesis the ideas and concepts developed during the creativity phase and to choose viable ideas for development into particular value enhancements. Ideas are selected and assessed according to how well they fulfill the evaluation criteria established during the pre-study process (Department of defence, 2011).

E. *Development Phase:* To increase the project's value, the Development Phase considers the most viable options and provides information such as sketches, narratives, and specifications (Abeer and Mohammed, 2015). The data package produced by each alternative's champion contains as much technical, cost, and schedule information as possible, allowing the designer and project sponsor to make an early assessment of their potential for implementation (The Value Society, 2007).

F. *Presentation Phase:* The presentation phase entails presenting the best options to people with the authority to put the offered solutions into action if they are accepted (Amit and Belokar, 2012). The team obtains either approval to proceed with implementation or instruction for additional information needed through the presentation and interactive conversations (Om and Anil, 2013).

Population Sampling And Questionaire Design

The total representative sample, n, and population size, n, for this study were obtained using the simple random sampling (srs) approach, in which items from the population can only be selected one at a time for inclusion in the sample. This ensures that everyone in the population has an equal chance of being picked for the study. Clients, consultants, contractors, and site engineers/supervisors were the targeted groups at the three road building sites. The sample size, n, was calculated as follows:

$$\text{n} = n'/[1 + \left(\frac{n'}{N}\right] \quad (Mahmoud, 2012) \tag{2}$$

where :

n = total number of population
n = sample size from finite population
n' = sample size from infinite population = S^2/V^2
where:
S^2 is the variance of the population elements and
V^2 is a standard error of sampling population
usually s = 0.5 and v = 0.06 (Assaf *et al.*, 2001, and Moore *et al.*, 2003)

The calculated sample size from the field population size was one hundred and fifty(150). Therefore one hundred and fifty-questionnaire were administerd for the research.

Descriptive Analysis

The SPSS software was used in this research to carry out a descriptive statistical analysis on the collected data. The measure of variability was carried out for all data collected and this revealed some significant information about the data collected. Variability analysis was carried out to give the spread or dispersion of the responses collected. This analysis consisted of data such as the range, standard deviation and the skewness.

- The range is the crudest measure of variability but does give an indication of the spread of the responses when ordered.
- Standard deviation (sd) quantifies variability or scatter. This common measure of variability is most appropriate when one has normally distributed data, although the mean of ranked ordinal data may be useful in some cases.
- Skewness refers to a frequency distribution's lack of symmetry. Positive skew is seen in distributions with a long "tail" to the right, while negative skew is found in distributions with a long "tail" to the left. A variable is considered to deviate from normal if its frequency distribution has a substantial (plus or minus) skewness value.

Relative Importance Index (R.I.I) Analysis

The relative importance index method (rii) was used to determine the respondents' perception of the level of importance of the highway project delay factors and their severity level. the formula used for calculating the relative importance index (rii) is as follows:

$$\text{relative important index (r.i.i)} = \frac{5_{n_5} + 4_{n_4} + 3_{n_3} + 2_{n_2} + 1_{n_1}}{5\text{n}} \tag{3}$$

where:

n_5 is number of respondent for strongly influence

n_4 is number of respondent for little influence
n_3 is number of respondent for may or may not influence.
n_2 is number of respondent for no influence.
n_1 is number of respondent for virtually no influence.
n is total number of respondent.
a is highest weight (as shown in table 1, where a is 5)
n is variable expressing frequency of *i*
a_i is constant expressing weight given to *i*th response: i = 1,2,3,4,5.
Severity level is calculated as R.I.I × 100.

Table 1: Linkert Scale showing ranking and weights

Item	Strong Influence	Little Influence	May or may not Influence	No Influence	Virtually no Influence
Description	Extremely Important	Important	Moderately Important	Not Important	Extremely non-Important
Weights	5	4	3	2	1

Predictive Regression Model

The multiple linear regression model was used as the predictive model. The regression analysis was done using SPSS software. The Cost Value Engineering Prediction Model (CVEPM) for Road Construction project was developed in the form of equation: $Y= \beta_\circ + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$. The Cost value (**CV**) was expressed as $\boldsymbol{\beta_\circ + \beta_1 T_1 + \beta_2 F_2 + \varepsilon}$ where cost (c) and function (f) were the independent variables. The multiple Regression square (R^2) for the model was also determined.

IV Result and Discussion

The analysis of the data collected and the results obtained are presented and discussed as follow;

Descriptive Analysis Result

The Mean, Range, Standard deviation, Variance statistics, and Skewness for the twenty-six (26) identified factors influencing cost overrun according to respondents is shown in Table no2. It showed the measures of variability in the data that was gathered. The range of agreement to importance of each factors was four (4), ranging from one (1) to five (5). The Standard error of each indicator was 0.218, which was relatively small enough to conclude that all the respondents agreed on its importance

Table no2: The Mean, Range, Standard deviation, Variance statistics, and Skewness for factors affecting project cost.

Factors I.D	Range Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Deviation Statistic	Variance Statistic	Skewness	
							Statistic	Std. Error
Q15.1	4	1	5	3.93	1.430	2.045	-.995	.218
Q15.2	4	1	5	3.63	1.393	1.941	-.708	.218
Q15.3	4	1	5	3.60	1.551	2.406	-.568	.218
Q15.4	4	1	5	3.72	1.485	2.205	-.749	.218
Q15.5	4	1	5	3.65	1.402	1.967	-.713	.218
Q15.6	4	1	5	3.71	1.475	2.176	-.680	.218
Q15.7	4	1	5	3.92	1.458	2.124	-.971	.218
Q15.8	4	1	5	3.61	1.458	2.125	-.616	.218
Q15.9	4	1	5	3.91	1.426	2.033	-.961	.218
Q15.10	4	1	5	3.85	1.477	2.181	-.878	.218
Q15.11	4	1	5	3.19	1.570	2.465	-.070	.218
Q15.12	4	1	5	3.82	1.432	2.050	-.872	.218
Q15.13	4	1	5	3.79	1.467	2.152	-.782	.218
Q15.14	4	1	5	2.93	1.579	2.495	.160	.218
Q15.15	4	1	5	2.89	1.608	2.587	.199	.218
Q15.16	4	1	5	3.15	1.540	2.372	-.058	.218
Q15.17	4	1	5	2.75	1.662	2.764	.279	.218
Q15.18	4	1	5	2.52	1.533	2.350	.599	.218
Q15.19	4	1	5	2.28	1.496	2.238	.829	.218
Q15.20	4	1	5	3.87	1.402	1.967	-.943	.218
Q15.21	4	1	5	3.77	1.503	2.259	-.766	.218
Q15.22	4	1	5	3.78	1.417	2.009	-.779	.218

Q15.23	4	1	5	3.45	1.505	2.266	-.359	.218
Q15.24	4	1	5	3.42	1.510	2.279	-.358	.218
Q15.25	4	1	5	3.43	1.563	2.444	-.380	.218
Q15.26	4	1	5	3.46	1.495	2.234	-.489	.218
Valid N (listwise)	123							

Ranking Analysis Result for the Cost overrun Risk Factors

Table no 3 revealed the mean value, relative importance index (RII) for twenty-six (26) cost influencing factors and their severities (in percentages). From table 3, According to the respondents, the five (5) most severe factors affecting cost are: risk and uncertainty associated with projects (92.2 percent severity), lack of financial power (91.8 percent severity), indiscriminate change in design/works (91.6 percent severity), improper material inspection, selection, checking & testing (90.7 percent severity), and subgrade conditions (90.1 percent severity), among others.

Table no3: Ranking Result for identified twenty-six (26) cost overrun factors

I.D	CRITERIA	n1	n2	n3	n4	n5	TOTAL	R.I.I	S.I (%)	RANK
Q15.1	Risk and uncertainty associated with projects	13	13	12	16	69	123	0.922	92.19	1
Q15.7	Lack of financial power	14	13	12	14	70	123	0.918	91.81	2
Q15.9	Indiscriminate Change in design/works (variations)	13	13	13	17	67	123	0.916	91.62	3
Q15.20	Improper material Inspection, selection, checking and testing before usage in accordance with specifications in contract	13	13	12	24	61	123	0.907	90.67	4
Q15.10	Subgrade conditions	15	14	12	16	66	123	0.901	90.10	5
Q15.12	Shop drawing	14	14	12	23	60	123	0.895	89.52	6
Q15.13	Sample approvals	14	17	12	18	62	123	0.888	88.76	7
Q15.22	Poor management commitment and leadership styles	13	15	16	21	58	123	0.886	88.57	8
Q15.21	Poor construction techniques	16	15	14	14	64	123	0.884	88.38	9
Q15.4	Equipment (what effect does equipment failure have in delaying your construction project?)	17	14	13	22	57	123	0.870	87.05	10
Q15.6	Use of unskilled or inexperienced operators	15	17	15	18	58	123	0.869	86.86	11
Q15.5	Non-measurement of equipment productivity	15	15	14	33	46	123	0.855	85.52	12
Q15.2	Manpower (Labor)	15	16	12	37	43	123	0.850	84.95	13
Q15.8	Construction mistakes	17	14	19	23	50	123	0.846	84.57	14
Q15.3	Unavailability of good quality construction materials	19	18	13	16	57	123	0.844	84.38	15
Q15.26	Project fraud and corruption	21	14	19	25	44	123	0.811	81.14	16
Q15.23	Poor motivation system (incentives)	18	21	20	16	48	123	0.808	80.76	17
Q15.25	Unstable interest rate	21	22	12	19	49	123	0.804	80.38	18
Q15.24	Unstable government policies	18	25	12	23	45	123	0.802	80.19	19
Q15.11	Permits	23	30	13	15	42	123	0.747	74.67	20
Q15.16	Non-performance of subcontractors and nominated suppliers	23	31	11	21	37	123	0.737	73.71	21
Q15.14	Weak regulation and control	31	30	13	15	34	123	0.686	68.57	22
Q15.15	Improper selection criteria of contractor and designer	33	31	10	14	35	123	0.678	67.81	23
Q15.17	Contract documents	45	20	12	13	33	123	0.644	64.38	24
Q15.18	Conflict between project parties (Disputes)	43	33	12	10	25	123	0.590	59.05	25

Q15.19	Industrial disputes	55	27	12	9	20	123	0.535	53.52	26

Ranking Result for Individual Highway Activities Functional Requirements

Table no4 showed the ranking for the highway activities (sub-grade, sub-base, base, surfacing, drainage and road marking) according to their functional requirement (i.e. influenced by functional factor [Fi]). From the Severity index (S.I) result of table 4, the subgrade-activities-dumping (S-G-Act-Dump showed the least SI value for the sub-grade activities with SI value of 32.95%. The least severity index result was shown by sub-base-activities-dumping (S-B-Act-Dump) activity for the sub-base with SI value of 32.95%, base-course-activities-dumping (B-C-Act-Dump) with SI value of 31.81% for the base course, surfacing-activities-curing (S-Act-Curing)) activity with SI value of 31.81% for the surfacing ,drainage-culvert-activities-casting (D-C-Act-Cast) activity with SI value of 32.00% for the drainage while the manual road marking method had the least SI value.

Table no 4: Ranking according to Individual Activities' Functional Requirement

S/N	CRITERIA	n1	n2	n3	Fi	
					R.I.I	S.I (%)
Q16.A1	subgrade-materials-natural (S-G-Mat-Nat)	62	43	18	0.385	38.48
Q16.A2	subgrade-materials-stabilized (S-G-Mat-Stab)	14	30	79	0.592	59.24
Q16.B1	subgrade-methods-manual (S-G-Meth-Man)	96	15	12	0.309	30.86
Q16.B2	subgrade-methods-mechanical (S-G-Meth-Mech)	9	27	87	0.617	61.71
Q16.C1	subgrade-activities-winning (S-G-Act-Win)	15	37	71	0.575	57.52
Q16.C2	subgrade-activities-loading (S-G-Act-Load)	14	88	21	0.482	48.19
Q16.C3	subgrade-activities-hauling (S-G-Act-Haul)	75	39	9	0.343	34.29
Q16.C4	subgrade-activities-dumping (S-G-Act-Dump)	88	20	15	0.330	32.95
Q16.C5	subgrade-activities-compaction (S-G-Act-Comp)	9	17	97	0.636	63.62
Q17.A1	sub-base-materials-natural (S-B-Mat-Agg)	16	17	90	0.610	60.95
Q17.A2	sub-base-materials-stabilized (S-B-Mat-Stab)	97	10	16	0.314	31.43
Q17.B1	sub-base-methods-manual (S-B-Meth-Man)	98	11	14	0.309	30.86
Q17.B2	sub-base-methods-mechanical (S-B-Meth-Mech)	11	23	89	0.617	61.71
Q17.C1	sub-base-activities-winning (S-B-Act-Win)	17	33	73	0.575	57.52
Q17.C2	sub-base-activities-loading (S-B-Act-Load)	16	84	23	0.482	48.19
Q17.C3	sub-base-activities-hauling (S-B-Act-Haul)	77	35	11	0.343	34.29
Q17.C4	sub-base-activities-dumping (S-B-Act-Dump)	90	16	17	0.330	32.95
Q17.C5	sub-base-activities-compaction (S-B-Act-Comp)	11	13	99	0.636	63.62
Q18.A1	base-course-materials-natural (B-C-Mat-Agg)	66	41	16	0.373	37.33
Q18.A2	base-course-materials-stabilized (B-C-Mat-Stab)	18	28	77	0.581	58.10
Q18.B1	base-course-methods-manual (B-C-Meth-Man)	100	13	10	0.297	29.71
Q18.B2	base-course-methods-mechanical (B-C-Meth-Mech)	13	25	85	0.606	60.57
Q18.C1	base-course-activities-winning (B-C-Act-Win)	19	35	69	0.564	56.38
Q18.C2	base-course-activities-loading (B-C-Act-Load)	18	86	19	0.470	47.05
Q18.C3	base-course-activities-hauling (B-C-Act-Haul)	79	37	7	0.331	33.14
Q18.C4	base-course-activities-dumping (B-C-Act-Dump)	92	18	13	0.318	31.81
Q18.C5	base-course-activities-compaction (B-C-Act-Comp)	13	15	95	0.625	62.48
Q18.C6	base-course-activities-primming (B-C-Act-Prim)	15	12	96	0.623	62.29
Q19.A1	surfacing-materials-natural (S-Mat-Nat)	64	45	14	0.373	37.33
Q19.A2	surfacing-materials-stabilized (S-Mat-Stab)	16	32	75	0.581	58.10
Q19.B1	surfacing-methods-manual (S-Meth-Man)	98	17	8	0.297	29.71
Q19.B2	surfacing-methods-mechanical (S-Meth-Mech)	11	29	83	0.606	60.57

Q19.C1	surfacing-activities-wetting (S-Act-Wet)	17	39	67	0.564	56.38
Q19.C2	surfacing-activities-brushing (S-Act-Brush)	16	90	17	0.470	47.05
Q19.C3	surfacing-activities-tack coating (S-Act-Tack)	77	38	8	0.337	33.71
Q19.C4	surfacing-activities-curing (S-Act-Curing)	90	22	11	0.318	31.81
Q19.C5	surfacing-activities-asphalt laying (S-Act-Asph)	11	19	93	0.625	62.48
Q20.A1	drainage-culvert-materials-cast (D-C-Mat-Cast)	65	45	13	0.370	36.95
Q20.A2	drainage-culvert-materials-precast (D-C-Mat-Prec)	17	32	74	0.577	57.71
Q20.B1	drainage-culvert-methods-manual (D-C-Meth-Man)	99	17	7	0.293	29.33
Q20.B2	drainage-culvert-methods-mechanical (D-C-Meth-Mech)	12	29	82	0.602	60.19
Q20.C1	drainage-culvert-activities-excavation (D-C-Act-Exc)	18	39	66	0.560	56.00
Q20.C2	drainage-culvert-activities-blinding (D-C-Act-Blind)	17	90	16	0.467	46.67
Q20.C3	drainage-culvert-activities-forming (D-C-Act-Form)	78	36	9	0.337	33.71
Q20.C4	drainage-culvert-activities-casting (D-C-Act-Cast)	91	22	10	0.314	31.43
Q20.C5	drainage-culvert-activities-backfilling (D-C-Act-Back)	12	19	92	0.621	62.10
Q20.C6	drainage-culvert-activities-paraphet (D-C-Act-Para)	14	16	93	0.619	61.90
Q21.B1	road-marking-manual (R-M-Meth-Man)	18	88	17	0.467	46.67
Q21.B2	road-marking-mechanical (R-M-Meth-Mech)	21	23	79	0.579	57.90

Key 1: Level of importance

n1 Not at all influenced by time factor

n2 Sometimes influenced by time factor

n3 highly influenced by time factor

Ranking Result for Individual Highway Activities Cost Implication

Table no5 showed the ranking of the road construction activities based on how they were influenced by the cost factor (Ci). From the result of table 5, the subgrade-activities-compaction (S-G-Act-Comp) showed the least time factor influence with a severity index (S.I) value of 47.05% for sub-grade, sub-base-activities-dumping (S-B-Act-Dump) with a severity index (S.I) value of 31.62% for sub-base, base-course-activities-dumping (B-C-Act-Dump) with a severity index (S.I) value of 30.48% for base, surfacing-activities-curing (S-Act-Curing) with a severity index (S.I) value of 32.38% for surfacing, drainage-culvert-activities-casting (D-C-Act-Cast) with a severity index (S.I) value of 32.00% for surfacing activities.

Table no 5: Ranking according to Individual Activities' Cost Implication Requirement

S/N	CRITERIA	n1	n2	n3	Ci	
					R.I.I	S.I (%)
Q16.A1	subgrade-materials-natural (S-G-Mat-Nat)	21	88	14	0.455	45.52
Q16.A2	subgrade-materials-stabilized (S-G-Mat-Stab)	8	19	96	0.636	63.62
Q16.B1	subgrade-methods-manual (S-G-Meth-Man)	92	17	14	0.320	32.00
Q16.B2	subgrade-methods-mechanical (S-G-Meth-Mech)	13	25	85	0.606	60.57
Q16.C1	subgrade-activities-winning (S-G-Act-Win)	8	15	100	0.644	64.38
Q16.C2	subgrade-activities-loading (S-G-Act-Load)	24	26	73	0.562	56.19
Q16.C3	subgrade-activities-hauling (S-G-Act-Haul)	16	25	82	0.594	59.43
Q16.C4	subgrade-activities-dumping (S-G-Act-Dump)	26	10	87	0.585	58.48
Q16.C5	subgrade-activities-compaction (S-G-Act-Comp)	14	94	15	0.470	47.05
Q17.A1	sub-base-materials-natural (S-B-Mat-Agg)	26	10	87	0.585	58.48
Q17.A2	sub-base-materials-stabilized (S-B-Mat-Stab)	76	35	12	0.347	34.67

Q17.B1	sub-base-methods-manual (S-B-Meth-Man)	100	14	9	0.295	29.52
Q17.B2	sub-base-methods-mechanical (S-B-Meth-Mech)	13	26	84	0.604	60.38
Q17.C1	sub-base-activities-winning (S-B-Act-Win)	19	36	68	0.562	56.19
Q17.C2	sub-base-activities-loading (S-B-Act-Load)	18	87	18	0.469	46.86
Q17.C3	sub-base-activities-hauling (S-B-Act-Haul)	79	38	6	0.330	32.95
Q17.C4	sub-base-activities-dumping (S-B-Act-Dump)	92	19	12	0.316	31.62
Q17.C5	sub-base-activities-compaction (S-B-Act-Comp)	13	16	94	0.623	62.29
Q18.A1	base-course-materials-natural (B-C-Mat-Agg)	68	44	11	0.360	36.00
Q18.A2	base-course-materials-stabilized (B-C-Mat-Stab)	20	31	72	0.568	56.76
Q18.B1	base-course-methods-manual (B-C-Meth-Man)	97	16	10	0.303	30.29
Q18.B2	base-course-methods-mechanical (B-C-Meth-Mech)	15	28	80	0.592	59.24
Q18.C1	base-course-activities-winning (B-C-Act-Win)	21	38	64	0.550	55.05
Q18.C2	base-course-activities-loading (B-C-Act-Load)	20	89	14	0.457	45.71
Q18.C3	base-course-activities-hauling (B-C-Act-Haul)	76	40	7	0.337	33.71
Q18.C4	base-course-activities-dumping (B-C-Act-Dump)	94	21	8	0.305	30.48
Q18.C5	base-course-activities-compaction (B-C-Act-Comp)	15	18	90	0.611	61.14
Q18.C6	base-course-activities-primming (B-C-Act-Prim)	17	15	91	0.610	60.95
Q19.A1	surfacing-materials-natural (S-Mat-Nat)	66	48	9	0.360	36.00
Q19.A2	surfacing-materials-stabilized (S-Mat-Stab)	18	35	70	0.568	56.76
Q19.B1	surfacing-methods-manual (S-Meth-Man)	95	20	8	0.303	30.29
Q19.B2	surfacing-methods-mechanical (S-Meth-Mech)	13	32	78	0.592	59.24
Q19.C1	surfacing-activities-wetting (S-Act-Wet)	19	42	62	0.550	55.05
Q19.C2	surfacing-activities-brushing (S-Act-Brush)	18	93	12	0.457	45.71
Q19.C3	surfacing-activities-tack coating (S-Act-Tack)	74	41	8	0.343	34.29
Q19.C4	surfacing-activities-curing (S-Act-Curing)	87	25	11	0.324	32.38
Q19.C5	surfacing-activities-asphalt laying (S-Act-Asph)	13	22	88	0.611	61.14
Q20.A1	drainage-culvert-materials-cast (D-C-Mat-Cast)	67	48	8	0.356	35.62
Q20.A2	drainage-culvert-materials-precast (D-C-Mat-Prec)	19	35	69	0.564	56.38
Q20.B1	drainage-culvert-methods-manual (D-C-Meth-Man)	96	20	7	0.299	29.90
Q20.B2	drainage-culvert-methods-mechanical (D-C-Meth-Mech)	14	32	77	0.589	58.86
Q20.C1	drainage-culvert-activities-excavation (D-C-Act-Exc)	20	42	61	0.547	54.67
Q20.C2	drainage-culvert-activities-blinding (D-C-Act-Blind)	19	93	11	0.453	45.33
Q20.C3	drainage-culvert-activities-forming (D-C-Act-Form)	75	39	9	0.343	34.29
Q20.C4	drainage-culvert-activities-casting (D-C-Act-Cast)	88	25	10	0.320	32.00
Q20.C5	drainage-culvert-activities-backfilling (D-C-Act-Back)	14	22	87	0.608	60.76
Q20.C6	drainage-culvert-activities-paraphet (D-C-Act-Para)	16	19	88	0.606	60.57
Q21.B1	road-marking-manual (R-M-Meth-Man)	20	91	12	0.453	45.33
Q21.B2	road-marking-mechanical (R-M-Meth-Mech)	23	26	74	0.566	56.57

Cost Value Ranking Result for Highway methods, materials and activities

Table no6 showed the individual highway methods, material and activities time value and their respective rankings. The time value was calculated as ${F_i}/{C_i}$. From table 6, highway activities with the highest time value for subgrade is subgrade-activities-compaction (S-G-Act-Comp) with cost value of 1.019, for sub-base it is sub-base-activities-dumping (S-B-Act-Dump) with cost value of 1.042, for base it is base-course-activities-dumping (B-C-Act-Dump) with cost value of 1.044, for surfacing it is surfacing-activities-brushing (S-Act-Brush) with cost value of 1.029 and for drainage, it is drainage-culvert-activities-blinding (D-C-Act-Blind) with cost value of 1.029

Table no 6: Cost Value Engineering Ranking Result

ACTIVITY	I.D	DESCRIPTION	R.I.I FUNCTION (Fi)	R.I.I COST (Ci)	COST-Value (Vc)	RANK
SUBGRADE ACTIVITIES	Q16.A2	subgrade-materials-stabilized (S-G-Mat-Stab)	0.592	0.636	0.931	1
	Q16.A1	subgrade-materials-natural (S-G-Mat-Nat)	0.385	0.455	0.845	2
	Q16.B2	subgrade-methods-mechanical (S-G-Meth-Mech)	0.617	0.606	1.019	1
	Q16.B1	subgrade-methods-manual (S-G-Meth-Man)	0.309	0.320	0.964	2
	Q16.C5	subgrade-activities-compaction (S-G-Act-Comp)	0.636	0.470	1.352	1
	Q16.C1	subgrade-activities-winning (S-G-Act-Win)	0.575	0.644	0.893	2
	Q16.C2	subgrade-activities-loading (S-G-Act-Load)	0.482	0.562	0.858	3
	Q16.C3	subgrade-activities-hauling (S-G-Act-Haul)	0.343	0.594	0.577	4
	Q16.C4	subgrade-activities-dumping (S-G-Act-Dump)	0.330	0.585	0.564	5
SUB-BASE ACTIVITIES	Q17.A1	sub-base-materials-natural (S-B-Mat-Agg)	0.610	0.585	1.042	1
	Q17.A2	sub-base-materials-stabilized (S-B-Mat-Stab)	0.314	0.347	0.907	2
	Q17.B1	sub-base-methods-manual (S-B-Meth-Man)	0.309	0.295	1.045	1
	Q17.B2	sub-base-methods-mechanical (S-B-Meth-Mech)	0.617	0.604	1.022	2
	Q17.C4	sub-base-activities-dumping (S-B-Act-Dump)	0.330	0.316	1.042	1
	Q17.C3	sub-base-activities-hauling (S-B-Act-Haul)	0.343	0.330	1.040	2
	Q17.C2	sub-base-activities-loading (S-B-Act-Load)	0.482	0.469	1.028	3
	Q17.C1	sub-base-activities-winning (S-B-Act-Win)	0.575	0.562	1.024	4
	Q17.C5	sub-base-activities-compaction (S-B-Act-Comp)	0.636	0.623	1.021	5
BASE-COURSE ACTIVITIES	Q18.A1	base-course-materials-natural (B-C-Mat-Agg)	0.373	0.360	1.037	1
	Q18.A2	base-course-materials-stabilized (B-C-Mat-Stab)	0.581	0.568	1.023	2
	Q18.B2	base-course-methods-mechanical (B-C-Meth-Mech)	0.606	0.592	1.023	1
	Q18.B1	base-course-methods-manual (B-C-Meth-Man)	0.297	0.303	0.981	2
	Q18.C4	base-course-activities-dumping (B-C-Act-Dump)	0.318	0.305	1.044	1
	Q18.C2	base-course-activities-loading (B-C-Act-Load)	0.470	0.457	1.029	2
	Q18.C1	base-course-activities-winning (B-C-Act-Win)	0.564	0.550	1.024	3
	Q18.C6	base-course-activities-primming (B-C-Act-Prim)	0.623	0.610	1.022	4
	Q18.C5	base-course-activities-compaction (B-C-Act-Comp)	0.625	0.611	1.022	5
	Q18.C3	base-course-activities-hauling (B-C-Act-Haul)	0.331	0.337	0.983	6
SURFACING ACTIVITIES	Q19.A1	surfacing-materials-natural (S-Mat-Nat)	0.373	0.360	1.037	1
	Q19.A2	surfacing-materials-stabilized (S-Mat-Stab)	0.581	0.568	1.023	2
	Q19.B2	surfacing-methods-mechanical (S-Meth-Mech)	0.606	0.592	1.023	1
	Q19.B1	surfacing-methods-manual (S-Meth-Man)	0.297	0.303	0.981	2

	Q19.C2	surfacing-activities-brushing (S-Act-Brush)	0.470	0.457	1.029	1
	Q19.C1	surfacing-activities-wetting (S-Act-Wet)	0.564	0.550	1.024	2
	Q19.C5	surfacing-activities-asphalt laying (S-Act-Asph)	0.625	0.611	1.022	3
	Q19.C3	surfacing-activities-tack coating (S-Act-Tack)	0.337	0.343	0.983	4
	Q19.C4	surfacing-activities-curing (S-Act-Curing)	0.318	0.324	0.982	5
DRAINAGE ACTIVITIES	Q20.A1	drainage-culvert-materials-cast (D-C-Mat-Cast)	0.370	0.356	1.037	1
	Q20.A2	drainage-culvert-materials-precast (D-C-Mat-Prec)	0.577	0.564	1.024	2
	Q20.B2	drainage-culvert-methods-mechanical (D-C-Meth-Mech)	0.602	0.589	1.023	1
	Q20.B1	drainage-culvert-methods-manual (D-C-Meth-Man)	0.293	0.299	0.981	2
	Q20.C2	drainage-culvert-activities-blinding (D-C-Act-Blind)	0.467	0.453	1.029	1
	Q20.C1	drainage-culvert-activities-excavation (D-C-Act-Exc)	0.560	0.547	1.024	2
	Q20.C6	drainage-culvert-activities-paraphet (D-C-Act-Para)	0.619	0.606	1.022	3
	Q20.C5	drainage-culvert-activities-backfilling (D-C-Act-Back)	0.621	0.608	1.022	4
	Q20.C3	drainage-culvert-activities-forming (D-C-Act-Form)	0.337	0.343	0.983	5
	Q20.C4	drainage-culvert-activities-casting (D-C-Act-Cast)	0.314	0.320	0.982	6
ROAD MARKING	Q21.B1	road-marking-manual (R-M-Meth-Man)	0.467	0.453	1.029	1
	Q21.B2	road-marking-mechanical (R-M-Meth-Mech)	0.579	0.566	1.024	2

Cost value multiple linear regression analysis result

Cost-Value (CV) regression model was formulated by importing Time-value data as the dependent variable while keeping functional and cost impact of project resources as the independent variable using SPSS software to give the result shown in Table 7 while table 8 showed the model validation summary of the cost-value model

Table no 7: *Cost Value (CV) Model Coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	.998	.008		121.839	.000	.982	1.015		
	COST	-1.792	.035	-1.985	-51.187	.000	-1.863	-1.722	.220	4.539
	FUNCTION	1.801	.033	2.094	54.007	.000	1.733	1.868	.220	4.539

a. Dependent Variable: VALUE-C

Table no 8: Model summary when Cost value is the Dependent variable

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.977[a]	.954	.952	.030584	.954	478.930	2	46	.000	1.980

a. Predictors: (Constant), TIME, FUNCTION

b. Dependent Variable: VALUE-T

From table 7, The Cost-Value (CV) regression model is shown as:

$Y= \beta_\circ + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon$

$TV=0.998 + 1.801F_1 - 1.792C_2 + \varepsilon$

$\sum_{i=1}^{n} \boldsymbol{CV} = \mathbf{0.998} + \sum_{i=1}^{n}(\mathbf{1.801}\boldsymbol{F_i}) - \sum_{i=1}^{n}(\mathbf{1.792}\boldsymbol{C_i}) + \boldsymbol{\varepsilon}$

(4)

Table 8 shows the value of R^2 to be 95.2% i.e. project cost value could be seriously affected by improper time management and functional impact of project resources.

V. Conclusion

From the study, the most severe factors causing road construction delay or abandonment in Nigeria are: risk and uncertainty associated with projects (unpredictable weather); lack of financial power; indiscriminate change in design/works (variations); improper material inspection, selection, checking, and testing before usage in accordance with specifications in contract; subgrade conditions; shop drawing; sample approvals; and poor management commitment and leadership styles with severity of 92.19%, 91.81%, 91.62%, 90.67%, 90.10%, 89.52%, 88.76% and 88.57% respectively.

According to the model results, the functional factor had a somewhat greater impact on the cost-value of an activity than the cost factor. This revealed that the more each project activity is handled functionally (i.e. performance), the more likely the project is to be finished on time and on budget

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