*IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*
*e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 19, Issue 1 Ser. I (Jan. – Feb. 2022), PP 15-27*
*www.iosrjournals.org*

# Optimal Timely and Efficient Road Project Delivery with the Use of Value Engineering

Oluyemi-Ayibiowu, B. D[1], Elusanmi, A.M[2], Babalola, H.I[3]
[1](Department of Civil Engineering, Federal University of Technology, Akure, Nigeria)
[2](Department of Civil Engineering, Federal University of Technology, Akure, Nigeria)
[3](Department of Project Management, Federal University of Technology, Akure, Nigeria

***Abstract***
*In Nigeria, Government at all levels has expended so much on improving the road networks but despite these, the nation is still faced with poor roads and incessant failures. This research applied Value Engineering (VE) technique to evaluate construction activities and management of three selected road projects in Abuja, Nigeria. The research commenced with necessary data collection and was completed with a predictive Value Engineering (VE) model (timely delivery) for improving road project performance. The work considered all the influencing factors causing untimely project delivery in road construction projects. Clients, consultants, contractors, subcontractors, site engineers, project managers, and road users were among the responders. A total of 150 questionnaires were delivered to randomly selected respondents, with 123 being deemed to be consistent and valid for usage. Field data was gathered on the construction areas of the roads. The ranking study was carried by using the Relative Importance Index (RII) and the Severity Index. The elements that influence the timely delivery of Nigerian road construction projects have been identified and ranked.. Results showed that delay in road project is majorly caused by: risks and uncertainty associated with projects, lack of financial power, indiscriminate change in design works and improper material inspection, selection and testing before usage. The value index/value engineering prediction model for sustainable road development was developed, tested and validated for use in preventing unnecessary delay during the entire project as:* $\sum_{i=1}^{n} \boldsymbol{TV} = \mathbf{1.015} + \sum_{i=1}^{n}(\mathbf{2.061}\boldsymbol{F_i}) - \sum_{i=1}^{n}(\mathbf{2.079}\boldsymbol{T_i}) + \boldsymbol{\varepsilon}$.
***Keywords:*** *Value Engineering, Timely delivery, Road Project, Project Performance, Value Index*

---

Date of Submission: 20-12-2021 Date of Acceptance: 04-01-2022

---

## I. Introduction

A project is an effort to develop a unique product or service that is broken down into a well-defined collection of tasks (jobs, subtasks). Many road construction projects in Nigeria are never completed on time, and poor performance of road construction projects has been a serious concern in Nigeria, as it has been in many other countries. Construction projects and the sector as a whole have done poorly in both industrialized and developing countries, according to studies. 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. This study was conducted to investigate some of the factors that contribute to the late delivery or abandonment of road projects, as well as poor performance of road building projects in Nigeria. The study looked at how Value Engineering (VE) can be used to improve highway building performance for long-term road development.

## II. Literature Review

### 2.1 Value Engineering in Construction

Construction projects are growing in scale and breadth as a result of modern technology advancements. Construction firms are frequently under pressure to produce projects at a cheaper cost while still ensuring that they work as intended. With the growth of science and technology, it is becoming substantially easier to cut construction costs; nevertheless, the concept of functional utility was not given proper consideration, and reliability and durability were not taken into account. Engineers have begun to consider these crucial criteria, such as reliability and durability, as well as practical utility, in order to reduce building costs.

Engineers are increasingly seeking for solutions to cut building costs without sacrificing quality or functionality; nevertheless, their approach is mostly based on previous experiences. Everyone promotes the concept of saving money while also giving higher value. Value Engineering (VE) is a function-oriented, innovative, and 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.

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. The engineer must design the project in such a way that it is economical in terms of both cost and output, while the contractor must use his competence to build the project at the predicted cost, or even less if possible.

### 2.2 Value Engineering Process and Study

Value Engineering is a structured problem-solving process based on function analysis to improve the value of a system. Value is defined as a ratio of function to cost and consequently, it can be increased by either improving the function or reducing the cost. The VE study is normally conducted by team of members of multi-disciplinary experience and expertise. First, the VE team establishes the functional relationships in a system through a “how why” questioning technique. Then, the VE team develops a matrix of the various functions of the system against their associated costs. The value of the system is maximized by an optimal tradeoff between the functions and their associated costs. In the context of construction, the objective of the VE study is to achieve the necessary functions with the lowest project life cycle cost. This may be done through the use of new material, creative design, simplified construction process, innovative construction method, reduced construction cost and time, improved construction quality and safety, and minimal environmental impacts (Jiayou and Yanxin, 2009).

According to Yung and Yip (2010) value engineering focuses on analysis of research objective functional impact, and strives to achieve the required function reliably at the lowest life cycle cost to gain the best integrated benefits. The basic formula for VE is:

$$V_i = \frac{F_i}{C_i} \quad \text{Or } V_i = \frac{What\ you\ get\ (want)}{What\ you\ pay} \tag{1}$$

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.

### 2.3 Previous Reviews on Use of Value Engineering Technique

Shen and Liu.(2003) suggested that the application of value engineering to construction project has proven to be an effective way to save the cost of a project. Sungwoo *et al.* (2012) stated that value engineering is an effort to improve the value of a system through a creative and organized approach. The most important part in a VE job plan is idea generation. Kelly *et al.* (2014) carried out a comprehensive review of briefing studies for construction and deduced that the major weaknesses of the current briefing guides were too general and implicit to offer real assistance to clients and designers. The guides show what should be done without explaining how things can be done. They concluded by suggesting the use of Value engineering (VE) for the future development of the briefing guide. Tae *et al.* (2015) in their conclusion affirmed that application of a systematic value engineering process can be beneficial to develop cost effective design alternatives.

## III. Methodology

### The Study Area

Three road building sites in Abuja, Nigeria's Federal Capital Territory (FCT), were chosen for the study. Commercial viability, social standing, economic considerations, and region accessibility were all factors in the selection of locales, which provide prospects for building, consultancy, manufacturing, agricultural, telecom, marketing, legal, health, and technological advancement.

Abuja is the capacity of Nigeria. It lies between latitudes $8^o25'$N and $9^o20'$N and between longitude $6^o39'$E and $7^o28'$E, with an area of $713km^2$. According to Jaiyeola (2016), Abuja has a population of about 6 million persons, making it the fourth largest city in Nigeria. Being the nation capital city, it has witnessed huge influx of people with lots of industrial, commercial and road developments. Figure 1 shows the map of the study areas in Abuja, Nigeria.


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

The three selected roads construction sites are:

1. Site A: Abuja – Abaji, which involves the construction of a 71.5km asphaltic road pavement, of 7m width with 1.50m road shoulders on each side. It also consists of some ancillary works such as provision of drainage facilities.
2. Site B: Bwari – Kau road (phase 1), which involves asphaltic road pavement construction
3. Site 3: Abuja – Keffi road. This also is asphaltic overlay of a 85 km road.

**Data Source/Research Methodology**

A systematic approach known as a task plan is used in a value engineering research. The task 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. Pre-study, Value study, and Post-study are the three key periods of activity covered by the VE job plan. as shown in Figure 2. All phases and steps were performed sequentially.

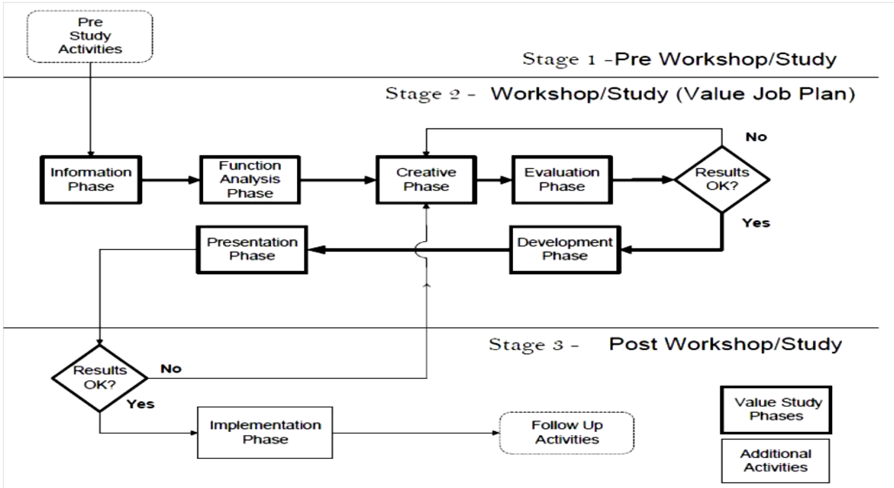


Figure 2: The Job Plan (Om and Anil, 2013)

**Pre-study**

Collect user/customer attitudes, complete data file, identify assessment variables, scope the study, develop physical road-models, and determine team makeup were all part of the pre-study duties..

**Value engineering (VE) study**

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

**Post-study**

The objective during post-study activities is to ensure the implementation of the approved value study change recommendations. Assignments were made to individuals and also by management to other individuals within the VE study team, to complete the tasks associated 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:

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

b. Function analysis phase: According to Department of defence, 2011, Amit and Belokar, 2012 it involves determination of functions, classification, estimation of the cost of performing each function, determination of the best opportunities for improvement, and refining of study scope.

c. Creative phase: This involved developing of ideas and alternative ways for efficient and effective functions selected for the study to give optimal performance (Om and Anil, 2013). It determines what the project and its components should accomplish, such as to reduce costs, save time, or minimize maintenance. It also determines customers satisfaction, and also developing a concise statement of what is to be achieved by considering some factors such as aesthetic features, specifications, design and construction methods, operation and maintenance costs.

d. Evaluation Phase***:*** According to Amit and Belokar, 2012, The evaluation phase's goals are to synthesize ideas and concepts developed during the creativity phase, as well as to choose feasible ideas for development into specific value enhancements. Ideas are selected and assessed according to how well they fulfill the evaluation criteria established during the pre-study process.

e. Development Phase: This phase considers the best options and provides material such as sketches, narratives, and specifications to increase the project's value (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.

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 population size, N, and total representative sample, n, for this study were established using the simple random sampling (SRS) approach, which allows only one item from the population to be chosen for inclusion in the sample at a time. This ensures that every person of the population has an equal probability of being selected for the study.Within the three selected road construction sites, the targeted groups to which questionnaire was administered were: clients, consultants, contractors and site engineers/supervisors. Sample size, n was determined using:

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

Where :

N = total number of populations

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 administered for the research.

**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:

$$\text{Relative Important Index (R.I.I)} = \frac{5_{n_5} + 4_{n_4} + 3_{n_3} + 2_{n_2} + 1_{n_1}}{5\text{N}} \quad (3)$$

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 Time Value Engineering Prediction Model (TVEPM) 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 Time value (**TV**) was expressed as $\boldsymbol{\beta_\circ + \beta_1 C_1 + \beta_2 F_2 + \varepsilon}$ 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;

**Identification of Factors Influencing Delays**

Table no 2 showed the twenty-six (26) factors that influence road construction project time completion. In the table, individual factors identified were clearly represented with different identity number so as to ease proper identification for the case of this research

**Table no 2:** Description of Identified Factors Influencing Delay

| S/N | CRITERIA | I.D |
|---|---|---|
| 1 | Risk and uncertainty associated with projects (Unpredictable weather conditions): What role does the weather play in your infrastructure projects triggering delays? | Q15.1 |
| 2 | Manpower (Labour): What role does labor availability play in producing delays in your infrastructure projects? (For example, wasted time, labor disputes, shortages, and so on.) | Q15.2 |
| 3 | Unavailability of good quality construction materials: To what extent are delays in your construction projects caused by a lack of construction materials? | Q15.3 |
| 4 | Equipment: What impact can equipment failure have on your constructing project's timeliness? | Q15.4 |
| 5 | Non-measurement of equipment productivity: What impact does equipment performance have on the timely completion of your project? | Q15.5 |
| 6 | Use of unskilled or inexperienced operators: What impact does a lack of required staff (crew) training have on the timely completion of your project? | Q15.6 |

| | | |
|---|---|---|
| 7 | Lack of financial power:<br>How crucial is funding in causing project delays? | Q15.7 |
| 8 | Construction mistakes: How important are errors made on the job site during field construction in causing project delays? | Q15.8 |
| 9 | Indiscriminate Change in design/works (variations):<br>How significant are client or agency variances in causing delays in your building projects? | Q15.9 |
| 10 | Subgrade conditions:<br>How crucial are subgrade conditions on the job site in slowing down construction? | Q15.10 |
| 11 | Permits:<br>What impact does acquiring permits from authorities (federal, state, local, and others) have on the time it takes to complete your building projects? ? | Q15.11 |
| 12 | Shop drawing:<br>What impact does preparing and approving shop drawings have on the time it takes to complete your construction projects? | Q15.12 |
| 13 | Sample approvals:<br>What impact does the approval of sample materials have on the timeliness of your construction project? | Q15.13 |
| 14 | Weak regulation and control (Codes):<br>What impact does adherence to building norms and regulations have on the time it takes to complete your construction projects? | Q15.14 |
| 15 | Improper selection criteria of contractor and designer: | Q15.15 |
| 16 | Non performance of subcontractors and nominated suppliers:<br>What role do subcontractors play in causing project delays for you? | Q15.16 |
| 17 | Contract documents:<br>What effect do the contract documents (for example a problem can be encountered with respect to changes or extra work that is beyond the scope of the changes clause of the contract.) have in delaying your construction projects? | Q15.17 |
| 18 | Conflict between project parties (Disputes):<br>What effect do disputes between the principal and contractor have in delaying your projects? | Q15.18 |
| 19 | Industrial disputes:<br>How would you classify Industrial disputes as source of delays? | Q15.19 |
| 20 | Improper material inspection, selection, checking and testing before usage in accordance with specifications in contract:<br>Field or laboratory tests, such as geotechnical testing, concrete testing, and analysis, are required for some projects. How much does inspection and testing cause delays in your projects? | Q15.20 |
| 21 | Poor construction techniques: | Q15.21 |
| 22 | Poor management commitment and leadership styles: | Q15.22 |
| 23 | Poor motivation system (incentives): | Q15.23 |
| 24 | Unstable government policies: | Q15.24 |
| 25 | Unstable interest rate: | Q15.25 |
| 26 | Project fraud and corruption: | Q15.26 |

**Ranking Analysis Result for the Delay Risk Factors**

Table no 3 revealed the mean value, relative importance index (RII) for twenty-six (26) indicators and their severities (in percentages). From table 3, the six (6) most severe factors affecting cost as opined by the respondents are: Risk and uncertainty associated with projects with severity of 92.2%, Lack of financial power with 91.8% severity, Indiscriminate change in design/works with severity of 91.6%, Improper material inspection, selection, checking & testing of 90.7% severity, and subgrade conditions with 90.1% severity among other factors were ranked to contribute severe effect to performance of road construction projects.

**Table no3:** Ranking Result for identified twenty-six (26) delay 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, 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 31.43% for the drainage while the manual rodad 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 |

**Ranking Result for Individual Highway Activities Time Implication**

Table no5 showed the ranking of the road construction activities based on how they were influenced by the time factor (Ti). From the result, the subgrade-activities-dumping (S-G-Act-Dump) showed the least time factor influence with a severity index (S.I) value of 43.81% for sub-grade, sub-base-activities-dumping (S-B-Act-Dump) with a severity index (S.I) value of 30.86% for sub-base, base-course-activities-dumping (B-C-Act-Dump) with a severity index (S.I) value of 34.10% 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' Time Implication Requirement

| S/N | CRITERIA | n1 | n2 | n3 | Ti | |
|---|---|---|---|---|---|---|
| | | | | | R.I.I | S.I (%) |
| Q16.A1 | subgrade-materials-natural (S-G-Mat-Nat) | 76 | 35 | 12 | 0.347 | 34.67 |
| Q16.A2 | subgrade-materials-stabilized (S-G-Mat-Stab) | 11 | 27 | 85 | 0.610 | 60.95 |
| Q16.B1 | subgrade-methods-manual (S-G-Meth-Man) | 75 | 38 | 10 | 0.345 | 34.48 |
| Q16.B2 | subgrade-methods-mechanical (S-G-Meth-Mech) | 20 | 32 | 71 | 0.566 | 56.57 |
| Q16.C1 | subgrade-activities-winning (S-G-Act-Win) | 12 | 22 | 89 | 0.615 | 61.52 |
| Q16.C2 | subgrade-activities-loading (S-G-Act-Load) | 13 | 16 | 94 | 0.623 | 62.29 |
| Q16.C3 | subgrade-activities-hauling (S-G-Act-Haul) | 10 | 27 | 86 | 0.613 | 61.33 |
| Q16.C4 | subgrade-activities-dumping (S-G-Act-Dump) | 28 | 83 | 12 | 0.438 | 43.81 |
| Q16.C5 | subgrade-activities-compaction (S-G-Act-Comp) | 68 | 32 | 23 | 0.383 | 38.29 |
| Q17.A1 | sub-base-materials-natural (S-B-Mat-Agg) | 12 | 26 | 85 | 0.608 | 60.76 |
| Q17.A2 | sub-base-materials-stabilized (S-B-Mat-Stab) | 16 | 95 | 12 | 0.461 | 46.10 |
| Q17.B1 | sub-base-methods-manual (S-B-Meth-Man) | 103 | 12 | 8 | 0.288 | 28.76 |
| Q17.B2 | sub-base-methods-mechanical (S-B-Meth-Mech) | 16 | 24 | 83 | 0.596 | 59.62 |
| Q17.C1 | sub-base-activities-winning (S-B-Act-Win) | 22 | 34 | 67 | 0.554 | 55.43 |
| Q17.C2 | sub-base-activities-loading (S-B-Act-Load) | 21 | 85 | 17 | 0.461 | 46.10 |
| Q17.C3 | sub-base-activities-hauling (S-B-Act-Haul) | 78 | 36 | 9 | 0.337 | 33.71 |
| Q17.C4 | sub-base-activities-dumping (S-B-Act-Dump) | 95 | 17 | 11 | 0.309 | 30.86 |
| Q17.C5 | sub-base-activities-compaction (S-B-Act-Comp) | 16 | 14 | 93 | 0.615 | 61.52 |
| Q18.A1 | base-course-materials-natural (B-C-Mat-Agg) | 71 | 42 | 10 | 0.352 | 35.24 |
| Q18.A2 | base-course-materials-stabilized (B-C-Mat-Stab) | 23 | 29 | 71 | 0.560 | 56.00 |
| Q18.B1 | base-course-methods-manual (B-C-Meth-Man) | 101 | 14 | 8 | 0.291 | 29.14 |
| Q18.B2 | base-course-methods-mechanical (B-C-Meth-Mech) | 18 | 26 | 79 | 0.585 | 58.48 |
| Q18.C1 | base-course-activities-winning (B-C-Act-Win) | 24 | 36 | 63 | 0.543 | 54.29 |
| Q18.C2 | base-course-activities-loading (B-C-Act-Load) | 23 | 87 | 13 | 0.450 | 44.95 |
| Q18.C3 | base-course-activities-hauling (B-C-Act-Haul) | 76 | 38 | 9 | 0.341 | 34.10 |
| Q18.C4 | base-course-activities-dumping (B-C-Act-Dump) | 97 | 19 | 7 | 0.297 | 29.71 |
| Q18.C5 | base-course-activities-compaction (B-C-Act-Comp) | 18 | 16 | 89 | 0.604 | 60.38 |
| Q18.C6 | base-course-activities-primming (B-C-Act-Prim) | 20 | 13 | 90 | 0.602 | 60.19 |
| Q19.A1 | surfacing-materials-natural (S-Mat-Nat) | 69 | 46 | 8 | 0.352 | 35.24 |
| Q19.A2 | surfacing-materials-stabilized (S-Mat-Stab) | 21 | 33 | 69 | 0.560 | 56.00 |
| Q19.B1 | surfacing-methods-manual (S-Meth-Man) | 96 | 18 | 9 | 0.303 | 30.29 |
| Q19.B2 | surfacing-methods-mechanical (S-Meth-Mech) | 16 | 30 | 77 | 0.585 | 58.48 |
| Q19.C1 | surfacing-activities-wetting (S-Act-Wet) | 22 | 40 | 61 | 0.543 | 54.29 |
| Q19.C2 | surfacing-activities-brushing (S-Act-Brush) | 21 | 91 | 11 | 0.450 | 44.95 |
| Q19.C3 | surfacing-activities-tack coating (S-Act-Tack) | 75 | 39 | 9 | 0.343 | 34.29 |
| Q19.C4 | surfacing-activities-curing (S-Act-Curing) | 88 | 23 | 12 | 0.324 | 32.38 |
| | | | | | | |
| Q19.C5 | surfacing-activities-asphalt laying (S-Act-Asph) | 16 | 20 | 87 | 0.604 | 60.38 |
| Q20.A1 | drainage-culvert-materials-cast (D-C-Mat-Cast) | 70 | 46 | 7 | 0.349 | 34.86 |
| Q20.A2 | drainage-culvert-materials-precast (D-C-Mat-Prec) | 22 | 33 | 68 | 0.556 | 55.62 |
| Q20.B1 | drainage-culvert-methods-manual (D-C-Meth-Man) | 97 | 18 | 8 | 0.299 | 29.90 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Q20.B2 | drainage-culvert-methods-mechanical (D-C-Meth-Mech) | 17 | 30 | 76 | 0.581 | 58.10 |
| Q20.C1 | drainage-culvert-activities-excavation (D-C-Act-Exc) | 23 | 40 | 60 | 0.539 | 53.90 |
| Q20.C2 | drainage-culvert-activities-blinding (D-C-Act-Blind) | 22 | 91 | 10 | 0.446 | 44.57 |
| Q20.C3 | drainage-culvert-activities-forming (D-C-Act-Form) | 76 | 37 | 10 | 0.343 | 34.29 |
| Q20.C4 | drainage-culvert-activities-casting (D-C-Act-Cast) | 89 | 23 | 11 | 0.320 | 32.00 |
| Q20.C5 | drainage-culvert-activities-backfilling (D-C-Act-Back) | 17 | 20 | 86 | 0.600 | 60.00 |
| Q20.C6 | drainage-culvert-activities-paraphet (D-C-Act-Para) | 19 | 17 | 87 | 0.598 | 59.81 |
| Q21.B1 | road-marking-manual (R-M-Meth-Man) | 23 | 89 | 11 | 0.446 | 44.57 |
| Q21.B2 | road-marking-mechanical (R-M-Meth-Mech) | 26 | 24 | 73 | 0.558 | 55.81 |

**Time 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 $F_i/T_i$. From the table, highway activities with the highest time value for subgrade is subgrade-activities-compaction (S-G-Act-Comp) with time value of 1.662, for sub-base it is sub-base-activities-dumping (S-B-Act-Dump) with time value of 1.068, for base it is base-course-activities-dumping (B-C-Act-Dump) with time value of 1.071, for surfacing it is surfacing-activities-brushing (S-Act-Brush) with time value of 1.047 and for drainage, it is drainage-culvert-activities-blinding (D-C-Act-Blind) with time value of 1.047.

**Table no 6 :** Time Value Engineering Ranking Result

| ACTIVITY | I.D | DESCRIPTION | R.I.I FUNCTION (Fi) | TIME (Ti) | TIME-Value (Vt) | RANK |
|---|---|---|---|---|---|---|
| SUBGRADE ACTIVITIES | **Q16.A1** | subgrade-materials-natural (S-G-Mat-Nat) | 0.385 | 0.347 | **1.110** | **1** |
| | **Q16.A2** | subgrade-materials-stabilized (S-G-Mat-Stab) | 0.592 | 0.610 | **0.972** | **2** |
| | **Q16.B2** | subgrade-methods-mechanical (S-G-Meth-Mech) | 0.617 | 0.566 | **1.091** | **1** |
| | **Q16.B1** | subgrade-methods-manual (S-G-Meth-Man) | 0.309 | 0.345 | **0.895** | **2** |
| | **Q16.C5** | subgrade-activities-compaction (S-G-Act-Comp) | 0.636 | 0.383 | **1.662** | **1** |
| | **Q16.C1** | subgrade-activities-winning (S-G-Act-Win) | 0.575 | 0.615 | **0.935** | **2** |
| | **Q16.C2** | subgrade-activities-loading (S-G-Act-Load) | 0.482 | 0.623 | **0.774** | **3** |
| | **Q16.C4** | subgrade-activities-dumping (S-G-Act-Dump) | 0.330 | 0.438 | **0.752** | **4** |
| | **Q16.C3** | subgrade-activities-hauling (S-G-Act-Haul) | 0.343 | 0.613 | **0.559** | **5** |
| SUB-BASE ACTIVITIES | **Q17.A1** | sub-base-materials-natural (S-B-Mat-Agg) | 0.610 | 0.608 | **1.003** | **1** |
| | **Q17.A2** | sub-base-materials-stabilized (S-B-Mat-Stab) | 0.314 | 0.461 | **0.682** | **2** |
| | **Q17.B1** | sub-base-methods-manual (S-B-Meth-Man) | 0.309 | 0.288 | **1.073** | **1** |
| | **Q17.B2** | sub-base-methods-mechanical (S-B-Meth-Mech) | 0.617 | 0.596 | **1.035** | **2** |
| | **Q17.C4** | sub-base-activities-dumping (S-B-Act-Dump) | 0.330 | 0.309 | **1.068** | **1** |
| | **Q17.C2** | sub-base-activities-loading (S-B-Act-Load) | 0.482 | 0.461 | **1.045** | **2** |
| | **Q17.C1** | sub-base-activities-winning (S-B-Act-Win) | 0.575 | 0.554 | **1.038** | **3** |
| | **Q17.C5** | sub-base-activities-compaction (S-B-Act-Comp) | 0.636 | 0.615 | **1.034** | **4** |
| | **Q17.C3** | sub-base-activities-hauling (S-B-Act-Haul) | 0.343 | 0.337 | **1.017** | **5** |
| BASE-COURSE ACTIVITIES | **Q18.A1** | base-course-materials-natural (B-C-Mat-Agg) | 0.373 | 0.352 | **1.059** | **1** |
| | **Q18.A2** | base-course-materials-stabilized (B-C-Mat-Stab) | 0.581 | 0.560 | **1.037** | **2** |
| | **Q18.B2** | base-course-methods-mechanical (B-C-Meth-Mech) | 0.606 | 0.585 | **1.036** | **1** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Q18.B1** | base-course-methods-manual (B-C-Meth-Man) | 0.297 | 0.291 | **1.020** | **2** |
| | **Q18.C4** | base-course-activities-dumping (B-C-Act-Dump) | 0.318 | 0.297 | **1.071** | **1** |
| | **Q18.C2** | base-course-activities-loading (B-C-Act-Load) | 0.470 | 0.450 | **1.047** | **2** |
| | **Q18.C1** | base-course-activities-winning (B-C-Act-Win) | 0.564 | 0.543 | **1.039** | **3** |
| | **Q18.C6** | base-course-activities-primming (B-C-Act-Prim) | 0.623 | 0.602 | **1.035** | **4** |
| | **Q18.C5** | base-course-activities-compaction (B-C-Act-Comp) | 0.625 | 0.604 | **1.035** | **5** |
| | **Q18.C3** | base-course-activities-hauling (B-C-Act-Haul) | 0.331 | 0.341 | **0.972** | **6** |
| **SURFACING ACTIVITIES** | **Q19.A1** | surfacing-materials-natural (S-Mat-Nat) | 0.373 | 0.352 | **1.059** | **1** |
| | **Q19.A2** | surfacing-materials-stabilized (S-Mat-Stab) | 0.581 | 0.560 | **1.037** | **2** |
| | **Q19.B2** | surfacing-methods-mechanical (S-Meth-Mech) | 0.606 | 0.585 | **1.036** | **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 | 0.450 | **1.047** | **1** |
| | **Q19.C1** | surfacing-activities-wetting (S-Act-Wet) | 0.564 | 0.543 | **1.039** | **2** |
| | **Q19.C5** | surfacing-activities-asphalt laying (S-Act-Asph) | 0.625 | 0.604 | **1.035** | **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 | 0.349 | **1.060** | **1** |
| | **Q20.A2** | drainage-culvert-materials-precast (D-C-Mat-Prec) | 0.577 | 0.556 | **1.038** | **2** |
| | **Q20.B2** | drainage-culvert-methods-mechanical (D-C-Meth-Mech) | 0.602 | 0.581 | **1.036** | **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 | 0.446 | **1.047** | **1** |
| | **Q20.C1** | drainage-culvert-activities-excavation (D-C-Act-Exc) | 0.560 | 0.539 | **1.039** | **2** |
| | **Q20.C6** | drainage-culvert-activities-paraphet (D-C-Act-Para) | 0.619 | 0.598 | **1.035** | **3** |
| | **Q20.C5** | drainage-culvert-activities-backfilling (D-C-Act-Back) | 0.621 | 0.600 | **1.035** | **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 | 0.446 | **1.047** | **1** |
| | **Q21.B2** | road-marking-mechanical (R-M-Meth-Mech) | 0.579 | 0.558 | **1.038** | **2** |

**Time value multiple linear regression analysis result**

Table no 7 showed the Time-Value (TV) regression model that 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

**Table no 7:** *Time Value (TV) 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) | 1.015 | .018 | | 56.464 | .000 | .979 | 1.051 | | |
| | FUNCTION | 2.061 | .067 | 1.901 | 30.538 | .000 | 1.925 | 2.196 | .257 | 3.889 |
| | TIME | -2.079 | .072 | -1.797 | -28.870 | .000 | -2.224 | -1.934 | .257 | 3.889 |

| 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) | 1.015 | .018 | | 56.464 | .000 | .979 | 1.051 | | |
| | FUNCTION | 2.061 | .067 | 1.901 | 30.538 | .000 | 1.925 | 2.196 | .257 | 3.889 |
| | TIME | -2.079 | .072 | -1.797 | -28.870 | .000 | -2.224 | -1.934 | .257 | 3.889 |

**a. Dependent Variable: VALUE-T**

The formulated model is shown as:

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

$TV= 0.998 + 1.801F_1 - 1.792T_2 + \varepsilon$

$$\sum_{i=1}^{n} \boldsymbol{TV} = \mathbf{1.015} + \sum_{i=1}^{n}(\mathbf{2.061}\boldsymbol{F_i}) - \sum_{i=1}^{n}(\mathbf{2.079}\boldsymbol{T_i}) + \boldsymbol{\varepsilon} \quad (4)$$

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

**Table no 8:** Time-value Model Summary

| 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

## 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.

From the model result, the functional factor showed a bit more influence on the time-value of an activity than the time factor of the activities. This showed that the more each project activity is properly handled functionally (i.e performance), the greater the tendency of the project to be completed on-time.

## References


[1]. Abeer Khalid Mansour and Mohammed Abueusef. Value Engineering in Developing Countries, International Conference Data Mining, Civil and Mechanical Engineering (ICDMCME), Bali, Indonesia. 2015:101-104

[2]. Amit Sharma and Belokar R.M. Achieving Success through Value Engineering: A Case Study, Proceedings of the World Congress on Engineering and Computer Science (WCECS). San Francisco, USA. 2012. ISSN: 2078-0966

[3]. Assaf, A, Bubshait, A.A, Atiyah, S and Al-Shabri, M. The Management of Construction Company Overhead Cost, International Journal of Project Management. PII:SO263-7863 (00) 00011-9, Elsevier Science Ltd. And IPMA. 2001;19: 265-303

[4]. Department of Defence United State of America. Value Engineering: A Guidebook of Best Practices and Tools:2011

[5]. Faridi, A. and El-Sayegh, S.Significant factors causing delay in the UAE construction industry, Journal of Construction Management and Economics.2006; 24(11):1167- 1176.

[6]. Jiayou, L. and Yanxin, Z.. Application of value engineering in selection of villa air-conditioning system. Proceeding of the International Conference on Information Management, Innovation Management and Industrial Engineering, IEEE Xplore Press, Xi'an. 2009:517-520.

[7]. Kelly, J., Male, S. and Graham, D Value Management of Construction Projects, Blackwell Science Ltd, 1st Edition. 2014: ISBN-13: 978-0632051434, ISBN-10:0632051434.

[8]. Mahmoud, M. A. 'A Construction Resources Management System for Gaza Strip Contractors'. *IJSERT*.2012:100-110.

[9]. Moore, D., McCabe, G., Duckworth W, and Sclove, S. (2003). 'The Practice of Business Statistics, Freeman, New York.

[10]. Oluyemi-Ayibiowu, B.D, Aiyewalehinmi, E.O and Omolayo, O.J: Evaluation of Factors Causing Delay in Building Construction Projects in Ondo State, Nigeria, European Journal of Engineering and Technology.2019; 7(2):56-69

[11]. Om Ji Shukla and Anil Kumar Misra. Easily & Economically Feasible Value Analysis &Value Engineering Concepts for Manufacturing industry, Engineering Management Reviews (EMR). 2013;2(3): 81-85

[12]. Shen, Q. and Liu, G.. "Critical success factors for Value Engineering studies in construction, Journal of Construction Engineerind Management.2003:485-491.

[13]. Sungwoo Moon, Chideok Ha, and Jinkook Yang. Structured Idea Creation for Improving the Value of Construction Design, Journal of Construction Engineering andManagement, ASCE. 2012: 38(7) https://doi.org/10.1061/(ASCE)CO.1943-7862.0000491

[14]. Tae Hyung Kim, Hyun Woo Lee, and Seok Woo Hong. Value Engineering for Roadway Expansion Project over Deep Thick Soft Soils, Journal of Construction Engineering and Management. 2015; 142(2), ASCE, ID 05015014.http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0001054

[15]. Yung, P. and Yip, B.Construction quality in China during transition: A review of literature and empirical examination. International Journal of Project Management. 2010; 28:79-91


Oluyemi-Ayibiowu, B. D, et. al. "Optimal Timely and Efficient Road Project Delivery with the Use of Value Engineering." *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 19(1), 2022, pp. 15-27.