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EVALUATION OF BUILDING PROJECTS USING EARNED VALUE TECHNIQUE

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ABSTRACT
This study evaluates building construction projects using the Earned Value Analysis technique, the Experimental Approach, and Value Concept Analysis. The aim was to compare the cost incurred for an identified amount of work done on a project with the cost budgeted for the same work. The results were used to calculate the Cost Performance Index (CPI) for each project. The experimental approach was used to detect the true cost-effect relationships, while the value concept analysis was used to estimate the value of selected projects as they relate to cost. Two methods were adopted in collecting the empirical data for the study. The first involves the review of relevant literature to provide a sound background to the study. The other method involves the collection and analysis of data obtained from records of the construction firms sampled. Data obtained from each method was calculated, analyzed and presented in tables. It was discovered from analyses that projects that were abandoned for some time before completion has radios that indicate a low level of Value Engineering in their design and construction. For example, projects like the Adamawa Plaza and the Eagle square in Abuja show favorable ratio of 1 and 0.9 respectively, which is less than 1. The results further show that for Adamawa state stadium in Yola, the CPI is far much greater that 1.0 it shows a value of 5.3. This denoted that only about 20 percent of the total contract work was done. The value of money spent is far greater than the work done. Other projects like the Federal University of technology entrance road gave a value rating of unity (1.0) this implies that the project is fully completed and the cost completely paid hence the value of 1.0. On the other hand, it was observed that the total cost of the Eagle Square in Abuja was increased by 14% before the completion of the project. This increase in cost affected the value of the project as the cost performance index reduced to 0.8 instead of 1.0 as the case would have been. Finally, the study revealed that the cost of a project is tied to its function. Abandoned projects always lead to increase in the cost of completion whereby the Cost Performance Index (CPI) of such projects increases. The implication of this is that there is gross misuse of money.
Keywords; Value engineering, Value analysis, Value concept, Function analysis, Cost performance index.

INTRODUCTION
The value approach to engineering and building projects is an organized, interactive, creative and systematic process of improving value and quality of products, processes, institution and system for individuals, groups or society (Gowdy 1999) Value approach was described by Leally and Male (1993) "as a service which maximizes the functional values of a project by managing its development from inception to completion". On the other hand, Parker (1985) described value approach as "as instruction of organizing a medium for persuasion, a means of relating objects to people, and a method for improving safety and efficiency". He extolled the merits of the

value approach (VA) in the following ways: "VA can do more than merely save money. It has proved to be effective in improving the reliability, maintainability and performance of product and processes. VA has contributed towards improving human factors, safety, energy conservation, quality and energy conservation, quality and ecology." Value approach accomplishes all these through extending the use of resources by eliminating unnecessary or excessive cost without necessary quality stakeholder satisfaction with the outcome of the process through cost and effective awareness.

The concept of value as developed by economist is that value is a feature that belongs to a thing. A thing is said to posses such feature that together represent its it6s value (Bowden, 1986). This value is then equated to worth or price or opportunity cost (Rees, 1980). Value is seen as a related 'thing' that develops only when two or more independent objects or things are suitably juxtaposed.

De Marle (1992) provided a convincing argument that value is more than property of matter; it is a force that governs our behavior and is regarded as a force existing between an object and the person(s) who desire them to enable value to be quantified. The magnitude of this value force according to De Marle (1992) is depended on the interplay between needs, usefulness and cost. This theoretical underpin enabled 'valuist' to derive a formula for the quantification of value. The quantification is based on the principles that "value force is directly proportional to the product of the need of an object times the object's ability to satisfy this need, and inversely proportional to the cost of obtaining the object" (De Marle 1992).

This is mathematically expressed as:

$$V = \frac{na}{c} \quad \text{..... (1)}$$

where V = value of some object of service
n = the need of an object or service
a = the ability of an object or service of satisfy this need
c = the cost of the object or service

However, the product of the intensity of need and the ability of the object to satisfy this need defines: importance (I) = needs (n) X ability (a)

Importance (I) = Needs (n) X Ability (a)..... (2)

$$I = n \times a \quad \text{..... (3)}$$

Where I = importance
a = ability to satisfy need
n = need

Therefore, $V = \frac{I}{c}$ ..... (4)

Where, c = as defined earlier.

Since value is a relative concept, equation (4) can be normalized by expressing this value function in percentage terms..

$$V = \frac{I \times 100}{C} \quad \text{..... (5)}$$

Where V = value of a thing (project, service etc)
I = the relative importance of this thing in percentage
C = the relative cost of this thing in percentage

The importance of this equation is that it can be used to measure and to plot the graph showing the value of different projects. Value design on the other hand, it the process of creating or improving the values of goods and services. This process is referred to as a function analysis. Function analysis is basically a technical term for analyzing the performance and usefulness of products and service (Parker 1992). It is the distinguishing feature of the value approach which separates it from either design or cost reduction processes. It starts by assuming that need exist for product or services. It then specifies how these needs are met through design.

Some value design tools described by Shillito and De Marle (1992) include the Function Analysis System Techniques (FAST), Quantity Function Development (QFD), Technology Road-Maps and customers – Oriented Product Concept (COPC). The most widely used among these tools is FAST because of its simplicity and general applicability.

Function analysis is the heart of value engineering. The analysis involves the classification of functions. Function-logic processes are used to describe needs, purposes and ramifications. In addition to its many benefits, function-logic removes people from many of their preconceived biases Parker (1985). These bias become more pronounced due to political affiliations, and in the present democratic dispensation where changes in Government policies is becoming the norm, it becomes difficult to predict what project will be needed after a change of government or what policy will remain. So in order to optimize the benefits of the construction projects in nation building, proper value engineering techniques should be explored before any construction projects is embarked upon.

Furthermore, lots of structures were destroyed in the Federal Capital Territory (FCT) Abuja recently because they did not meet up with the city's Master plan. The use of Value Engineering techniques as management tool, would measure realistic budget, identify and remove non-essential capital and operating costs, and improve and maintain optimum quality of programme and acquisition functions. The objective of this study therefore are to evaluate and Break down construction projects into its various Value Engineering steps and to compare the cost incurred for work on site with the budgeted for the same work with a view to determining the performance index. (Earned Value Analysis).

METHODOLOGY

The research adopted the survey and documentary analysis. The survey research design involves the gathering of data from existing record and seeking the opinion of professionals through structured questionnaire. Documentary analysis involved the examination of existing record related to the completed projects. A total of 10 questionnaires were distributed to selected firms handling construction projects in the Federal Capital Territory Abuja, and Yola the Adamawa State capital. Five (5) firms responded by completing the questionnaires administered to them and also providing records on the projects completed. Data on the following five construction projects; Adamawa Plaza Abuja, Adamawa State Stadium Yola, Federal University of Technology (FUTY) Yola Entrance Road and the Adamawa State Secretariat Yola was collated and consequently evaluated using the Earn Value Analysis (EVA).

Earned Value Analysis is aimed at comparing the cost incurred for an identified amount of work done on a project with the cost initially budgeted for the same work. It was applied at the level of individual task or completed work packages and the data

were collected for the whole particular project. The results were used to calculate the cost performance index for each project. If the project is going on or progressing exactly according to plan, the Cost Performance Index will be 1.0. On the other hand, an index of less than 1.0 indicates that the value earned for the money being spent on the project is less than that expected.

Data on work done on each project site was analyzed on percentages and the corresponding cost of such works was obtained from ministries and companies records and. The data were recorded on a score sheet. The score sheet was designed such that it presents the value of a project in terms of money and need for proper analysis of value.

Experimental approach involves the manipulation of variables to check their effects on a constant factor. This type of approach helps to detect the true cost-effect relationships. Variables considered are basic needs and function against initial cost as a constant.

In Value Concept Analysis, the qualification of value is based on the principle that "Value" force is directly proportional to the product of the need (n) for an object multiplied by the objects ability (a) to satisfy this need, and inversely proportional to the cost (c) of obtaining the object
(De Marle 1992).

$$V = \frac{na}{c}$$

This concept was used to estimate the value of selected projects as they relate to cost.

RESULTS AND DISCUSSION

Earn Value Concept (Experimental) Approach

The Earn Value deals with the cost for an estimated amount of work against the budgeted sum for the same work. It is very possible to calculate the cost performance index of an uncompleted or completed project as long as the percentage of work done and amount of money spent on such project is known.

An index of 1.0 shows normalcy, but an index grater than 1.0 shows that the value of money is grater than the work done and an index less than 1.0 indicates that value of money is less than work done.

The Earn Value Analysis breaks down the work plan stage of value engineering into various cost staged. The following are the main cost stages:

i. Budgeted Cost of Works Schedule (BCWS) is the budget or cost estimate for work schedule to be completed at the measurement data.
ii. Budgeted Cost of Work Performed (BCWP). This is the amount of money or labor time that the amount of work actually performed at the measurement data.
iii. Actual Cost of the Work Performed (ACWP). This is the cost of the actual work on ground.
iv. Cost Performance Index (CPI) indicates the measure of success in achieving results against budget. Anything less than unity indicated that the Value Earned from money spent is less than what was intended.
v. SPI: Schedule Performance Index: This can be used as a measure of progress performance against plant.

These quantities can be used in the following expressions:

$$CPI = \frac{BCWP}{ACWP}$$

And

$$SPI = \frac{BCWP}{BCWS}$$

Five projects were considered for the Earn Value analysis. Table 1 contains information on the cost break down various work stage of the projects selected. Earn Value Analysis was performed not just on one activity but on many project activities at any given measurement time in any large project under study. However, three stages of progress were applied to all the activities as follows:

i. Activity not started: Earn Value is therefore zero
ii. Activity completed: Earn Value is therefore equal to the activities cost budget.
iii. Activity in progress or interrupted: Earn Value is assessed by measuring actual quantities of work done.

Table 1 Earn Value and Value Concept Experiments

S/ No	Name of Project and Location	Total Cost of Project	Work Done %	Cost of Work Done	Rate of Use (Function %)	Need for Project (%)
1	Adamawa Plaza (Abuja)	2.6 billion	100%	2.6 billion	57%	80%
2	Adamawa State Stadium (Yola)	106 million	20%	20 million	0%	80%
3	Eagle Square (Abuja)	185 million	100%	210 million	20%	80%
4	Futy Enteran-Ce Road (Yola)	15 million	80%	16 million	80%	100%
5	State Secretariat (Yola)	95 million	80%	350 million	90%	100%

Source: Field Study

Cost Performance Index

Cost Performance Index (CPI) as earlier explained is a ratio that indicates the measure of success in achieving results against initial budget. Anything less than unity indicates that the Value Earned from money spent is less than what was intended. Below is the CPI for the five projects being considered:

Cost Performance Index Ratio Analysis

i. ADAMAWA PLAZA (ABUJA) CPI $= \frac{BCWP}{ACWP} = \frac{2.6\text{billion}}{2.6\text{billion}} = 1.0$

ii. EAGLE SQUARE (ABUJA) CPI $= \frac{BCWP}{ACWP} = \frac{185\text{million}}{210\text{million}} = 0.9$

iii. ADAMAWA STATE STADIUM (YOLA) CPI $= \frac{BCWP}{ACWP} = \frac{106\text{million}}{20\text{million}} = 5.3$

iv. FUT. YOLA ENTRANCE ROAD (YOLA CPI $= \frac{BCWP}{ACWP} = \frac{15\text{million}}{18\text{million}} = 0.8$

v. STATE SECRETARIAT (YOLA) CPI $= \frac{BCWP}{ACWP} = \frac{95\text{million}}{350\text{million}} = 0.3$

From the results of the cost performance indexes, only Adamawa Plaza satisfies the CPI of unity showing that the value of money spent on the project is equivalent to the work done on the project. It also denotes that this project is totally completed and in use.

It is also seen that in the case of the Adamawa state stadium in Yola, the CPI is 5.3. This denotes that only about 20 percent of the total contract work was done. The value of money spent is far greater than the work done. In such a case, the process of Value Engineering suggests an alternative project with a similar function to be constructed at a lower cost.

From the Earn Analysis of a project, the real Value of the project as it relates to Cost can be ascertained. Most often, from the initial Values of the Earn Values Analysis, a project would be abandoned or changed. From the values obtained in table 2, it was observed that projects that were abandoned for some time before completion has ratios that indicates a low level of Value Engineering involvement in their design and construction which may be attributed to existing government policies at the time of their execution. However, projects like the Adamawa Plaza and the Eagle square in Abuja show favorable ratio of 1 and 0.9 respectively, which is less than 1. These results could be attributed to Value Engineering procedure involvement in their design and construction.

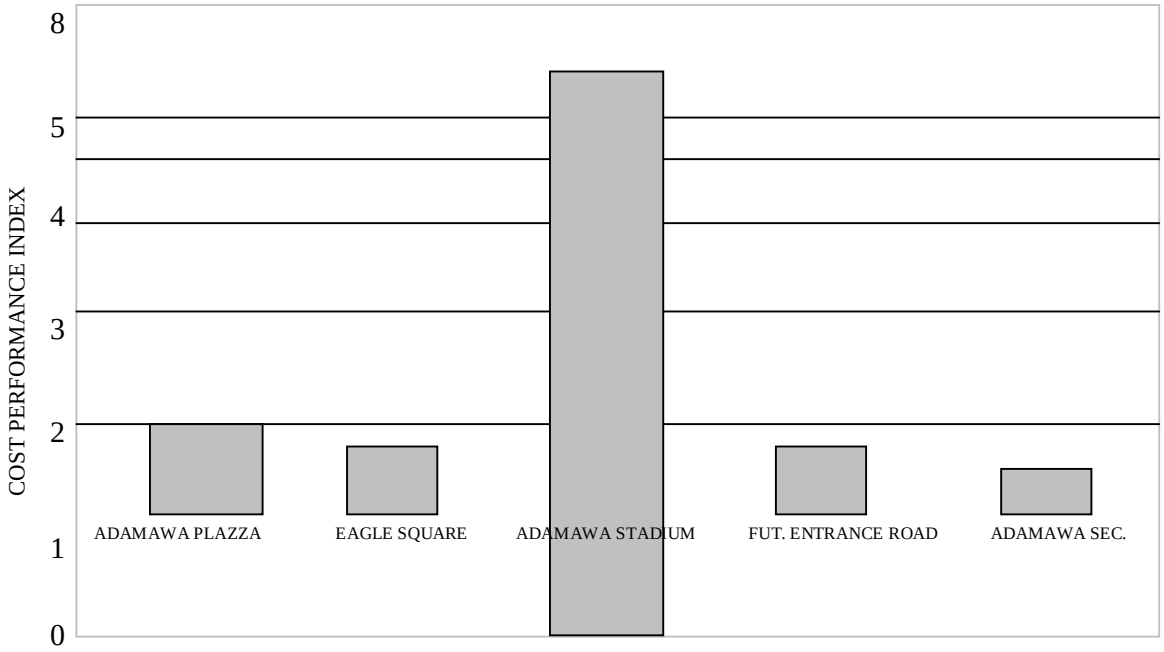

Fig: 1: Cost Performance Index Chart

Value Concept Analysis (Experimental Approach)

Value force is directly proportional to the product of the need for an object multiplied by the objects ability to satisfy this need, and inversely proportional to the cost of obtaining the object.

$$v = \frac{na}{c}$$

v = value of some of service
n = Need of an object
a = Ability of an object to satisfy need

c = Cost of the object

Also, value of an object can be calculated from:
Value = 1/c

where *I* = relative importance of a thing in percentage
c = Cost of the object also in percentage

Therefore Value (v) = $I \frac{\text{x } 100}{c}$

The real value in terms of importance of a project and its relative cost can be obtained using this formula. Value Engineering is basically about the value of a thing. Without value, a thing is said to be useless or valueless.

The values (V = I/c) of the selected projects chosen for the analysis are:

i. ADAMAWA PLAZA (ABUJA) $V = \frac{80}{100} = 0.8$

ii. ADAMAWA PLAZA (ABUJA) $V = \frac{80}{21.2} = 3.8$

iii. ADAMAWA PLAZA (ABUJA) $V = \frac{80}{114} = 0.7$

iv. FUT ENTRANCE ROAD (YOLA) $V = \frac{80}{100} = 1.0$

From the results obtained it is very clear that the value of the Adamawa State Stadium with respect to sports and development is very high but the percentage of money spent on it is less. Other projects like the Federal University of Technology entrance road have a value rating of unity (1.0). This shows that the project is fully completed and the cost completely paid hence the value of 1.0.

It was noticed that the total cost of the Eagle Square in Abuja has increased by 14% before the completion of the project. Due to this increase, the value of the project has reduced to 0.8 instead of 1.0 as the case would have been. Value is always related to the cost of an object. This implies that the greater the cost of an object, the more valuable it is. The higher the value of an object the more important the object is.

Table 2: Projects Value Concept Analysis

PROJECT	VALUE
ADAMAWA PLAZA	0.8
ADAMAWA STADIUM	3.8
EAGLE SQUARE	0.7
FUT. YOLA ENTRANCE ROAD	1.0

Source: Field Study

Value Analysis like the Earned value is an important stage to implement before the commencement of a project. It is a process that can relate the value of a project to its cost, thereby minimizing fancy and concentrating on needs and functions.

CONCLUSION

The application of Earned Value Analysis to selected ongoing projects has been illustrated. The following conclusions were reached as a result of the application of this method.

i) Earned Value Analysis is an important tool for project monitoring and evaluating which when used would reduce waste and thereby contribute to economical development of a nation
ii) The study revealed that the cost of a project is tied to its function and it is from this function that the need for a particular project is determined.
iii) The study also show that that selection phase of the job-plan is the most important phase where the project itself is to be selected. If at this stage, the wrong project is taken from the option presented, the end result will be disastrous in that cost will supersede function. The value of a project is very much tied to its importance in that the cost of a project is linked to its value.
iv) The study also revealed that abandoned projects always lead to increase in the cost of completion where the Cost Performance Index (CPI) of such projects increase significantly which implies gross misuse of money.

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