COST-TIME OVERRUN ANALYSIS OF SMALL SCALE METAL FABRICATION PROJECTS IN NIGERIAN: CASE STUDY

*Nwankwojike, B. N.[1], Onwuka, S. O.[2] and Onuekwusi, C. I.[3]

1,2,3 Department of Mechanical Engineering, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria

*Author for Correspondence: Nwankwojike B.N.; Email: jikeobodo@gmail.com

ABSTRACT

Earned Value Analysis was applied in this study to ascertain the level of cost-time overrun in small scale metal fabrication projects in Aba and the factors responsible for the deviance. Results showed that the Cost Performance Index, cost variance (negative) and time overrun of the projects sampled fall within the range of 0.95 to 0.99, ₦ 6155.56 to ₦ 30, 800.00 and 0.44 to 7.17 days respectively. In addition, poor planning and scheduling of project activities, fluctuations in prices of materials, superficial designs, inadequate review of project scope and epileptic power supply were identified as the major factors that contributed to the cost-time deviance. This is one of the causes of incessant liquidation of small metal fabrication companies in this region as they loose their clients' patronage due to regular inconsistency in both actual and scheduled project cost and duration. Thus, the government should revamp the country's steel sector so as to stabilize the prices of the raw materials and also improve on public power supply in this region so as to forestall this ugly trend. In addition, proprietors of metal fabrication companies in this region should adopt the use of computer aided design/manufacture and project management software in evaluating exact project worth and duration before execution so as to build customers trust.

Keywords: Metal fabrication, overrun, project cost, project duration, small scale firms

1.0 INTRODUCTION

Metal fabrication is a value added process involving creation of metal furniture, metal structures, machineries and components through forming, cutting, welding, lathing, broaching, grinding, milling, honing and other like processes. Its three major phases includes product design (including precise engineering measurements and evaluation), fabrication and installation of the final product. As a manufacturing subsector, it holds a leading position in promoting productivity, investment, import substitution, export expansion, employment and per capita income of any nation. A country's metal fabrication sector is the heart of its industrial revolution as its application cuts across construction, transport, energy, packaging, appliances and industry. According to Ede *et al.,* (2015) and Moore (2002), construction industries consume as much as 52% of world steel. Aba in Abia State of Nigeria has long been touted as the catalyst of industrial revolution in Africa given the many innovative and entrepreneurial small scale metal fabrication activities. Typically, fabricators in this city are known for quoting prices and project delivery dates based on guestimates or experience. This hasty, poor budgeting and scheduling often results to the inability to deliver projects on time, as well as complete projects with the estimated amount. Consequently, poor quality output and contractor-sponsor quarrels continue to thrive in this sector due to overrun in initial budget and schedule. The completion of donor-funded projects on time and within the estimated budget is often a critical factor and a measure

of project success (Gaturu and Muturi, 2014). To ensure metal fabrication projects are completed on time and on budget, there is need to evaluate the causes of cost-time deviations that characterize this sector.

Cost overrun constitutes the difference between the actually amount spent when a project is fully completed and the budgeted expenditure charged by a contractor which the client agreed to commit for creating/acquiring the desired service or goods while time overrun is the difference between the actual time used for executing a project and the time initially scheduled for the project (Chitkara, 2011; Subramani *et al*,, 2014). The search for possible causes of deviations in the planned cost and duration of projects is not new but none of the existing works surveyed the small scale metal fabrication in lieu of unhealthy operators-customers relationship that characterized this sector in Aba. Aziz (2013), revealed wrong method of cost estimation, funding problems, inaccurate cost estimation, mode of financing and payment for completed work, inflation and fluctuation in prices of raw materials as factors responsible for cost variation in wastewater projects in Egypt. Ali and Kamaruzzaman (2010), identified inaccurate or poor estimation of original cost and mistake in design as the major factors that affect cost performance of building construction projects in klang valley. Sweis (2013), identified weather conditions as the one and only factor affecting construction projects in Jordan while Nawaz *et al.* (2013), identified corruption and bribery, political interests, poor site management, delay in site mobilization, rigid attitude by consultants, extra work without approvals, frequent changes during execution, gold platting, safety and health and limited access to job sites as factors affecting cost performance of projects in Pakistan. Although, analytical tools such as regression modeling, frequency distributions, percentile analysis, severity ranking (relative importance index) methods have been in use for evaluating cost-time performance of projects, earned value analysis constitutes one of the most popular and standard method of monitoring and evaluating overruns in project cost and duration from beginning to end (Vanhoucke, 2011; Thirumalai, and Antony, 2014). According to these authors, Earned Value Analysis is a method of forecasting project cost and duration, evaluating variances in the schedule and budget as the project proceeds as well as factors responsible for the deviation. Application of this technique helps in identifying factors causing the shifts from planned cost and duration, thereby enable corrections to be made in cases where possible. Hence, this study evaluates cost and time overrun in small scale metal fabrication projects in Aba using earned value analysis in order to identify the key factors responsible for this menace.

2.0 MATERIALS AND METHODS

Direct practical monitoring of five different metal fabrication projects (from start to finish) in five different companies in Aba, Abia State, Nigeria (Table 1) was carried out between January and August, 2015. The tasks (activities) involved in each project as well as their corresponding timeline, costs and resources allotted were obtained from the concerned companies during the planning phase of the projects. Microsoft project software was used to track the progress of each project as well as check off activities as they are completed. Thereafter, the cost-time performance of the projects was evaluated using Earned Value Analysis.

Table 1: Metal Fabrication Projects Surveyed and their Contractors

S/No	Company Name	Metal Fabrication Project Executed
1	Favour Steel Construction Company, Aba	12m Overhead truss
2	Max Foth Steel Construction Company, Aba	12m Road tanker
3	Jimco Steel Construction Company, Aba	12.8m Truck
4	Ancos Steel Company, Aba	45m^3 Underground tank
5	Adruoe Steel Construction, Aba	6 m^3 Gas tank

The earned value parameters considered in this analysis include Cost Performance Index (CPI), Cost Variance (CV) and Time overrun. Cost Performance Index (CPI) is an indicator which shows how money is being spent as the project delivers or a measure of the efficiency of expenses spent on a project. It shows whether a project is either profitable or at least within its budget. If the project has a CPI of less than "1", it means that the project is over cost respectively.

Cost Variance (CV) compares actual project cost with the planned cost (Eqn. 2).

$$CV = EV - AC \quad (1)$$

The time overrun is the difference between the budgeted time and the actual time of completion of the projects. Microsoft project software (MSP) was used in the analyses of the CPI and CV. Fixed and variable expenses such as depreciation of equipment, labour, energy, transportation and contingency costs were accounted for in estimation of cost involved in each of the project surveyed. Depreciation charges of equipment were computed based on straight line method due their regular usage. Prevailing value added tax of 5% and profit rate of 3% to 7% were used in these analyses. In addition, the factors responsible for either cost or time overrun during each project delivery were also identified with their severity rating (SR) of thirty-three workers involved in the planning and execution of the projects studied. The severity of each of the factors associated with the cost-time deviance in each of the project studied was ranked on a scale of 1 to 5, with '1' being the highest severity and '5' the lowest. The factors average severity ratings (ASR) were computed from the following relation:

budget. CPI equal to "1" means that the project is on budget, which is a good condition, while a value greater than one indicates that the project is under budgeted which is also a favourable condition. CPI is expressed mathematically as follows;

$$CPI = \frac{EV}{AC} \quad (2)$$

Where EV and AC are the earned value and actual

$$ASR = \frac{\sum_{i=0}^{n} SR_i N_i}{\sum N} \quad (3)$$

Where N is the number of respondents.

3.0 RESULTS AND DISCUSSION

The Cost-Time performance analyses of the projects investigated presented in Figures 1-5 revealed cost performance indices of the overhead truss, truck, underground tank, road tanker and gas tank projects as 0.95, 0.99, 0.99, 0.99 and 0.96 respectively. This implies that for every ₦1 spent, ₦0.95, ₦0.99, ₦0.99, ₦0.99 and ₦0.96 worth were derived for each of the respective projects. More so, the cost variances (CV) and time overruns of the respective projects at 100% completion are -₦30, 800 and 4.2 days; -₦22, 866.67 and 7.17 days; -₦6, 155.56 and 0.44 day; -₦24, 150.00 and 2.89 days and -₦30, 166.67 and 0.5 day. The factors responsible for the observed overrun in both cost and time are shown in Table 2. Poor planning and scheduling of project activities, fluctuations in prices of materials, superficial designs, inadequate review of project scope and epileptic power supply with respective severity indices of 1.24, 1.27, 1.33, 1.97 and 2.24 constitute the major factors and should be given adequate attention

if projects are to be delivered on time and within the estimated budget.

Fig. 1: *Cost-Time Performance Analysis of Overhead Truss Project*

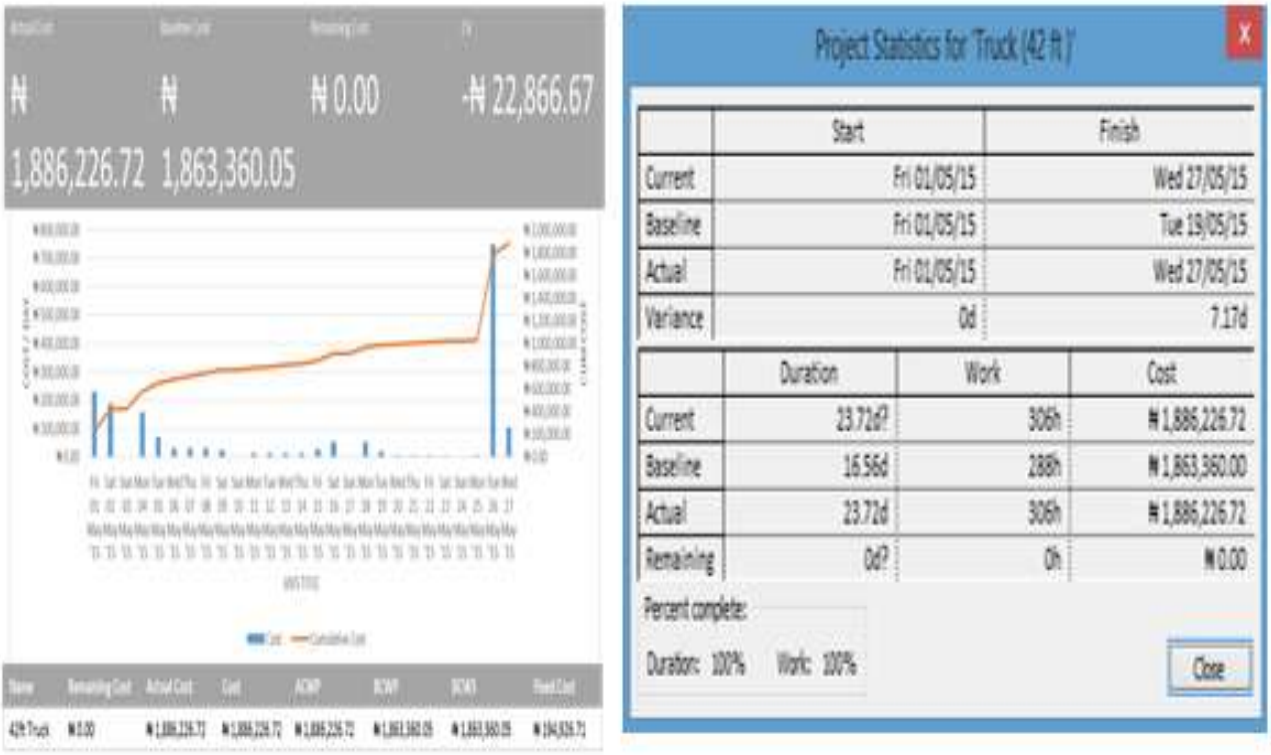
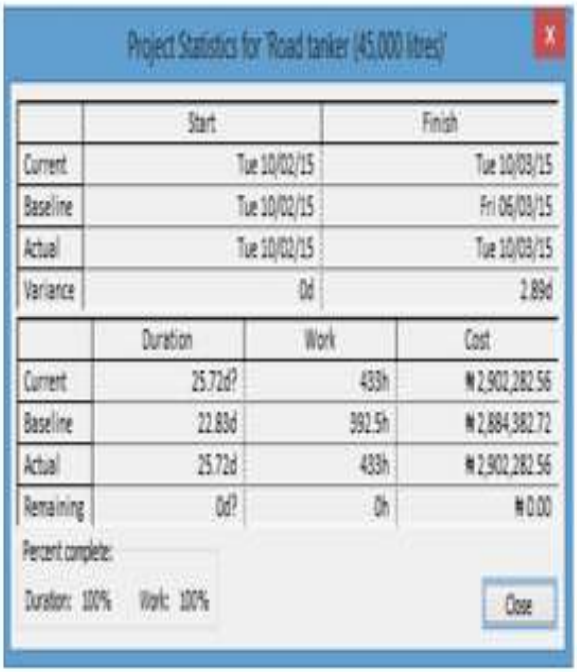


Fig. 2: *Cost-Time Performance Analysis of Truck Project*

Fig. 3: *Cost-Time Performance Analysis of Underground Tank Project*



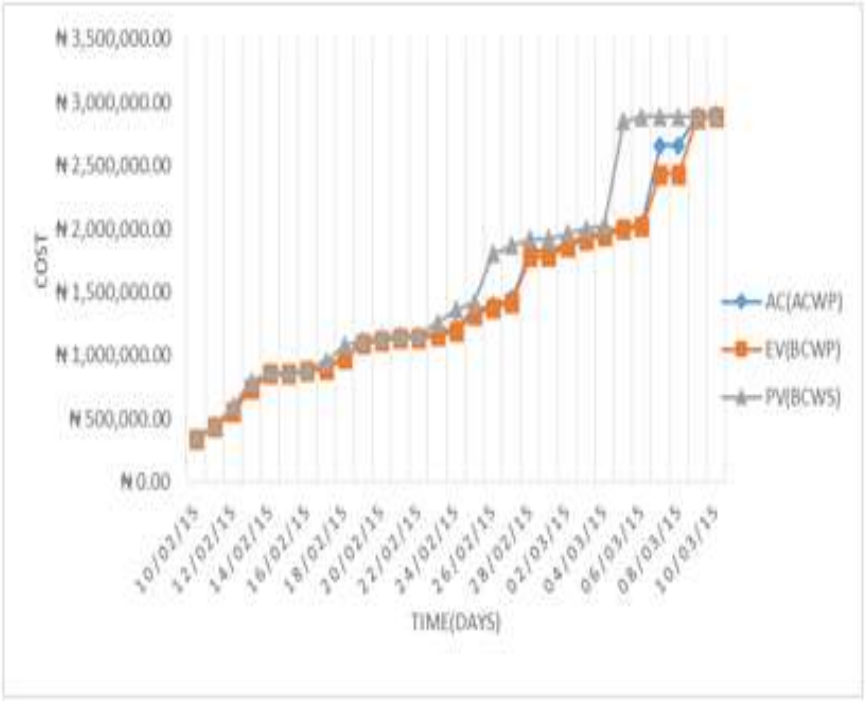
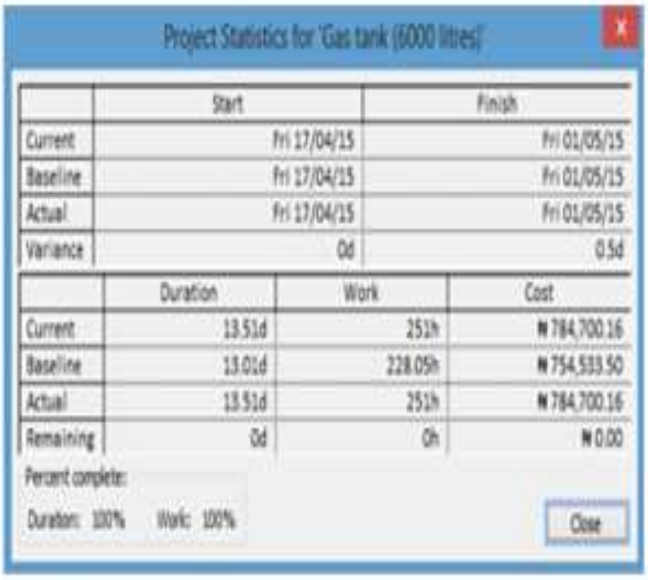


Fig. 4: *Cost-Time Performance Analysis of Road Tanker Project*



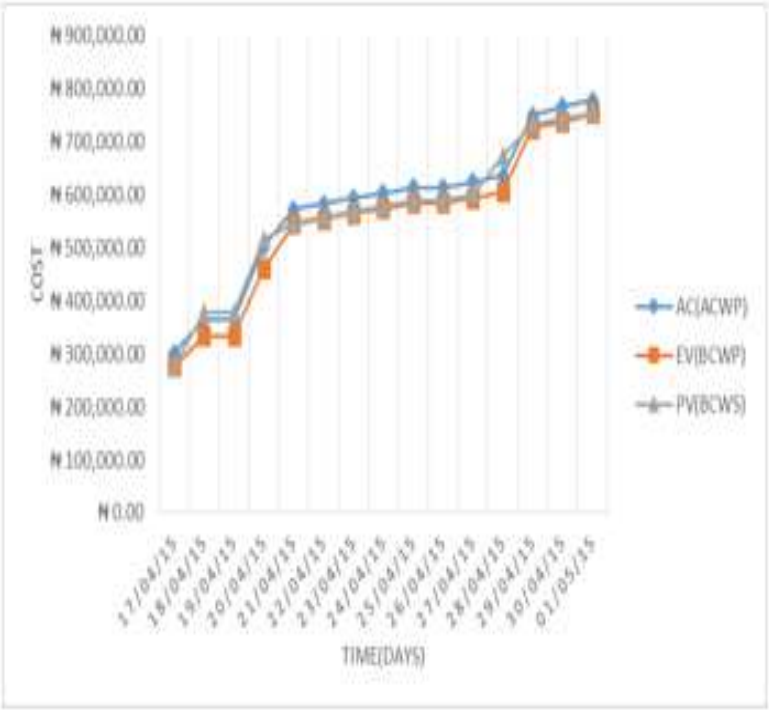


Fig. 5: *Cost-Time Performance Analysis of Gas Tank Project*

Table 2: Rating of Factors Causing Small Scale Metal Fabrication Projects Cost and Time Overrun in Aba

S/N	*Factors*	*SR/Number of Respondents*					*ASR*
		1	*2*	*3*	*4*	*5*	
1	Poor professional management	0	0	20	13	0	3.39
2	Additional work at owners' request	0	22	0	9	2	2.73
3	Project extension (Labour cost increase)	0	0	3	24	6	4.09
4	Lack of cost reports	0	0	32	1	0	3.03
5	Materials cost increased due to inflation	20	2	6	2	3	1.97
6	Poor Planning and scheduling of project activities	29	2	0	2	0	1.24
7	Inadequate review of project scope	28	1	2	2	0	1.33
8	Lack of cost planning / monitoring	0	15	14	4	0	2.67
9	Weather conditions	0	0	2	1	30	4.85
10	Works suspended due to safety reasons	0	0	0	32	1	4.03
11	Errors in the bills of quantities,	2	20	8	3	0	2.36
12	Superficial designs	27	4	1	1	0	1.27
13	Delay in progress payment/Disruption in cash flow	0	20	6	7	0	2.61
14	Poor estimation	0	0	6	18	9	4.09
15	Epileptic power supply	29	0	0	4	0	2.24

4.0 CONCLUSION

This study revealed that the cost performance index, cost variance (negative) and time overrun of small scale metal fabrication projects in Nigeria ranges from 0.95 to 0.99, ₦ 6155.56 to ₦30, 800.00 and 0.44 to 7.17 days respectively. Poor planning/scheduling of project activities, fluctuation in prices of materials, superficial designs, inadequate project scope definition and epileptic power supply were also identified as the major causes of cost-time deviance in this sector. Revamping of Nigerian steel and public power supply sector as well as the use of CAD/CAM/appropriate software in small scale metal fabrication project evaluation is recommended for effective performance of this sector.

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