Assessment of the Application of Project Management Tools and Techniques used for Building Construction Project Delivery [1]

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Abstract

While effective construction project delivery is an important goal every construction company seeks to achieve, the need to utilize various project management tools and techniques for building construction project delivery has become sacrosanct for effective construction project delivery. However the use of various project management tools and techniques by various construction firms is low. The main objective of this quantitative study is to assess the various project management tool and techniques used by contractors in building construction projects delivery, in Abuja Nigeria. Data were generated from closed ended structured questionnaire using Likert scale. A total number of forty five (45) questionnaires were distributed to nine (9) firms in Abuja. The analysis revealed various tools and techniques of project management used by the consulted construction companies in the study area. Appraisal (45), (100%), WBs (43),(96%), PERT (43),(96%) and Bar chart/Gantt (42),(93%) have the highest percentages of responses indicating that they are the most used tools and techniques in the construction companies consulted, whereas, EVM (29),(64%), GERT (19),(42%), Analogous Estimation (31),(69%) and Cost benefit analysis (29),(64%) are the least tools and techniques used by the construction companies. The findings suggested that the least used project management tools and techniques should be adequately utilized in order to achieve effective construction project delivery.

Keywords: *Assessment, Application, Project management tools and techniques, Construction project, Delivery.*

1. Introduction

Project management has been recognized for years and currently is being used as a project procurement method that helps organizations to achieve their project objectives. It helps

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organizations integrate available resources, utilize limited time, deliver projects within budgeted costs, enable organizations to meet up with global market competitions by ensuring that the time to market is as planned and scheduled, and customers demand are met profitably (Patanakul et.al. 2010). Nzekwe et al. (2015), Projects do not succeed as a fluke, rather successful delivery is as a result of careful conceptualization, planning, implementation and controlling of all the necessary variables that can influence projects success.Project Management tools and techniques assists Project manager in orchestrating activities throughout a project life circle/ Several studies have suggested that successful projects delivery is attainable through proper use of project management tools and techniques (Patanakul et al., 2010), they further explained in their work that inappropriate use of these tools and techniques, and clumsy strategies can lead to counter productivity. With the above mentioned, this study will seek to assess the various project management tool and techniques used by contractors in building construction projects delivery, in Abuja Nigeria.

2. Literature Review

2.1 Project management tools and techniques

The theory and practice of project management provides numerous methods, tools and techniques which support project throughout its life span. Different project management models are available, which help in successful implementation of individual phase. However, some methods are applicable within more than one phase or the entire project stages (Schwalbe, 2016). Peerasit et al. (2017), listed some possible project management tools and techniques applicable in conception phase, which includes Analogous estimate, Bar chart, Brainstorming, Checklist, communication plan, customer visits, project charter, scope statement and work breakdown structure (WBS).

2.1.1 Appraisal

This is a strategic and significant tool used in the conception phase of a project to establish the feasibility and viability of a propose project. "It helps to determine investment alternatives, how much to invest, how to invest, where to invest, cost benefit analyses of economic and social proposals, spill over advantages of project proposal, the rate at which a prudent investor could make profit with time, determine time value of present financial expenditure against future expected income and the environmental impact assessment of project proposal" (Theodoulides & Kormancova 2014). Some important tools associated with appraisal are; net present value, internal Rate of Return, the Net Terminal value, the Annual charge, the Annual sinking Fund etc. According to Sparrius (2019), appraisal gives understanding of various options /alternatives for a proposed project which is an edge for better choice of alternative. Samset (2010) also pointed out

appraisal as the successors of idea formulation which will enable managers opt for the best alternative. Also, Decision making succeeds appraisal, which is "the systematic thought aided at times by physical and quantitative models, by which alternatives are identified, evaluated and a choice made among them"(Akpan & Chizea, 2002).

Appraisal encompasses feasibility and Viability analysis. Kostalova & Tetrevova (2018) express this as a means of detailed evaluation of purpose and viability, through which best alternatives among others is obtained.

2.1.2 Work Breakdown Structure

This is one of the project management tools used in detailed project planning. It makes it possible for decomposition and hierarchical arrangement of project activities in such a way that they will enable assigning of responsibilities to each activity, labour and time demands (Kalsaas, 2012). According to Kostalova & Tetrevova (2018), "the WBS can be from the point of view of the project complexity and scope, diversely segmented, ranging from simple activity list to multilevel structure of grouped activities into comprehensive work Packages". The WBS is highly needful, because it prevents omission of activities, or repetition of an activity, under-estimation of project duration and aid systematic planning (Samset, 2010). This tool contribute to proper planning, time estimation and preparation of bills of quantities which is drawn from individual activities, stating the amount of work to be done in terms of quality (Akpan & Chizea, 2002). BOQ's are merely cost assigned to individual work packages. It is used to ascertain the total project capital outlay; this implies that a Faulty WBS will amount to improper project cost, which is a sign of incompetency and is tantamount to project delay. WBS as explained by (Theodoulides & Kormancova 2014) is essential for activity definition: identification of all activities that constitute a project which must be performed to produce the various project deliverables, and forms one of the key scope management tool used to subdivide the scope of work into manageable work packages for proper project planning, estimation, assignment and controlling. (Theodoulides & Kormancova 2014) opines that WBS function encompasses the decomposition /disintegration of a project into work packages or subtasks, thereby bringing a project into manageable elements in terms of size and complexity, and for proper accountability in terms of costing.

2.1.3 The Bar / Gantt Chart

The bar chart has been recognized as one of the traditional management tool for planning and scheduling functions. It has been recorded, as the most popularly used management tool (Akpan & Chizea, 2002). Many of this exit with their formats, having the ability to simultaneously show

both the planned and actual project progress. This singular characteristic makes the Gantt chart an important and significant tool in project progress reporting (Lewis, 2003). He also stated that the "proliferation of microcomputer based project management packages has led to the revival in the use of Gantt charts". Although it origin is traced to Henry L. Gantt as their developer. The chart is simply a graphical tool that relates the planned progress to a time schedule. The convention is to enumerate along the coordinates, the project activities in order of first activity at the top on the y-axis, while on the x-axis is the time scale. Each activity schedule is represented with a bar that extends from its start date to its termination date. The Gantt chart has stood the test of time and acknowledged by several authors as the most effective methods of communicating planning information, project progress against, actual schedule and effective presentation which is easy to understand and assimilate (Theodoulides & Kormancova 2014). Gantt chart was developed for the monitoring of projects progression and tracking, and has become common in representing activities of a project into work breakdown structure for easy assimilation by a wider audience (Wangi 2012; Olateju et al., 2011).

2.1.4 Gert, Pert and CPM (Networks)

Networks have different meaning depending on the context it's been used. Akpan et al, (2002), defined network as "an intersecting lines which can be simple or complex". It is the point of intersection (node) which is needful in analyzing any network system. It is a point of transition from one state to another, where changes in the input parameters occur (Akpan & Chizea, 2002). The peculiar characteristic of project network is that it is acidic-directed in nature; this means that all paths are linked together and the nodes are numbered in ascending order. Networks are used to obtain a quality tune estimate for individual activity, show the relationship and interdependency of project activities (Kostalova & Tetrevova 2018). According to (David et. al, 2017), PERT and CPM are used to show an explicit precedence relationship, they are both similar in approach and uses "Networks" to represent project task graphically, showing the interrelationship of project components and order of performance for a successful delivery. Network's are essential tools for project planning process and also possesses some distinguishable characteristic; CPM uses a deterministic model, which suits projects whose time duration can be forecast accurately. While PERT on the contrary uses probabilistic approach, suitable for projects whose time duration varies over a range of possibilities (the moderate time, the optimistic time and the pessimistic time), the average of the possibilities gives an acceptable activity time, whereas, GERT model concentrates mostly on probabilistic networks with probabilistic time estimate (Akpan & Chizea, 2002). While PERT and GERT are mostly suitable for complex projects where adequate information is lacking,

this is because it does not look for only one project implementation time and cost, realistic and pessimistic alternative time are considered too (Kostalova & Tetrevova2018).

2.1.5 Earned Value Analysis

The concept of earned value analysis came into existence in the 1967 when the US department of defence (DOD) established the cost / schedule control systems criteria (C/ SCSC) to standardize contractor requirements for reporting cost and schedule performance on major contracts. "It is a methodology for determining cost and schedule performance of a project by comparing the "planned" work with "accomplished" work in terms of monetary value assigned to the work" (Akpan et at, 2002). Earned value analysis then becomes an effective standard employed by industries for measuring of a project's progress at any point in time, predicting its, termination date and cost, and analyzing variances in schedule and budget as project proceeds. Nasser et al, (2016), recommended the use of EVM in controlling the activities of a project against the plan and schedule. This method creates indicators that display project statutes at any given time, whether on schedule or not, or whether is meeting the planned cost or not. According to Proano-Narvaez(2022), "Earned value is a well-known project management tool that uses information on cost, schedule, and work performance to establish the current status of the project". It enables managers to extrapolate a project final effect. EVM is a tool for enhancing project progress control. It help to determine current project status (is it behind or ahead of schedule?, is it over or under budget?) (Proano-Narvaez 2022). As deliveries are completed, project is considered 'EARNED". Earned value indicators as stated by PMI (2004); Akpan et al. (2002) are thus:

Schedule performance index (SPI) = (BCWP/BCWS)

Schedule variance (SV) = (BCWP - BCWS)/BCWS x 100%

Cost performance index (CPI) = BCWP/ ACWP

Cost variance (CV) = (BCWP - ACWP) / BCWP

Note: A negative schedule variance calculated at a given point in time means that the project is behind schedule while a negative cost variance means the project is over budget.

ACWP is the Actual cost of work performed

BCWP is the budgeted cost of work performed

BCWS is the budgeted cost of work scheduled

Cost Index (CI) = (Actual Project Cost) / (original Project Duration)

Schedule Index (SI) = (Actual Project Duration) / (Original Project Duration)

2.1.6 Cost Benefit Analysis (CBA)

This is one of the widely and applied method for project appraisal for complex infrastructural projects in both public and private sector before decisions are made on which alternative to implement. It is aimed at facilitating a more efficient recourse allocation for the convenience of investors, the economy and the project environment. "CBA is a prescriptive method that provides guidance on the criteria to take account in decision making,' ensuring that the net aggregate benefits to society or organization outweigh net aggregate costs"(Olateju et al., 2011). CBA typically uses microeconomic approach, aiding the assessment of a projects positive and negative impact on the society or the proposed environment. Based on this scenario, projections are made of all the cash flows accruable to the operation of the project during its life span and the environmental Condition of the area, with and without the existence of the project. Also projection on economic growth as an aspect of improvement of living standard is considered. According to World Bank, 2012), CBA is an important management tool used for quality planning and scope planning of projects. It helps in establishing the benefit of a project by expressing the project costs and benefits in monetary terms. If the benefit exceeds the cost, then the project passes the test.

According to the World Bank project (2010), cost benefit analysis encompasses sensitivity analysis and distributional analysis. The former accounts for considerable uncertainties about predicted/forecasted benefits and costs, scenarios based on fluctuations in key assumptions are presented, which clarify decision makers on possible uncertainties and how it affects the NPV, and the latter is based on the context of inequality, enabling mutual co-existence of a project and the environment whereby both gains.

2.1.7 Last Planner Technique System (LPS)

Last planner system is a lean construction technique developed by construction industry practitioners for managing Architectural and Engineering construction since the early 90's (Kalsaas, 2012). The LPS is a production planning and control approach that focuses on reducing uncertainties associated with work flow which has been spotted as a missing component in the traditional project management tools (Kalsaas, 2012). The term "lean" "basically means to make

work easy to understand, perform and manage and the main idea underlying this concept is about reducing the waste in process while focusing on things that add value to the customer" (Ansah et al., 2016). They further stated that lean is as much a philosophy and culture as a set of principles or methodologies and therefore could be applied to any industry. The concept of lean rest on five principles that when followed will reduce waste and maximize profit;

i. Value Specification: precisely identify what creates value from the client's perspective.
ii. Value Stream Identification: clearly identify all the steps in the process that delivers exactly the customers values and remove everything that does not add value to the customer.
iii. Flow: take actions that ensure continuous flow in the value stream. iv. Pull: this means to produce only what the customer wants just in time. v, Perfection: always strive for perfection by delivering what the customer wants and expects, through a continuous removal of waste.

LPS is aimed at achieving greater control and predictability in construction work compared to that offered by conventional project management. Koskela & Ballard (2017), describe LPS as a "Scientific experimentation" model. According to Kalsaas (2012), "The last planner system is a practical approach in which construction managers and team leaders collaborate to prepare work plans that can be implemented with a high degree of reliability, thus improving work stability and predictability". LPS seeks to achieve "coordination by plan" (Kalsaas, 2012). Last planner adopts the approach of decentralization in decision making prior to project implementation. It provides the cost planner, trade foremen and design-team leaders, with the authority, information and physical and social space they need to make decisions collaboratively about the use of resources to deliver the proposed project. And also help each team member develop their skills as decision makers (Alan, 2013).

2.1.8 Quality Function Deployment (QFD)

Every industry has its peculiar activities or operations, which may include complex processes or group of small processes which is known as the core business activities carried out by organizations in such industry (Akao, 2024). QFD "is a method for structured product planning and development that enables a development team to specify clearly the wants and needs of customers and evaluate each proposed product capability systematically in terms of its impact in satisfying those set wants and needs" (Akao, 2024). According to Kostalova & Tetrevova (2018), QFD "is an example of a facilitated workshop technique that helps determine criteria characteristics for new product development". QFD is also describe as an effective quality tool for

capturing consumers requirements in terms of achieving customers expected qualities in a project (product) (Cook-Davies & Crawford, 2019). The phases involved in QFD, according to Akao, (2024), are broken down into four respective phases (A, B, C and D) as discussed below:

PHASE A: Known as planning phase, it consists of customer requirement identification and documentation, strategic planning on how to executive a project, a statutory check on the strength and weakness of the organization, as well as a technical ability to meet requirements.

PHASE B: This is known as design phase. Every design requires high creativity and innovative team ideas to identify multiple construction options to satisfy client's requirements. Hence, the need for a good engineering team in an organization.

PHASE C: This phase is referred to as process planning phase. In this phase, plans are made on the best means to execute a project.

PHASE D: This is called the process control phase (Cohen, 1995). In this phase, performance indicators are created to monitor the effectiveness of the processes involved in production of a certain product or services.

3. Methodology

This research employs three primary approaches; these are the explanatory, descriptive and experimental approaches respectively.

3.1 Research design

This research is designed to assess the application of project management tools and techniques in successful delivery of projects, using Abuja as study area. The research design refers to the arrangement or procedures for collection and data analyses. "Research design is the conceptual structure within which research is conducted; it constitutes the blue print for the collection, measurement and analysis of data" (Kothari & Garg, 2014). This study, adopted the descriptive survey method and data were obtained by means of inquiries using questionnaire. These questionnaires were administered by direct contact. The survey took place in a number of forms necessitating a flexible observation method with the use of a "Random Sampling Technique"(Nworu 2009).

3.2 Method of Data Analysis

The data collected from the administered questionnaire were analyzed using the statistical package for social sciences (SPSS) version 17.0 software. Data generated from the study were analyzed and calculated with the use of simple percentage, mean score, Relative Importance Index (RII) method.

4.0 Results

This aspect of the study deals with analysis of results using the method presented in previous sections, which consists of proportions, percentages and tables. In order to assess the various project management tools and techniques used by contractors in building construction projects delivery in Abuja, and to achieve the objectives listed initially. SPSS statistical software version 17.0 was used to run all the analysis.

Table 1.0: APPLICABLE PROJECT MANAGEMENT TOOLS AND TECHNIQUES

TOOLS/TECHNIQUES	RESPONSES	PERCENTAGE	Rank
Cost benefit analysis	29	64	6
Appraisal	45	100	1
Analogous estimation	31	69	5
Bar chart/Gantt	42	93	3
WBS	43	96	2
CPM	34	76	4
PERT	43	96	2
GERT	19	42	7
EVM	29	64	6

Table 1.0 shows the various tools and techniques of project management with responses from construction companies in the study area. Appraisal (100%), WBS (43%), PERT (43%) and Bar chart/Gantt (42%) have the highest percentages of responses indicating that they are the most used tools and techniques in the construction companies consulted, whereas, EVM (29%), GERT (19%), Analogous Estimation (31%) and Cost benefit analysis (29%) are the least tools and techniques used by the construction companies.

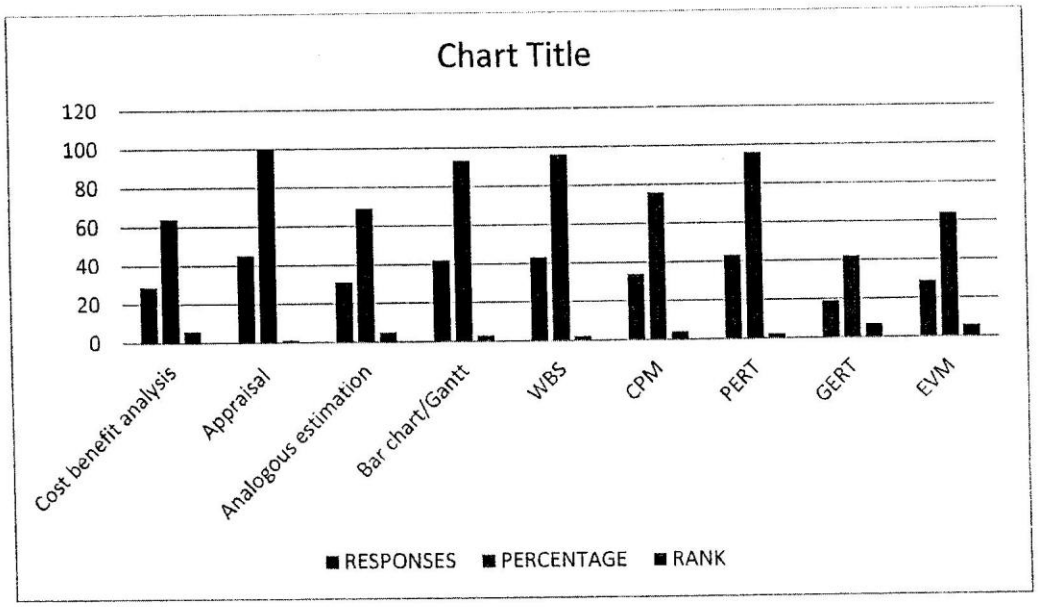

Table 1.0 Gives responses on the list of applicable project management tools and techniques (PMTT) in constructionorganization. The result shows that the rate of their application in the industry. Among all, Appraisal rank 1st with 100% application and others are as follows; WBS & pert rank 2nd, bar/Gantt chart rank 3rd, CPM 4th, Analogous estimation 5th,CBA &EVM6"1, GERT 7th.

Conclusion

This study focused on the assessment of the various project management tools and techniques used by contractors in building construction project delivery. The descriptive cross-sectional research design was used for the investigation. The research design was deemed adequate since it examined the present situation in terms of assessment of project management tools and techniques. These Tools and Techniques includes; Appraisal, Analogous Estimation, Bar Chart, CBA, Work Break-down Structure (WBS),Program Evaluation And Review Technique (PERT),Critical Path

Method (CPM),Graphical Evaluation And Review Technique (GERT), and Earned Value Management (EVM).They are applied in project delivery throughout a project life cycle, and some are phase specific; implying that they can only be applied in a single phase of a project while some can be applied in more than one Phases. The nine (9) PMTT in this study does not represent every PMTT available to project managers. Some PMTT such as Last planner and PRINCE2 were not identified by Respondents. The responses shows that these Project Management Tools and Techniques plays a vital role in helping organizations Integrate available resources, utilize limited time, increase global market competition by ensuring that the time to market is efficient and customer demands are met.

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