APPLICATION OF PROJECT MANAGEMENT CONTROL MECHANISMS IN CONSTRUCTION PROJECTS: A CASE OF PORTHARCOURT, RIVERS STATE, NIGERIA

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Abstract: The construction industry being an industry where large scale projects are undertaken and for the projects to be successfully completed, the right project control mechanism is needed for the achievement of informed decisions. Hence, this paper reviews the project management control mechanisms adopted by construction firms in Port-Harcourt, Rivers State. The major objective of this study is to identify and evaluate the project management control mechanisms used in the successful delivery of construction projects, investigate the extent of application of the project management control mechanisms in the successful delivery of construction projects. The study deployed a survey and exploratory research design methods of investigation, while a convenient/purposive sampling technique was adopted in selecting the sample size of 96 respondents from a population of 143 respondents using the Krejcie and Morgan method of sample size determination from four (4) construction projects located in Port-Harcourt, Rivers State. The instrument for data collection and measurement was made up of structured questionnaires in addition to semi-structured interviews, personal observations with a view to eliciting information from the targeted professionals. The instrument was further validated for reliability with the aid of the Cronbach's alpha test. The collected data were later presented using descriptive statistical tools in the form of frequency distribution, figures, charts, while relative importance index (RII) was used in analyzing some of the main theme of the study using the IBM SPSS Statistics version 20. The findings from the study indicate that earned value management (EVM), was the most deployed project control mechanism in construction project delivery. This was followed by the use of milestones, time-cost trade off analysis (TCTA), location based management (LBM) system and building information modelling (BIM).

Key words: Building information modelling, earned value management, milestones, time-cost trade off analysis, location based management system, project management control.

1. INTRODUCTION

A project is a series of complex and connected activities with a singular purpose of being completed within a specific time frame, budget, quality and specification. That a project must be completed within schedule, budget and according to specification denotes that the project is constrained by all of these parameters hence an effective control is needed in place to meet proposed planned time and budget for purposes of accomplishing the stated objectives (Kotb, Atwa, & Elwan, 2016).

According to Pinto and Slevin (1987), a project is said to be successful when it meet its schedule, budget and satisfies the client. To achieve this, there is need to deploy measurement of some sort to help decide if the project is on track, perhaps if something goes wrong, a corrective action will be put in place. As a project manager, understanding the impact and influence of monitoring and

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control as well as keeping them on check, is critical to the successful delivery of project to fruition (Rupen, 2011). Hence, there is need to expediently apply project control techniques in practically every aspect of a project's phase.

It is well a documented and well-known fact that a good number of construction projects have failed in recent time. Construction projects are dynamic in nature, that is to say that no two projects are exactly the same, hence its tendency to be prone to uncertainties (risks) and demand effective and efficient control. Project failure is usually a collection of minor items that individually have a negative or positive impact and if care is not taken, can lead to a serious impact on cost, schedule, as well as performance. Risks can manifest themselves in such a way that it will result to deviations from the original project plan. It is akin to the workings of a system that is made up of various components that works individually and collectively to achieve a particular aim. If on the other hand, one of the components becomes faulty, that scenario would definitely affect the overall functionality of the entire system. One of the major problem facing construction projects is the inability to deliver such project to time, at the estimated and budgeted cost and within specified quality standards (Usman, Kamau, & Mireri, 2014). Usman, et al., (2014) further pointed out that it is now a routine for construction projects to experience cost overruns accompanied by time overruns and low quality of delivery which often leads to client's dissatisfaction.

1.1 Objective of the study

I. To identify and evaluate project management control mechanisms in the successful delivery of construction projects

II. To investigate the extent of application of the project management control mechanisms in successful delivery of construction projects

1.2 Research questions

I. What are the project management control mechanisms that aid the successful delivery of construction projects?

II. What is the extent of application of project management control mechanisms in successful delivery of construction projects?

2. LITERATURE REVIEW

The construction industry is highly hazardous and comprises of a wide range of activities like construction, alteration and/or maintenance, road and railway construction, bridge erection, residential building construction, excavation, demolition and maintenance projects. It is termed hazard largely due to its complex and dynamic nature requiring a strategic approach and maximum control to achieve its objectives. Kenny (2007) opined that the scope of the construction industry is versed such that it requires utmost control for it to be able to achieve its stated objectives in developing economy. The industry in recent time is evolving, while also remaining so in continuation of its development activities especially in developing countries of the world. It's already one of the largest industry sectors accounting for more than 11 percent of global GDP and is expected to grow up to 13.2 percent (Bharadwaj, & Vara, 2008). On the other hand the issue of cost and time overruns is continuously affecting the construction industry and the economy at large. Leesard (2001) reiterates that the importance of construction projects and other large engineering projects hinge on not only on the transformation of the physical landscape and the change in the quality of human life, but because they are means in which new forms of collaboration are developed.

2.1 Project control and control process

Controlling a project involves making adjustment to both the plan and the schedule as well as where things involving change are inevitable (Kotb, et al., 2016). To be able to achieve predetermine success in the execution of projects, project control practices are established to detect and react appropriately to deviations presumed or detected ab initio. According to A guide to the project management body of knowledge (2000), controlling process is defined as a process that ensures that project objective are met by monitoring and measuring progress regularly to identify variance from plan, so that corrective actions can be taken when and where necessary. It is a complex action undertaken by a project manager in practical terms by constantly measuring progress, evaluating plans and taking corrective actions when required (Olawale, & Sun, 2010). Lewis (2007) defined control as an act of comparing progress plan so as to apply corrective actions as soon as deviations from planned performance are detected. According to the International Project Management Association IPMA (1999), in project management, control is based on comparing between baseline plans of contracts with actual events and deciding what to do when the two acts don't match. Kenley and Harfield (2015) also defined control as the application of project control systems systematically. Cost and time of construction projects are controlled with the sole objective of delivering projects within the predetermined time and budgeted cost and as a matter of fact, determining these objectives is the starting point of project control because it serves as a baseline for measuring performance. (Kotb, et al., 2016). In a bid to draw a clear distinction and understanding between monitoring and control, Ahern, Clouse and Turner (2001) noted that monitoring involves planning parameters, risk, stakeholder's involvement, milestone review, while control consist of both all the aforementioned and the necessary actions taken to control deviations. Bharadwaj, & Vara (2008) also affirmed that monitoring is the initial stage of project control and involves mostly the generation of reports. More so, in drawing a distinction between the two, Jackson (2004) reiterated that project control requires continuous monitoring and evaluation of actual performance for all aspect of the job that have impact on cost, time and quality of the project. While control could mean making decisions proactively not reactively to guide the direction of the project (Kotb, et al., 2016). While on the other hand, monitoring, evaluation and corrective actions are the critical aspects of project control (Bharadwaj, & Vara, 2008). The illustration below gives an explicit picture of a feedback process.

Bharadwaj & Vara (2008) noted that construction projects are dynamic and complex and as such monitoring and control actions are inevitable to achieve success. Almost all projects, including construction projects are exposed to threat or risk of cost overrun, delayed schedule, failure and desertion and there is likelihood of failing to meet the quality standard and set objective and A guide to the project management body of knowledge (2000) noted that controlling includes taking preventive actions in anticipation of possible problem. IPMA (1999) mentioned that project management should be backed up with project control processes that monitor work and detect or identify whether it is progressing as planned or not. Construction industries as stated above is a firm where large scale (mega project) and project of different kind are carried out and for these project to be successful various effective project control mechanisms are deployed to gather information to control projects as more projects are restricted to budget, schedule and specification, projects control mechanism are gaining importance (Bharadwaj, & Vara, 2008). Information as noted by Lewis (2007) are the primary ingredients of control rather than power hence we involve monitoring system as they are the start points to achieving effective and efficient control in construction projects.

As stated by Rupen (2011), the type of factors that influence a project during execution do find their roots in some obvious and some not-so-obvious sources like the scope, scheduling, human resources, cost and risk management. Therefore, project control techniques should be applied practically in every aspect of a project. Project control is being practised in construction industry to a greater extent, but unfortunately projects of various magnitudes runs over budget and behind schedule and quality. It is imperative to state in this situation that it's either that the control system is limited or the knowledge is lacking. A control system as opined by Lewis (2007), should focus on responses. Lewis (2007) went further to state that if a system doesn't use a deviation data to initiate corrective actions, then it is not really a control system but simply a monitoring system. In a nutshell, a project control environment should encompass the following project functions (Kotb, et al., 2016):

- Estimating
- Cost control
- Variation/change control
- Project reporting
- Planning and control management
- Risk analysis

Lewis (2007) noted that one of the characteristic of project control system is to focus on project objectives in order to ensure that the envisaged mission statement is accomplished. A typical project control system should therefore answer the following questions;

- ➢ What is its importance to the organisation?
- ➢ Which aspects of the work are most important to track and control?
- ➢ What are the critical points in the process at which controls should be placed?

Gardiner (2005) clearly noted that the complexity and dynamic nature of construction projects need unlimited control mechanism and Kotb, et al., (2016) confirms that control systems have to be dynamic and ongoing throughout the life of a project. Industries use control system/mechanism to provide stakeholders with reliable and accurate information that can be used to make decisions necessary to successfully deliver projects and the success of a project depends on employing the right project management control mechanisms (Kotb, et al., 2016)

2.2 Project control mechanisms

Generally, as it has been mentioned earlier on, the concept of project control mechanism is to detect problems and take corrective actions by putting things in their right perspective. This is basically focused mostly on cost, schedule and performance. A myriad of project control mechanisms exist in the literature, cursory look at some of them will suffice.

2.2.1 Earned value management (EVM)

Earned valued method has been developed as a tool for facilitating project progress. It allows project managers to make prepositions on the final effect of the project in terms of duration, by extrapolating current trends (Czarnigowska, 2008). Earned value management helps to provide basis for accessing work progress against baseline plans by relating technical, time and cost performance, provide data for pro-active management action and provide managers with summary for effective decision making (Nagarajan, 2014)**.** According to Naderpour and Mofid (2011), the earned value management concept was conceived by industrial engineers -working in American factories over a century ago. In 1960s, earned value management emerged as a financial analysis specialty in the United States' government Programme, but recently it has become a significant branch of project management in the late 1980s and early 1990s. EVM emerged as a project management methodology to be understood and used by managers and executives and not just EVM specialists (Leesard, 2001). Naderpour & Mofid (2011) stated that, EVM is an early warning tool for project control, that is, to say if you want to know what is happening to the cost and schedule indices of a project before its completion. EVM is considered as one of the most advanced technique for the integration of schedule and cost parameters (Naderpour & Mofid, 2011). It is imperative to note that before any EVM analysis can occur, a few basic project management activities must be handled. These activities includes; creating a work breakdown structure- that is, disaggregating the project into manageable elements of task or packages, such that each activity can be allocated cost and time variables.

According to Kenley and Harfield (2015), EVM has a significant feature in applying performance indices to forecast project cost and time, in this manner, the progress and performance analysis outcomes will indicate corrective actions that will go a long way in mitigating risk.

Parameters for Earned Value Computation

Prior to the computation of the relevant parameters in EVM, the following should be updated.

- ➢ Update the schedule based on the current progress

- Update the actual cost associated with the current progress
- Calculate key values variance (cost and schedule variance) and ratios (cost index, schedule index, resource and schedule index)

The input data required to calculate the variances in project status and the extent of the variances in EVM are as follow (Czarnigowska, 2008; Rory, 2009; Shirjeel, 2015).

Budgeted Cost of Work Performed (BCWP): This is also referred to as earned value. It is the measurement of the value of work done at a particular time.

Budgeted Cost of Work Scheduled (BCWS): Also referred to as planned cost. It is the cost of work planned/scheduled as at date of review.

Actual Cost of Work Performed (ACWP): This is the real amount/cost incurred as a result of executing the project up till the date of progress reporting.

Budget at Completion (BAC): This is the overall budget or total budget allocated to the project.

Estimate at Completion (EAC): This is the revised budget for the activity/work package/project. It is the estimate cost of the project at the end of the project hence if the ACWP is less than the BCWP, then the EAC will be less than the BAC as well. There are three methods of calculating EAC. The first assumption is that the current variance will continue to be present in the future then the formula used will be EAC = AC + (BAC – EV)/CPI

Secondly, when the present variances are typical and are not expected to occur in the future then, EAC = AC + (BAC – EV). Lastly when the past estimating assumptions are not valid and fresh estimates are applied then, EAC = AC + ETC.

Estimate to Completion (ETC): This is the total expended cost of the project- that is, the estimate required to complete the remaining part of the project, ETC = EAC-AC. Then to get the key indices in Earned Value Analysis.

Cost Variance (CV): This is the measure of the differences/deviations between the planned and actual cost of the work done as at the date of review (BCWP-ACWP). In this case, a positive value indicates that the project is running below budget, whereas a negative value indicates that the project is being cost overran with respect to the budget. To capture the extent of cost deviation, that is, how much overrun or under run the cost of the project is in terms of percentage (CV %). CV %=(CV/BCWP)*100.

Schedule Variance (SV): This is a measure of time deviation between the planned and actual progress. SV = BCWP – BCWS. A negative value indicates that the project is behind schedule and a positive value indicates that the project is ahead of planned progress. Then to equally determine the extent of schedule deviations, SV%=SV/ BCWS.

Cost Performance Index (CPI): This ratio shows the efficiency of utilization of resources allocated to projects. CPI = BCWP/ACWP. A value above “1” shows that the utilization efficiency is good and a value below “1” show utilization efficiency is not good.

Schedule Performance Index (SPI): Shows the efficiency utilization of project time. SPI = BCWP/BCWS. SPI value above “1” shows that the project time is being utilized well and if the value is negative, that shows that the time allocated to project is not being utilized well.

By using EVM in a project, the manager is able to have the exact and clear information concerning the project’s details and can mitigate the risks in his decisions in critical conditions of the project (Naderpour & Mofid, 2011). Andrzej (2014) pointed out that EVM can be used successfully not only for cost management of construction projects as has been the case, but also deploying some additional approaches for project duration management even if a lot of variation orders should be considered during the project execution period. Andrzej (2014) went further to state that the application of the method together with other contemporaries dedicated for EVM-known approaches, makes the method well fitted for use in complex, dynamic and multidisciplinary construction projects. According to Czarnigowska (2008), the EVM method has been recognized as one of the useful tools used by many practitioners and public institutions and as such has become a standard in project management. The method has proved to be versatile enough to be deployed to any type of a project, ranging from defence and to information technology related projects.

2.2.2 Time cost trade off analysis

Kotb, et al., (2016) confirms that cost and time are the two basic parameters that form the foundation of project control and that controls are instituted before the actual production/execution task commences and are fully functional until the completion of the project. Activity durations oftentimes vary depending on the type and amount of resources that are applied. For instance, more workers to a particular activity normally results in a shorter duration, and the crashing of activity duration may result in higher costs and lower quality. Time Cost trade-off is an important management tool for overcoming one of the critical path method limitations of not being able to bring project schedule to a specified duration (Elbeltagi, Hegazy, & Grierson, 2005). As the name implies, it involves striking a balance between time and cost of a project. This can be done by selecting some activities on the critical path to shorten their duration. This is achieved by studying the availability of resources and their demands as well for a given project (Nagarajan, 2014). The objective is to reduce the original duration at the minimal possible cost.

Activity time can be reduced by one of the following ways:

- Working on weekends or Holidays.
- Using additional resource
- Applying multiple shift or worker extending working hours
- Using materials or equipment/machines that have faster operating time (Elbeltagi, et al., 2005).

The aforementioned involves extra cost, so also when cost is limited, it also affects the duration of the project, and the main aim is to arrive at the very minimum. Shortening duration will always increase the direct cost associated with that particular activity. It is imperative to note that the cost of expediting any activity in a project is assumed to be linearly related to the activity duration such that as the duration increases, the cost decreases and verse versa. Time cost trade-off analysis generates a schedule of project activities to determine project duration having the minimum total project cost from a clear consideration of both the direct and indirect costs.

Biswas, Karmaker, & Biswas (2016) summarised the procedures for shortening the project duration in the following steps:

- Step 1: produce the network diagram.
- Step 2: determine the project activity duration by using either critical path method or PERT method, identify the critical path using normal duration and cost for all the activities.
- Step 3: determine the cost slope of each activity using the formula, Cs =(crash cost – Normal cost)/(Normal duration – crash duration).
- Step 4: start by shortening the activity duration on the critical path which has the least cost slope and do not shortened beyond its crash duration or until the critical path changes.
- Step 5: when multiple critical paths are involved, the activity to shorten is determined by comparing the cost slope of the activity which lies on all critical path with the sum of cost slope for a group of activities.
- Step 6: having shortened a critical path, adjust timing and floats.
- Step 7: the cost increase due to activity shortening is calculated as the cost slope multiplied by the timing units shortened.
- Step 8: continue until no further shortening is possible and then the crash point is reached.

Crashed time and cost according to (Biswas, et al., 2016) are conflicting factors, in that the reduction of one increases the other. Time-cost trade off will help achieve the following:

- Finish the project in a predetermined deadline date.
- Recover early delays.
- Receive an early completion bonus.
- Improve project cash flow.
- Free-key (make resource available) early for others projects.
- Avoid adverse weather completion that might affect work at a construction site.

2.2.3 Building information model (BIM)

BIM is a digital representation of physical and functional characteristics of a particular facility (Building project) (Cramer, Cramer, & Hunt, 2010). It allows the building to be built in a virtual environment before the actual execution of the building project. Kenley and Harfield (2015) defined it as a set of interacting policies and technologies that generates a methodology to manage all essential design and project information of construction projects. According to Denis (2015), it is a 3-dimensional representation of a building in which all the element that comprise of the building are considered as objects connected to each other. BIM is driven by the desire to effectively allocate and consume the huge but scarce resource required to put up a construction project. It allows contractors to easily figure out deviation during the execution process. BIM is not about the "B" and the "M", the key thing is the "I" (Information) in it (Cramer, et al., 2010). The purpose of BIM is to make the design lucid and the program properly communicated and understood, it is therefore not just a drawing. It is a data repository for building project design. The use of BIM is seen in cost management, construction management, project management and facility operation, it goes beyond the planning and design phase of the building project lifecycle, supporting and controlling processes in construction in order to reduce uncertainty, improve safety, workout problems on time, simulate and analyse potential impact hence minimise waste of resources generally.

BIM is an emerging technology and procedure shift within the Architecture, Engineering, Construction and Operations fields (AECO). Kenley and Harfield (2015) mentioned that the result from project control professionals made them conclude that BIM tool is still a "work-in-progress" and that a continual research will propagate its growth. BIM is generally used during design, construction and operations in order to;

- Provide support for project decision making process.
- Enhance communication and give a clearer understanding of the project to the stakeholders.
- Help visualize design solutions and make execution process more effective and efficient.
- Support the cost and lifecycle of the system and provide a baseline for project monitoring and control (Denis, 2015).

In addition BIM allows project manager to quickly optimize construction schedule with ever-changing material deliveries, seasonal cost and availability. It goes a long way to reduce error and omission. Nevertheless, it is argued that BIM still possesses certain limitations, in that, the aspect that borders on innovations are still being studied. Denis (2015) opined that BIM usage induces changes in the repetition of workload hence resulting to the adjustment of financial plans. Kenley and Harfield (2015) further noted that organisations that make use of BIM do not use it in all projects largely due to issues relating to capacity and capability of all types of resources. BIM is effective in some projects and works reasonably well but it is still only 50% effective on sites (Kenley, & Harfield, 2015). As stated by Cramer, et al., one of the main problems BIM adoption is encountering today, is the lack of BIM expertise and lack of industry standards as well as the perspective BIM places on construction project management domain (Bryde, Broquetas, & Volm, 2013). However the prospect of BIM is optimistic beyond 3D, BIM is emerging as a new powerful technology (Denis, 2015). BIM is currently the most common denomination for a new way of approaching the design, construction and maintenance of building projects.

2.2.4 Milestone

Milestones are tools used in project management control processes to mark specific points along a project timeline. They are the underlying important events during the life cycle of a project. It is a significant event in the project usually achieved at the completion of major deliverable (A guide to the project management body of knowledge, 2000). Milestones tend to focus on major progress points that must be reached to achieve success. Milestone provides detail review at different points during project execution and hence it may be referred to as a project control tool as it is much more used to accurately determine if a project schedule is on track or not, allow indications of schedule deviations and provide a better view into the activity whose completion is critical. By so doing, the project activity are broken down into different sections referred to as control points, and this breakdown into manageable chunks would naturally aid effective cost and schedule control of a complex project as opined by (Olawale, & Sun, 2010).

Furthermore, every milestone can only be passed when the previously formulated requirements for the detected deviations have actually been fulfilled; it is equally possible to make an exception only in cases that are non-critical. Milestones are a feature of many project management software tools and often appear on Gantt Chat view, represented by a diamond symbol. On display, the client of project manager can assess the state of development of the project and consider whether to progress to the next stage or do some adjustments. However, it is important that milestones are allocated to the achievement of a task, not to the task itself. However, there are also limitations to their effectiveness. They usually show progress only on the critical path and non-critical activities.

2.2.5 Location based management system (LBMS)

LBM approach assumes that a project should be broken down to a physical location and detailed design work and all project data should be planned and controlled using those locations (Seppänen, 2017). Kenley and Harfield (2015) opined that location based data allows performance to be reported at the level of location for many functions including time, quality and cost throughout a project lifecycle, hence LBM constitutes both planning and controlling system. LBM controlling system includes collecting detailed location based progress data and refining it by calculating progress metrics, forecast and alarms (Seppänen, 2017). Seppänen (2017) also noted that tracking the actual quantities for each location helps to detect quantity deviation which can get critical if they repeat in other locations.

Kenley & Seppänen (2009) stated that locations are important in construction because building can rarely be seen as a continuous repetitive construction process but rather as a series of physical locations in which work of various types and quantity must be completed. Seppänen and Kenley (2005) noted that the basis for monitoring in LBM falls on four aspects viz:

- Actual start and finish dates and interruptions.
- Actual quantities.
- Actual resources.
- Actual shift length and day offs.

According to Seppänen and Kenley (2005), actual start and finish dates of each location is a basic requirement for tracking and for all downstream calculations and visualisation. However, it is possible to show status in control chart if the actual start and actual finish dates are known. Nevertheless, LBM is limited in that the people using it are not following the location philosophy and as such control tools will not become an industry standard without significant capability and capacity (Kenley, & Harfield, 2015).

According to Kenley and Harfield (2015), in a study, only few project control professionals gave positive evaluations of the effectiveness of LBM, that is to say, it possess some limitations as well. It is on that note that Seppänen (2017) pointed that more research is required to determine the best location based planning and controlling strategy.

3. RESEARCH METHODOLOGY

The survey research method of collecting data is used in this study as well and it is predominately carried out by the use of questionnaire and then others which includes interview, semi structured interviews and observation. And this is often used to assess opinion, thoughts and feelings of some of the professionals who are experienced personnel on the subject matter. This will allow one to accurately generalise the findings and make conclusions. Primary and secondary sources of data were also used in collating information related to the study.

The survey questionnaire was prepared in different sections. Section A consists of the demographic information about the respondent profile, Section B contains the general concept and understanding of project control mechanisms. A Likert 5-point scale was used in eliciting responses from the respondents. The organisation chosen are well known construction firms located in Port Harcourt. The individuals selected from these organisations consist of project managers, site engineers, project engineers, projects supervisors, clients, consultants and other individuals that work in the project monitoring and control departments of these organisations hence their responses are expected to be of valuable importance to this work and as such the data collected will meet the requirements of the study.

In determining the sample size, the Krejcie and Morgan method of sample size determination was deployed (Krejcie, & Morgan, 1970). While the convenience/purposive sampling techniques were deployed in selecting key professionals from the construction firms. From a population one hundred and forty three (143), ninety six (96) questionnaires sent to the professionals as part of the sample size.
The collected data was edited, coded, and tabulated, while descriptive statistics was deployed in analyzing the quantitative data. Tables were used in presenting and explaining the results. Relative importance index (RII) was adopted in evaluating the extent of use/application of the project management control mechanisms in the successful delivery of construction projects in the study area. This was achieved with the aid of IBM SPSS version 20. The Relative Important Index (RII) is given in the formula below:

RII= Sum of weights (W1+W2+W3+……+Wn)/A*N (1)

Which is RII=∑W/A*N (2)

Where w=weight given to each factor that ranges from 1-5 where is the highest weight (that is 5 in this case) and N is the total number of respondents.

3.1 Results responses from questionnaire

The population for the study consists of one hundred and forty three (143) practitioners from four (4) selected construction projects located in some construction firms in Port-Harcourt, Rivers State. Convenience/purposive sampling techniques were deployed in selecting key professionals from the construction firms. About ninety six (96) questionnaires were retrieved thus forming part of the sample size. Ninety (90) questionnaires were thereafter collated for purposes of data analyses, while eighty four (84) of the questionnaires were later found useable for further data analyses.

Test for reliability and validity

The level of consistency for of each item related to the questions on project management control mechanisms for successful delivery of construction projects was carried out with the aid of the Cronbach's alpha test. The Cronbach's alpha coefficient as stated by Guar, & Guar, (2009); and Pallant (2005) is one of the critical tools used in determining how reliable and valid a data is. Table 1 below shows the result of the internal consistency of the various items of the project management control mechanisms using IBM SPSS version 20.

Table 1: Cronbach's Alpha Coefficient

Reliability Statistics	
Cronbach's Alpha	N of Items
.847	8
.865	5

The outcome of the Cronbach's Alpha coefficient for all the eight (8) perceptions of the respondents to project control mechanisms and five (5) project management control mechanisms for successful delivery of construction projects is 0.847 and 0.865 respectively. This results show that the instrument is reliable and has some level of proof of internal consistency. According to (Guar, & Guar, 2009; Pallant, 2005), a Cronbach's Alpha coefficient reliability value of 0.6 to 0.7 is usually adjudged acceptable and hence could be used for further analysis. The data set for this study possesses some high level reliability and is valid given the results of the reliability statistics.

Categorising the respondent's profile with frequency distribution.

Table 2: Type of construction related activities

	Frequency	Percentage
Road and bridge construction	22	26.19%
Residential and commercial Buildings	61	72.62%
Stadium and other facilities	1	1.19%
Total	84	100

Table 2 show that the construction firms engage more on residential and commercial building projects (72.62%), while road and bridge construction projects followed suit with (26.19%) and least were stadium and other facilities (1.19%).

Table 3: Industrial Players

	Frequency	Percentage
Contractors	27	32.14%
Consultants	12	14.29%
Project/Site Engineers	14	16.67%
Site Managers	11	13.10%
Project Managers	9	10.71%
Quantity Surveyors	5	5.95%
Project Supervisors	6	7.14%
Total	84	100

The professionals in the industry consist of contractors dominating the space with 27 (32.14%), while project and site engineers 14 (16.67%) followed suit. While project supervisors 6 (7.14%) were least.

Table 4: Years of Experience

Years	Frequency	Percentage
0-5	16	19.05%
6-11	32	38.10%
12-17	24	28.57%
18 and above	12	14.29%
Total	84	100

In terms of the years of experience of the respondents, majority 32 (38.10%) have spent between 6 to 11 years, while 24 (28.57%), spent between 12 to 17 years. While the least 12 (14.29), have put in 18 years and more in the industry.

Table 5: Qualifications of Respondents

Qualifications	Frequency	Percentage
OND	7	8.33%
HND/B.Sc./B.Eng.	53	63.10%
MBA/M.Sc./M.Eng.	24	28.57%
Ph.D	0	0%
Total	84	100

In terms of academic qualification, majority 53 (63.10%), had HND/B.Sc/B.Eng as their qualification. This is followed by 24 (28.57%) having a master's degree. While none had a Ph.D.

Table 6: Source of knowledge of project control mechanisms

	Frequency	Percentage
Company Training	21	25.0%
Personal Knowledge	17	20.24%
Educational/Institutional Training	34	40.48%
Experience	12	14.29%
Total	84	100

On the sources of knowledge about project management control mechanism, majority of the respondents 34 (40.48%) had about it via educational/institutional trainings. This is followed by company training with 21 (25.0%) affirming to that. While 12 (14.29%) making the least had theirs via experience.

Table 7: A confirmation of the respondent's perception of project control mechanisms

S/N		Frequency	Percentage
1	The company see project control mechanism as a sensitive practice that is ongoing throughout the life cycle of their project	22	26.19%
2	Control processes begin at the initial phase and end at the conclusion phase of the project	14	16.67%
3	The organisation deploy project control mechanism in project delivery	10	11.90%
4	We sometimes deploy control mechanism but my company prefers the manual method of project control	8	9.52%
5	The organisation is not aware of project control mechanisms and therefore rely on manual method of project control	5	5.95%
6	My company does not see the need to implement/adopt project control mechanisms	4	4.76%
7	The company has a reliable reporting system	15	17.86%
8	The control procedure is the same for every project.	6	7.14%
	Total	84	100

The table above confirms the perceptions of the respondents on project management control mechanism. Majority, about 22 of the respondents (26.19%), opined that their company see project control mechanism as a sensitive practice that is ongoing throughout the life cycle of their projects. This is followed by the company has a reliable reporting system with 15 (17.86%) of the respondents attesting to that. While 8 (9.52%), being the least were of the view that they sometimes deploy control mechanism but that their company prefers the manual method of project control.

Table 8: Extent of application of project management control mechanisms

S/N		SA	A	N	DA	SD	Sum	**RII**	Ranking
		5	4	3	2	1			
1	Earned Value Management (EVM)	32	17	15	12	8	305	0.20	1st
2	Milestone	28	18	12	16	10	290	0.19	2nd
3	Location Based Management (LBM) system	15	25	6	18	20	249	0.17	4th
4	Building Information Modelling (BIM)	10	19	20	17	18	238	0.16	5th
5	Time-cost trade off analysis (TCTA)	23	15	19	14	13	273	0.18	3rd
SA=strongly apply, A=apply, N=neutral, DA=do not apply, SD=strongly do not apply									

From the table above, it can be inferred that earned value management is the most frequently applied/used project management control mechanism with a relative importance index (RII) score of 0.20 and was ranked first. This is followed by the use of Milestone with RII score of 0.19, Time-cost trade off analysis with RII of 0.18, location based management system 0.17 and finally building information modelling system, 0.16

4. DISCUSSION OF RESULTS

From the findings, the responses were gotten from more of project engineers, contractors, consultants and site managers in the field and it has been authentically deduced from the findings that the industry makes use of these tools and the agreed that is quite expedient and effective for the successful delivery of construction projects. From the result, it was deduced that these mechanisms are deployed to a fair extent except to the fact that the above mentioned factors pose a serious issue and results to low implementation of these mechanism. As shown in table 7, the findings confirm the perceptions of the respondents on project management control mechanisms. Majority of the respondents, consisting about 22 of the respondents (26.19%), were of the view that their company see project control mechanism as a sensitive practice that is ongoing throughout the life cycle of their projects. While the company having a reliable reporting system in place with 15 (17.86%) of the respondents affirming. While the least, about 8 (9.52%) of the respondents affirm that they sometimes deploy control mechanism but on the other hand, their company prefers deploying the manual method of project control. From the foregoing, it is obvious that the respondents were not ignorant of the fact that project control is part and parcel of proper project management. Control plays a pivotal role in the construction industry, this is because despite the fact that planning is expedient, most times projects do not achieve their stated goals 100% as planned, but as such, what drives the project to a successful end is the control practices adopted. Controlling a project involves making adjustment to both the plan and schedule where changes are envisaged (Kotb, et al., 2016) with a view to bringing the project back on track.

On the extent of application of project management control mechanisms, the study found out that, earned value management (EVM) was the most frequently applied/deployed project management control mechanism with a relative importance index (RII) score of 0.20 and was ranked first. This was followed by the use of Milestone as a control mechanism with a RII score of 0.19, while time-cost trade off analysis (TCTA) with RII of 0.18, location based management (LBM) system 0.17 and finally building information modelling (BIM) system 0.16 in that order.

The findings from this study agrees with that of Czarnigowska (2008); Naderpour, & Mofid (2011), who were of the view that despite the fact that EVM is being deployed on a much simplified model of a project, it has been widely used in practice, in a nutshell, many organizations worldwide adopted EVM as a standard management tool. The outcome of this finding is totally at variance with the recent modern day deployment of information technology related project control mechanisms that has been used to achieve effective and efficient control in project management. Notable amongst these control tools are the use of building information modelling system. As stated by Denis (2015), BIM facilitates the quality control process as well as validates the processes by clearly defining the project's specifics.

5. CONCLUSION AND RECOMMENDATIONS

From the research, five (5) project management control mechanisms were identified and from the result obtained in the analysis, there is a general believe on the awareness on the use/application of project management control mechanisms in the delivery of construction projects in Port-Harcourt, Rivers state. Majority of the respondents opined that their organization see project management control mechanism as a sensitive practice that exist throughout the life of their projects and as such, adequate attention should be accorded to their entire control processes.

The study finally concludes that, earned value management (EVM) was the most frequently applied/deployed project management control mechanism amongst the various project management control mechanisms identified and evaluated.

Based on the findings emanating from this work, we hereby recommend that project managers should try as a matter of necessity insist on the best practice for every construction firm. Ignorance of the project management control mechanisms should not be an excuse, practitioners within the built industry should go for the knowledge in other to improve on their project management control performances.

Project managers and other construction managers within the built industry should avoid at all cost *cutting corners* and do their job as perfect as possible. Construction firms should as a matter of necessity train their staff on how to apply some of these mechanisms notable amongst them, the use BIM, TCTA in addition, to help critically *nip in the bud* the problems associated with project management controls.

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