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Proactive Project Management Framework

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ABSTRACT: *The characteristics of construction projects pose serious challenges in its management. Yet, the management is still largely traditional which is reactive in nature. Traditional management doesn't match the challenges of complex nature of construction characteristics. This breeds suboptimal responses toflow inefficiencies in the management process. Construction projects therefore continue to present cases of failed objectives. Posited, is the need for proactive management approach as feasible way to attain the requisite success level in construction projects management. However, models that satisfactorily offer the proactive need are still on demand. This work is a prelude study to the development of a proactive management model. A framework developed herein will offer a guide for the development of afeasible proactive management model for construction projects. Three main components were first theorised and developed. These are (1) Management Best Practice Modulesarea set of twelve modules collated from literature andorganisedin a manner that can guide the project implementation process, (2) the Culpability Measurement Card classified impeding factors against project management successesand present a means to measure flow inefficiencies and the culpability of a stakeholder in an ongoing process. Lessons are learned, captured, processed and stored for reuse, and the data form basis for depicting trend in process flow direction. Finally (3) a MathematicalModel was developed using the incremental rate approach. The model can predict values of cost changes at chosen periods in an ongoing project. Synthesised these three theories together presents the desired flow chart framework. The model will effectively respond in a proactive manner to cost, time andquality challenges if key variables identified are attained and fed into the frame. Researchers are offered a framework to develop a proactive cost management model which also provokes interest for further research in a field that has been left underexploited for long. It is recommended that further research on this field be explored more vigorously especially along computer programming systems.*

Key Words:*Best practice, Building Construction, Framework, Proactive project Management, Process Flow, Traditional management*

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I. INTRODUCTION

The management of construction projects is aimed at achieving success on set objectives, but the success level in the sector had been poor despite efforts. Constructionproves more difficult to manage when compared to other kinds of projects due to its complex characteristics (Muhamid, 2013). Attempts to improve on the success level has not yet reached the desired satisfactory stage (Abanda, Tah, Pettang&Manjia, 2011; Omotoso, 2012, Iyer& Banerjee, 2015). Johnson (2010) opined that innovations in the management practice ofconstruction projects lag behind, consequently, faces impediments from the traditional way it is prevalently being managed, which is reactive in nature. Most times (Johnson,2010), managers are backward looking, and determining where to go based on what happened (or didn't happened). Projectmanagers resolve problems and apply resources in areas that need fires put out". Blended with this, is inadequate cost accounting system because (Kern &Formoso, 2003) cost control still consists mainly of monitoring actual performance against costestimates and identifying variances This practice lackstransparency allied with late responses to challenges, thus, preventing early identification andcorrection of process flow inefficiencies. To attain the desired success level in management, the proactive way of managing construction projects was recommended(Lockyer and Gordon, 1996; Arrow, 2008; Johnson, 2010; Bal, Bryde, Fearon. &Ochieng, 2013). Proactive is not asking "What went wrong last week?" Rather,"What is about to go wrong?" (Johnson, 2010).

However, the development of a feasible model to proactively manage construction projects seems to allude researchers as little efforts have been put along this direction when compared to other construction research fields. Developing a proactive management model (PMM) to manage construction projects will bring about the desired level of success envisaged in management. This worknot only elicit more research interest in this field, but develops a framework that lays a comprehensive background for the developmentof a feasible proactive management model (PPM) for construction projects.

II. LITERATURE REVIEW

The concept "proactive" has been long in research fields and described in diverse ways. Related concepts and terminologies common in literature are forecasting, predicting, estimating, anticipatory management etc. These terminologies connote availing today the future expectations. However, when it relates to construction projects, the predictive practices have been so difficult. The application of these concepts have not also been restricted more to cost projections which fall short of the more robust need in Proactive Project Management (PPM) content, but lack comprehensive models to meet the PPM demand. OpinedArrow (2008), PPM is very much a pragmatic way of working toward project objectives which entails availing flaws in the management practice before they actually occur (Johnson,2010). Stated further, resources are assigned to areas where the greatest risks lie, as opposed to where thebiggest fires rage.Added Johnson (2010), formal discussion, documentation, tracking andreporting performance is best means of PPM. Arrow (2008) posited seven tenets of PPM as:

i. Management committed to performance.
ii. Starting the management process early in the project lifecycle.
iii. All key stakeholders included in the process.
iv. Evaluating and updating responses periodically during the project life cycle.
v. Following through with actions until risks are acceptable.
vi. Align a project's level of risk with cost and schedule contingencies. And,
vii. Effectively communicate to stakeholders on the progress, changes and responseplans.

These tenets believed Arrow (2008), form the key to a proactive management of projects which are lacking in allied concepts like forecasting, predicting, etc. Yu, Yang, Tseng and Yu (2007) in attempt to be proactive proposed a proactive problem solving system which works by accumulating previous lessons that solves problems based on lessons-learned from previous projects. Pursuant to Arrow (2008), the development of a framework that will lead to the development of a more feasible proactive management model is achieved herein. The research consulted wide literature while blending amathematical model to achieved the aim of the paper.

III. METHODOLOGY OF THE RESEARCH

Literatureavailed the kind of challenges construction production process encounters most often. These challenges emanate from two dimensions namely, process flaws and market price changes (inflation) in which any feasible management model must consider. Three components of the framework were therefore developed and synthesized into the desired frame in line with this. To attain to the process flaws in building construction, these (1) Best Practice Modules and (2) TheCulpability Measurement Card were developed. These two components offer a process implementation efficacy through effective review and feedback, preemptive information acquisition and lessons learning mechanism for a continuous process improvement approach. To care for inflation, a (3) Mathematical model was also developed. The mathematical model predicts cost changes arising fromhistorical cost data that established market trends. The various components of the model are discussed more detailed as follows:

Best Practice Modules

Construction project management consists of various aspects, concepts and stages that pool together to bring about success in the acquisition process. For example, good supply chain management brings about improved productivity (Vrijhoel and Koskela, 2000), material management reduces waste (Veronika, Riantini, &Trigunarsyah, 2006), a well-planned and carefully monitored and controlled contract impacts positively and directly on performance and profitability (Inuwa, Githae and Stephen, 2014), and stakeholders' management aligns interests and reduce disputes (Bal et al., 2013). Table 1 presents some aspects of research works that point to best practices for successful construction projects execution.

Table 1: Research works that address management challenges

	Researchers	Area of research interest addressed	Key issues addressed
1	Vrijhoel&Koskela (2000)	Supply chain management	Clarifies the roles and possibilities of supply chain management in the construction industry.
2	Inuwaet al. (2014), Gandu, (2015)	Planning, monitoring and control	Planning techniques and application to projects,
3	CIOB (1997), Brook, (1998), Aretouliset al. (2006), Bari (2008), Carbasho, (2009), Ashuri& Lu, (2010), Marzouk& Amin, (2013), Bayraktaret al. (2011). Gandu, (2015).	Forecasting cost, estimating functions, cost modelling	Cost forecasting models and index developed, best practice in estimating, building information modelling.
4	Construction Excellence, (2004), Rashid et al., (2006), Oyegoke, (2006), CII, (2008a), Yusofet al. (2011), Idoro, (2011), dvpm, (2013), Kadiri et al., (2014), Muhammad et al., (2015).	Procurement options	Sequential development of methods, strength and weakness, choice of relevant methods for projects, characteristics that influence construction to deliver.
5	Ashworth (2010), Ali et al. (2010).	Collaborative procurement like partnering and alliancing.	Principles of collaborative procurement, partnering chatter
6	Chinyo (2009), Bal et al. (2013).	Stakeholders' management.	Identification of interests and mapping of stakeholders
7	Yu et al. (2007), Construction Industry Institute, (2008b), Billows, (2011).	Knowledge management and lessons learnt	Identifying reasons for lessons loss in construction, Capture, retention and processing of knowledge capital, effective management practices and technologies, proactive way of managing projects
8	Koskela (1992), Bertelsen, (2004), Marchensan&Formoso (2003).	Process design and management, Lean construction.	Articulation of new production paradigm, managing processes and elimination of waste or extraction of non-value adding activities in processes
9	Senaratne& Sexton (2008), Sun &Meng, (2009), Hwang & Low, (2011), Gunduzet al., 2013, Zadehet al. (2016).	Change management system.	Models to manage change developed, causes of change in construction, recommendations on how to handle change.
10	Creedy (2006), Li et al. (2015), Abdul-Rahman et al. (2015). Menches&Saxena (2016), Kulkarni &Pimplikar (2016), Liu et al. (2016).	Risk management	Risk factors and effect on projects leading to cost overruns, risk decisions, risk assessment and profile identification, managing and responses to risks factors
11	Rahman & Omar, (2006), Lessing, (2006), Begum et al., (2010).	Industrialization of construction	Identification of impediments to industrialization, advantages and steps to industrialization

Recommendations on best practices span through the inception of a project to completion which are still in disarray. This part therefore collate diverse recommendations on best practices and organized into modules. Driven by the foregone research works, twelve modules that cover varying management segments from starting to completion are as follows:

Module A:
Activity: Supply chain management
Responsibility: Client
Stage: Inception
Actions:

a. Carefully select and bring in the supply chain that will deliver design services, supplyservices, manufacturing and assembling of products.
b. Consider as criteria the qualification, experience, and the ability of individuals to worktogether as part of an integrated project team starting from the earliest possible stage.
c. Establish the integrated project team consisting of client and supply chain underpartnering principles
d. adequate briefing of the supply chain team

Module B:
Activity: Process design and management
Responsibility: Consultants
Stage: Planning and implementation
Actions:
Design actions:

a. Understand the user properly
b. Write the specifications correctly and clearly

c. Design within the best acceptable error limit
Management:
a. Decompose the whole process into a work breakdown structure (WBS)
b. Understand the customer and its peculiar needs- internal and external customers
c. Group similar tasks to reduce the number of steps and number of involvements
d. Determine a standard procedure for cluster activities
e. Determine the shortest and also compress the cycle time for each cluster
f. Identify the flow and conversion sub-processes in each task
g. Set up a flow sub-process suppression and a strategy for waste elimination
h. Set up a continuous process improvement mechanism
i. Set up a lessons learning mechanism for managing internal and external lessons
j. Decide on the best transparent process

Module C:
Activity: Contract Placement
Responsibility: Clients and Consultants
Stage: Planning
Action:
a. Study the builder's capability for the proposed project at feasibility
b. Prequalify, shortlist and notify all prospective bidders at outline proposal stage
c. Issue scheme design and detailed design to all bidders as they are produced
d. Invite bidders to bid, select a successful contractor and place a contract

Module D:
Activity: Cost Estimating
Responsibility: Consultants
Stage: Planning
Action:
a. Prepare an estimate for the proposed building project in the elemental bill format
b. Ensure a complete Cost estimate
c. Ensure accurate Cost estimate
d. Forecast the risk of the estimate failing
e. Advice on cost behavior of the project

Module E:
Activity: Cost advice
Responsibility: Consultants
Stage: Planning
Action:
a. The estimate forms the basis for the awarding of the contract
b. Determine the construction period for the project
c. Forecast the trend in cost changes at different milestones within the contract period by inserting key variables (to be developed) in the mathematical model to get the total cost at time intervals.
d. Depict the results in a line graph to avail change trend in the cost of the project
e. Advice on contingency plans against inflationary trend on the entire contract.

Module F:
Activity: Cost Control
Responsibility: Contractor
Stage: Implementation stage
Action:
a. Undertake performance analysis
b. Predict cost changes
b. Compare actual expenditure at each stage with the projected cost changes
c. Identify areas of high cost challenges and act accordingly
d. Collate all information for the next stage of the work

Module G:
Activity: Process monitoring

Responsibility: Client, Consultants and contractor
Stage: Inception, Planning and Implementation
Action:
a. Plan for proper process monitoring and control
b. Monitor and control process implementation and cost performance
c. Feed back to managers
d. Comparing results with plans and then
e. Taking action against odds

Module H:
Activity: Lessons learnt process
Responsibility: Client, Consultants and contractor
Stage: Inception, Planning and Implementation
Action:
a. Deliberately capture and store lessons learnt from every member in the team
b. Process and analyse the information captured and depict the trend for feedback
c. Identify the areas of weaknesses of each member from the assessment
d. Present the weaknesses at site meetings for discussions and collective decisions
e. Repeat the process before each site meeting, document and

Module I:
Activity: Continuous process improvement
Responsibility: Client, consultants and contractor
Stage: Planning and implementation
Action:
a. Collate all lessons learnt within and benchmark outside the process
b. Evaluate relevant lessons and feed back into the process to improve performance
c. Document results and study the trend in the improvement process

Module J:
Activity: Change management process
Responsibility: Consultants and contractor
Stage: Planningand implementation stages
Action:
a. Set up a well-defined change review and control process early
b. Evaluate every change initiated to find out how beneficial
c. Resist change until it is necessary
d. Communicate change accepted early and clearly

Module K:
Activity: Stakeholders' management
Responsibility: Client and Consultants
Stage: Planning and Implementation stages
Action:
a. Identify stakeholders important to the project and list the interest of each member
b. Classify the stakeholders according to the power each can exert in the project (critical and less critical ones)
c. List the interests and priority of each stakeholder
d. Decide on the best management strategy to satisfy every interest

Module L:
Activity: Strategic initiative
Responsibility: Contractor
Stage: Planning and Implementation stages
Action:
a. Decide on parts to industrialise
b. Set up a strong information and communication flow system
c. Employ the available information and communication technologies for better performance
d. Decide on and employ relevant plant and equipment for optimum performance of the assembly process

Process Flaw Culpability Measurement

Yu et al. (2007) believe that construction is an experienced based discipline in which knowledge or experience accumulates from previous projects plays important role in the successful performance of new works. Liu, Zhao & Yan, (2016) presented a risk profile that can cause international construction practice to fail. The list is not significantly different from the non-international risks identifiedby (Li, Fang, & Sun,2016). However, apart from natural causes, the risk profile substantially contained flaws in form of actions and inactions of individuals. The inability of an individual to act when and as due; the individual acting wrongly or concentrating actions on less relevant issues are flaws found to cause delay. Delay was invariably found to be a major challenge in construction management in Malysia (Abdul-Rahman, Wang and Mohamad, 2015). However, Knowledge Management (KM) attempts to address this aspect of flaws in diverse ways. KMcan point to managers the flaw likely to occur and the stakeholder culpable. This remains asset to proactive response to flow inefficiency. Li et al. (2016) looked at challenges in terms of risks in construction, believing that assessing the potentiality of risks occurrence in construction projects is a major management step which lays the basis for right responses to curb delay and subsequent cost overruns. Li et al. (2016) considered the probability of risk occurrence and their impact on projects as major determinants in developing a risk assessment model. Therefore, predicting which risk or flaw likely to occur and which stakeholder is culpable will enable proactive responses possible. The Culpability Measurement Card (CMC) proposed herein addresses effectively and efficiently the problem of flaws identification in construction projects management process.

The CMC contains array of flaws or flow inefficiencies that often impede successful management of construction projects. As soon as a project commences the frequency of occurrence as well as the degree of impact of each item on the ongoing process are assessed and ranked byadministering the card as a set of questionnaires on project participants. Demonstrated herein, the research used a focused group of 15 qualified professionals in Nigeria to generated data and assessed identified flaws. In practical cases, the client's team, design team, suppliers and contractor's teams or any other person knowing or associated with the project can respond to the questionnaires. The culpability in terms of frequency of occurrence of an item and the impact on the project, as well as the source of the risk identified determine where to place a particular item on either having high, medium or low effect on project success.

Respondents rated a five point Likert's scale on the frequency of occurrence and degree of impact. Where 1 is very low, 2-low, 3-average, 4-high and 5-very high. Sambasivanand Soon (2007) similarly gave the relative index computation as:

$$RI = \frac{(n1W1 + n2W2 + n3W3 + n4W4 + n5W5)}{A * N}$$

Where W is the weighting given to each factor by the respondents ranging from 1 to 5, "n" is thenumber of respondents in each weight (W), "A" is the highest weight (i.e. 5 in this case) and N is the totalnumber of respondents that weigh each factor. In this work, values from 0 to 0.39, 0.40 to0.49 and 0.50 to 1.00 were considered below average (low), moderate and above average (high) values respectively. The culpability of each flaw and the corresponding stakeholder has been computed and classified using the questionnaire and Table 2 to 4 indicate the result of the impact as high, moderate or low.

Table 2: Identified flaws with high impact on building projects

	General factors	Mean Freq.	Freq. ranking	Mean Impact	Impact Ranking	Impact Level
1.	Complex project characteristics	0.57	6	0.53	7	High
2.	Inadequate budget for the work	0.35	16	0.51	8	High
10.	Non-availability of electricity for the work	0.46	12	0.69	2	High
11.	Poor attitudes of benefiting/neighboring communities	0.57	6	0.58	6	High
13.	Poor information flow among stakeholders	0.46	13	0.60	5	High
15.	Political instability and government policies	0.48	11	0.68	3	High
16.	Corruption factor in the project process	0.48	11	0.71	1	High
18.	Wrong choice of procurement option	0.63	4	0.51	8	High
19.	Wrong choice of the type of contract	0.54	7	0.50	9	High
	Client's factors					
23.	Low level of importance attached to the project by the client	0.46	6	0.55	5	High
24.	Poor client's commitment to project success	0.42	9	0.50	7	High
26.	Instability in client's cash flow	0.38	10	0.60	4	High
27.	Poor client's credit worthiness	0.35	11	0.87	1	High

28.	Poor planning by the client	0.49	4	0.71	2	High
30.	Delay in response to interim payments	0.45	7	0.67	3	High
31.	Inadequacy of client's brief	0.52	2	0.51	6	High
36.	Constant interference of work progress by the client	0.43	8	0.60	4	High
35.	Poor client's attitudes to dispute resolution	0.51	3	0.50	7	High
	Contractors factors					
37.	Poor organisational setting of the constructing firm	0.62	9	0.52	6	High
38.	Incompetent personnel in the constructing firm	0.62	9	0.52	6	High
39.	inadequacy of relevant personnel for the work	0.42	20	0.53	5	High
42.	Poor experience of the contractor on similar jobs	0.62	9	0.55	4	High
45.	Poor attitudes and general responses to site instructions	0.87	3	0.52	6	High
48.	Lack of clear identification of customers and their needs	0.55	11	0.62	1	High
53.	Poor attitudes and poor productivity of labourers engaged	0.96	1	0.52	6	High
54.	Poor attitudes to the contractor to dispute resolution	0.51	13	0.60	2	High
55.	Large amount and frequency of rework due to error	0.51	13	0.55	4	High
58.	Poor communication arrangement between site and head office	0.62	9	0.52	5	High
62.	Threats to Job stability of workers	0.49	14	0.58	3	High
	Consultants factors					
68.	Poor qualification of consulting team in handling the job	0.49	12	0.78		High
69.	Poor experience of the consultants in the kind of job	0.37	15	0.57		High
70.	Poor commitment of consultants to the job	0.30	16	0.57		High
73.	Delay in designs and other documents delivery	0.56	8	0.62		High
74.	Delay in response to calls for interim valuations	0.91	1	0.62		High
75.	Delay in contractors' request for approvals of stage of work	0.84	2	0.60		High
78.	Incomplete and unclear engineering design	0.64	6	0.62		High
79.	Incomplete and unclear bill of quantities	0.52	10	0.53		High
83.	Poor attitudes of consultants to dispute resolution	0.57	7	0.57		High
84.	Constant architect's instructions on site	0.47	13	0.59		High

Table 2: Identified flaws with moderate impact

	General Factors	Mean Freq.	Freq. ranking	Mean Impact	Impact ranking	Degree of impact
1.	Poor risk allocation among parties to the contract	0.57	6	0.45	4	Mod
2.	Effect of inclement weather	0.64	3	0.48	2	Mod
3.	Non-availability of locally sourced materials	0.60	5	0.44	5	Mod
4.	Non-availability of local labour	0.52	9	0.46	3	Mod
5.	Non-availability of water for the work	0.49	10	0.45	4	Mod
6.	Inflation or economic instability	0.47	12	0.49	1	Mod
7.	Dispute among team members	0.42	15	0.45	4	Mod
	Client's factors					
8.	Poor client's commitment to management success	0.48	5	0.47	1	Mod
9.	Frequent change initiated by the client	0.49	4	0.47	1	Mod
10.	Incomplete design team appointed	0.45	7	0.44	2	Mod
	Contractors factors					
11.	Inadequacy of relevant equipment	0.55	11	0.40	6	Mod
12.	Poor planning by the contractor	0.51	13	0.43	4	Mod
13.	Poor site layout and site organisational pattern	0.66	7	0.40	6	Mod
14.	Poor contractor's general attitude to the work	0.43	19	0.40	6	Mod
15.	Delay caused by sub-contractors/suppliers	0.83	4	0.43	4	Mod
16.	Poor cooperation among sub-contractors/suppliers	0.95	2	0.47	2	Mod
17.	Poor process management mechanism in place	0.53	12	0.47	2	Mod
18.	Poor attitudes of contractor's personnel to instructions	0.49	14	0.42	5	Mod
19.	Poor work break down structure	0.46	17	0.43	4	Mod
20.	Poor transportation arrangement to and from site	0.58	10	0.36	7	Mod
21.	Poor staff motivation scheme	0.48	15	0.48	1	Mod
22.	Absenteeism from work due to drugs, alcohol, health	0.51	13	0.43	4	Mod
23.	Poor health and safety measures	0.43	19	0.40	6	Mod
24.	Delay in payment of staff emoluments	0.45	18	0.45	3	Mod
25.	Delay in payments to sub-contractors/suppliers	0.82	5	0.48	1	Mod
26.	Ad-hoc nature of employment of workers	0.73	6	0.47	2	Mod
	Consultants factors					
27.	Incompetent staff in the consulting team	0.65	5	0.48	2	Mod
28.	Inadequate consulting personnel for the job	0.54	9	0.45	4	Mod
29.	Inadequate site condition and geotechnical survey information	0.81	3	0.40	6	Mod
30.	incomplete and unclear architect's designs	0.70	4	0.43	5	Mod
31.	Discrepancies in contract documents	0.43	14	0.47	3	Mod
32.	High change frequency initiated by consultants	0.57	7	0.43	5	Mod
33.	Poor coordination and in-cohesion in consulting team	0.50	11	0.49	1	Mod

Table 2: Identified flaws with low impact

	General Factors	Mean Freq.	Freq. Ranking	Mean Impact	Impact ranking	Impact Level
1.	Statutory authorities' interruptions	0.45	14	0.29	6	Low
2.	Bad general access to site	0.53	8	0.37	2	Low
3.	Poor team spirit among stakeholders	0.42	15	0.30	5	Low
4.	Negative socio-cultural effect on the project	0.19	18	0.34	4	Low
5.	Poor adoption of emerging technologies	0.65	2	0.38	1	Low
6.	Low frequency of site meetings	0.45	13	0.35	3	Low
	Client's factors					
7.	Delay in approval of change request	0.52	2	0.35	2	Low
8.	Lack of full time project management engagement	0.55	1	0.38	1	Low
	Contractors factors					
9.	Low level of industrialisation in the production process	0.45	18	0.35	2	Low
10.	Poor transportation arrangement to and from site	0.58	10	0.36	1	Low
11.	Unclear instructions to workers	0.65	18	0.32	3	Low
12.	Long distance between head office and site	0.38	21	0.29	4	Low

The items with high impact (Table 2) indicate that once such risks occur, the likelihood that it impacts negatively on the project at significant level is high, likewise those with medium and low impact. The factors have also been grouped into their sources which points to the stakeholder culpable. Therefore the culpability of the risk and the source are identified for possible response. Side by side with the impact measurement is the frequency of occurrence of each item. The process flow management therefore should consider items identified with high impact and those with high frequency to reduce their inefficiencies. The lessons to learned and documented is the impact and frequency of each flaw and the stakeholder culpable. Repetitive assessment establishes a trend for each factor and stakeholder.Measurements are documented which point clearly to the direction of inefficiencies in the process, thus, calling for proactive intervention.

The Mathematical Model

The third component of the model is the development of a mathematical model. Mathematical models often predict empirical values. In this case, the mathematical model developed deals with values related to cost-time relationship at the implementation stage and essentially addresses cost changes of projects over time. Elemental cost format was used based on the fact that the format is still a favorable method in bill preparations in Nigeria. It is also most convenient and most widely used format for cost researches. Market forces in Nigeria (Abandaet al., 2011), in most cases, push the cost of construction projects upward which can occur severally and at varying degree throughout the construction stage. While it is difficult to control the forces of inflation, increase in cost should be predicted and managed accordingly. A mathematical model using the incremental rate principle addresses cost changes. The model is developed as follows:

Let the cost of an element in a building X be= χ
If, for a period p, the cost has increased by $\Delta\chi$
Then, the total cost of an element at that period P is $Cp = \chi + \delta\chi$ …..eqn. 1
Therefore, to express cost at different periods where P=1, 2, 3…p
First period, $C1 = \chi + \delta\chi$…….eqn 2
Second period, $C2 = \chi + 2\delta\chi$….eqn 3
Third period, $C3 = \chi + 3\delta\chi$….eqn 4
.
.
.
P^{th} period, $Cp = \chi + p\delta\chi$……eqn. 5
(Provided that $\delta\chi$ is constant).

If cost change $\delta\chi$ is expressed such that $\delta\chi = \chi$ x r, where r is the yearly ratio of cost change

Then, from eqn. 5, $Cp = \chi + (p \times \chi \times r)$

$= \chi + p\,\chi\,r$

$= \chi\,(1+p\,r)$………..eqn. 6

The total cost of a building facility at a particular point p is Tp which is the sum of the cost of all the elements (Cp) of that facility at that point and counted from the cost of element number 1 = (C1) to element number n = (Cn). Therefore,

$$Tp = C1 + C2 + C3 + \ldots + Cn \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{eqn. 7}$$

Substituting eqn. 6 into 7,

$$Tp = \chi_1 (1 + pr_1) + \chi_2 (1 + pr_2) + \chi_3 (1 + pr_3) + \cdots + \chi_n (1 + pr_n) \ldots\text{eqn. 8}$$

$$T_p = \sum_{i=1}^{n} x_i (1 + pr_i)$$

However, x can be obtained by first principle and r through mean analyses of mass historical cost data. Therefore, given the estimated cost of elements (xi) and the rate of change in cost ofcorresponding elements (ri) the total cost (T_p) can be projected at a chosen period p.

The Framework

Three components of the framework namely, the Best Practice Modules, the Culpability Measurement Card and a mathematical model were developed. Figure 1 synthesised the components into a framework in form of a flow chart that guides the development of a proactive construction project management model. The flow chart covers three developmental phases of construction projects, namely inception,planning and production. The end of production is the closing stage which brings about the end of the assembly process. Each phase contains a set of activities-the best practice details for each contained in the best practice modules.

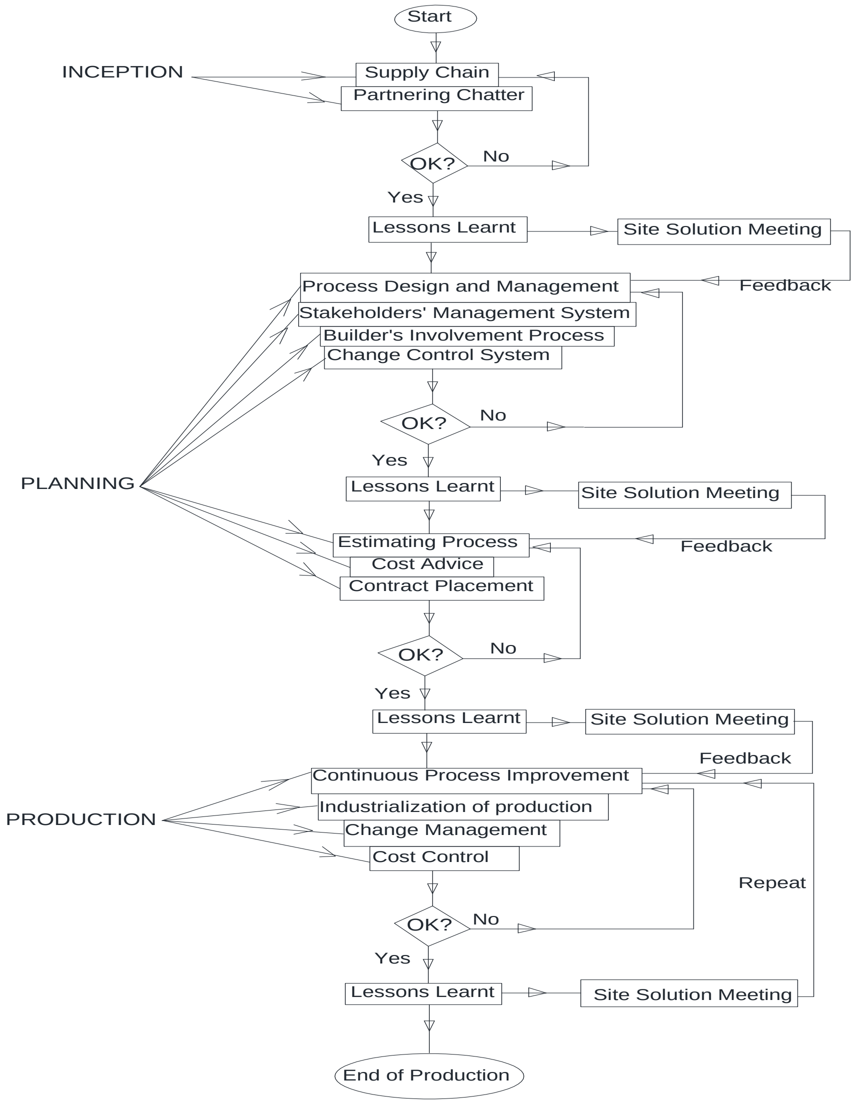

Figure 1: Framework for developing a proactive construction project management model

At inception phase, a supply chain team is set up by the client, preferably under the collaborative charter and the team properly briefed. The best practice of the supply chain is specified and found in module A. The stage is then reviewed by applying the culpability measurement card to find out if the accomplished task was satisfactory and if in consonance with management objectives or not. The card measures and indicates areas of strengths of each team member and the kind of challenges encountered. The teamthen documents the first lessons learnt as a group at this stage and either review the activities if the result of the assessment is not satisfactory and then prepare to proceed to the next stage. Challenges encountered from the lessons become subject of discussion at the next site meeting and solutions proffered. The next phase is the planning phase which essentially involves the designs development and contract placement. Within this stage, a mechanism is set up towards achieving project objectives. The best practice modules recommend how best to management challenges related to the design, change, and stakeholders' management, estimating functions etc.

Assessment of outcome at the milestone using the measurement card is done each time a task is accomplished. The content or nature of the task to be carried out and also the milestone have no any fixed rule on how to determine, rather, the tasks may depend on the work breakdown structure and the milestone as agreed during planning. At each site meeting, the results of the measurement should be subject of discussion. The production stage consists of the implementation of the designs. At this stage many activities could be repetitive. Periodic measurement using the card, review of results and feedback onto the implementation activities span throughout the production process. Best practices to guide this stage are also contained in the modules. The lessons learnt are progressively documented. The culpability of each factor and the corresponding stakeholder, successes and failures of the process flow are documented. Cost increase at chosen time frame is measured using the mathematical model. The process continues till the close where production ends and the project handed over.

IV. DISCUSSIONS

The need to develop a feasible proactive management model for construction projects bring about this research. The key objective here being the development of a framework as prelude to developing a feasible proactive management model. Three key components of the framework were developed, namely, the best practice module, the culpability measurement card and a mathematical model. These components that were synthesised into a framework as in Figure 1, functions as a system that guides the development of a proactive project management model related to construction. Two key kinds of flaws related to management were identified in the process of developing the framework namely- the flaws in process flow which cause delay or management inefficiencies as well as inflation of market values of resources caused by market forces that add directly to total cost of the project. The framework therefore addressed both cases and guides the process of developing a proactive management model. Predicting the chances of occurrence of flaws is possible through knowledge. Preemptive knowledge is possible through knowledge management science. Therefore, the list of identified and classified impediments was organised into a score card. The card assesses, classifies and documents successes as well as flow inefficiencies, thus acting as a knowledge management mechanism. The card captures, processes and stores information for retrieval and feedback. The mathematical model derived addresses the direct cost changes for possible empirical cost monitoring and control of the ongoing project process. The framework synthesised all the findings into a single system. The proactive model will be achieved if the variables of elemental cost and rate of cost changes are assessed and inserting into the frame to form a model that can addresses the cost, time and quality objectives effectively to a desired level. The framework therefore provides guides pursuant to Arrow (2008)'s tenets. Tenets 1-3 are achieved at the inception of the project by involving all stakeholders under collaborative charter and the measurement of stage performance. Since it is known that the culpability of every member is measured, every stakeholder will be committed to success without which he can be easily identified and appropriate actions taken. The score card evaluates and feeds back responses periodically on process flow to enable follow up with actions as per tenets 4-6. The constant assessment of and by every stakeholder ensures the achievement of objective 7 where no one is left in doubt regarding effective communication of progress, changes and responses. Johnson (2010)'s recommendation of formal discussion, documentation, tracking andreporting performance have clearly been achieved. Records of periodic assessment of tasks accomplished and be used to depict trends for easy prediction of the project process flow direction.

The assertion by Kern and Formoso (2003) that cost control still consists of monitoring actual performance against costestimates and identifying variances is no longer tenable. This model rather predicts cost changes intermittently and avail the magnitude of change for comparison with estimates in advance. The mathematical model preempts cost changes at varying milestone using the rate of cost growth. With this, the key elements that will enable a proactive cost management has been availed.

V. CONCLUSION

The components of a proactive construction project management have been developed and synthesised into a framework. The framework puts into consideration the challenges of process flaws and direct cost changes due to market forces. The key concern is the provision of a forward looking management system. Following the development of the framework, the proactive management model can now be developed. Key variables suggested herein to be developed further so as to achieve the proactive management model relate to the mathematical equation derived. The equation demands a feed-in of elemental cost estimate of a proposed project. The elemental cost provides the first variable that will be fed into the equation, and this can easily be estimated using first principle. The second variable is the rate of change of cost of elements that can be computed through historical cost data. Historical cost data provide the trend in cost changes and can be used in predicting cost changes at varying points. The third variable is the choice of varying milestone in which cost is intended to be projected. This paper therefore should elicit keen interest in advancing the science of proactive management field, especially that literature posit that researchers believe that managing proactively is the sure way to successfully achieve the frequent failed construction projects objectives. This framework provides a shift towards a feasible paradigm of proactive project management system which completely reforms the traditional passive/reactive management approach. This work is beneficial to all the key construction stakeholders (client, contractor, consultants) and can help improve teamwork for better performance. Each member gains effective and quick access to information flow in the management process which meets the tenets postulated by Arrow (2008). Future works should develop a proactive management model and also consider developing a computer program to enhance the application of the model.

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