Quantitative Approach to Project Scope Change Management in Building Projects [1]

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ABSTRACT

This study focused on Quantitative Approach to Project Scope Change Management in Building Projects. The objective is to determine how quantitative method can be applied in managing variations in building projects due to scope change. Survey method was adopted. Earned Value Analysis was partly used to evaluate ten building projects. Questionnaire were administered to 52 respondents. Descriptive statistics and Probability Impact Matrix (PIM) were used for analysis. The result show that the most significant scope changes occur in the execution stage of the project lifecycle. The study recommends the application of PIM in mitigating scope change problem in building projects.

Keywords: Building Projects, Scope change, Project Management and Quantitative Techniques, project Lifecycle.

1.0 INTRODUCTION

Achieving the planned result is the primary test of effective performance in project management, and this is achieved through the realization of the project scope. The failure to manage and control this aspect of the project appear to be the principal reason why most projects fail. Harrington and McNellis, (2006) suggest that implementing the process described in particular project requirements provides an effective approach to building scope management into that project.

The Federal Capital Territory, Abuja has witnessed series of developmental activities over time, since it assumed the seat of power of Government of Nigeria. These developmental activities cut across roads, housing, bridges, schools and other infrastructure executed by both government and private sector which have contributed to the rapid development of the city. Other developmental activities have resulted in renovations of old buildings, conversion of old buildings to meet up with the trends in designs as well as remodeling of buildings for private and public uses. These activities however, have costs and schedule implications and other factors that may undermine their implementation. The owners of these projects have also developed strategies to meet up the demands. Sadly, projections on time and cost of executing these projects by contractors are often done inadequately (just to win the contract), thereby giving room for the projects to suffer both time and cost overruns. Unfortunately, most related literatures have not really emphasized prioritizing scope changes in accordance with their individual impacts on the respective building

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projects for effective management decisions. Project scope change is inevitable and one must be prepared to deal with it when it happens (Suchan, 2007). The current approaches to project scope change management only specify or identify the project scope changes, and without quantifying them, proceed straight to addressing them; as a result, management efforts are not directed towards determining the changes with the highest impact. Hence, this study seeks to provide an approach that not only identifies project scope change but also quantifies their impacts on the project, so that they can be prioritized and management efforts best directed in order to reduce the tendencies of building projects suffering time and cost overruns.

The aim of this study therefore, is to formulate quantitative approach in managing project scope change in building construction projects. To achieve this, the following objectives were set:

i. to determine the stage of project where scope change can affect building project,
ii. to ascertain level of impacts that the identified scope changes have on building projects,
iii. to determine the most significant identified scope changes in building projects, and
iv. to determine the extent to which probability and impact matrix, a quantitative techniques, can be applied in mitigating identified scope change problems in building projects.

To achieve the study objectives, the following research questions form the basis for data collection;

i. At what stage of project can scope change affect building project?
ii. What level of impacts can the identified scope changes have on the building projects?
iii. What could be the most significant identified scope changes in building projects?
iv. How can the Probability and Impact Matrix be applied in mitigating identified scope change problems?

To achieve the set objectives, this study focused on scope changes and its management in ten selected building projects carried out by PUZO Construction Limited, located in Abuja. The generated scope change management approach is generic since it can be easily adopted for use in any type of project.

2.0 RELATED LITERATURE

Disruption theory discussed by Baca (2005) states that there are disruptions of the project that result from change requests. Anytime a change request comes along, the core team must stop the forward motion of the project to analyze the request. This process has to determine whether the change request is out of scope or not, to decide if the project is to be expended or only rectified. In doing this, attention should be paid to the time and cost implications of the change since performance will only be measured in line with the objectives of time, cost and quality as put together by Atkinson (1999), Okorafor (2008), Kezner (2009) and Nwachukwu, Echeme and Okoli (2010).

Project Scope Management

Project scope identification and management is important as it involves getting information required to start a project, and the features the end result would have that would meet project stakeholders' requirements. This means that project scope looks at the work that needs to be accomplished to deliver a product, service, or result with the specified features and functions.

Project scope defines what is or is not included in the project, and controls what is added or removed as the project is executed. According to Schwalbe (2010) scope refers to all the work involved in creating the products of the project and the processes used to create them. It ensures that the project team and stakeholders have the same understanding of what products the project will produce and what processes the project team will use to produce them. Scope management helps avoid challenged projects with every growing scope and unruly requirements list (Turner, 2009).

For project managers to manage and control the project scope, Schwalbe (2010) proposes five main processes they should consider. Those processes are:

(a) Collecting requirements which involves defining and documenting the features and functions of the products to be produced during the project as well as the processes used for creating them. The project team creates stakeholder requirements documentation, a requirements management plan and requirements traceability matrix as outputs of the requirements collection process.

(b) Defining scope which involves reviewing the project charter, requirements documents, and organizational process assets to create a scope statement, adding more information as requirements are developed and change requests are approved. The main outputs of scope definition are the project scope statement and updates to project documents.

(c) Creating the work break down structure (WBS) which involves subdividing the major project deliverables into smaller, more manageable components. The main outputs include a work breakdown structure, a WBS dictionary, a scope baseline, and updates to project documents.

(d) Verifying scope which involves formalizing acceptance of the project deliverables. Key project stakeholders, such as the customer and sponsor for the project, inspect and then formally accept the deliverables during this process. If the deliverables are not acceptable, the customer or sponsor usually requests changes. The main outputs of this process, therefore, are accepted deliverables and change requests.

(e) Controlling scope which involves controlling changes to project scope throughout the life of the project. Scope changes often influence the team's ability to meet project time and cost goals. The project managers must carefully weigh the costs and benefits of scope changes. The main outputs of this process are change requests, work performance measurements, and updates to organizational process assets, the project management plan, and project documents.

In managing the project, project manager must be sure of what is and is not to be covered by project work. Heldman (2011) argues that project scope management must be concerned with defining and controlling what is and what is not part of the project. This is measured against the project management plan, the project scope statement, the work breakdown structure (WBS), and the WBS dictionary. Schwalbe (2014) adds that project managers cannot do a good job of managing the scope if they do not first do a good job of collecting requirements, defining scope and validating scope.

According to Heldman (2011) and Schwelbe (2010), to define scope, create WBS, verify scope, and control scope involves defining and derailing the deliverables and requirements of the product of the project; creating a project scope management plan; creating a WBS; verifying deliverables using measurement techniques and controlling changes to these processes.

CAUSES OF SCOPE CHANGE

Changes to scope during a project would be best to be avoided as they bring the challenge of increasing cost and schedule. Since, it is always difficult to get additional finance resource, hence it is important to justify the causes of any scope request. Jones, Snyder, Stackpole and Lambert (2011) elaborate on different causes of project scope change. They proposed the following as the common causes of scope changes:

(i.) External event: Changes in the competitive environment or a new regulation can cause the team or the stakeholders to reconsider the product Scope.

(ii.) Error in defining project/product scope: If a requirement was left out in defining the scope originally, the scope will have to be changed to include the new requirement. An error in defining the project scope, such as needed to employ specific procedures or processes, could entail changing the project scope.

(iii.) Value-adding change: Sometimes a team member finds a better way of accomplishing the work or determines how to improve quality by doing things differently.
(iv.) Implementing a contingency plan or work around: If a risk event occurs and there is need to take actions to respond to it, the actions could cause a change to either the project or product scope.

(v.) Beneficiaries see the outcome and wants changes: Some outcomes of development projects employ a life cycle that allows for iterative development as the beneficiaries see interim deliverables. This is still a scope change, but the project team plans for the design and the deliverables to evolve with each of iteration.

PROJECT SCOPE CHANGE CONTROL FEATURES

The change control can also include the following features as listed by Hill (2010):

Change control responsibilities: Specification of each team member's responsibility to manage project scope change, including guidance for project team members to use reasonable judgment before adjusting work that could be considered "out of scope," and related guidance for managing stakeholders requests or directions for work adjustments that could present scope issues or otherwise be contrary to the established work assignment.

Control authority: Specification of who is authorized to approve changes in project scope; usually the project manager, but sometimes the project executive (sponsor) or other senior manager (or control board) retains this responsibility.

Control plan management: Designation of a change control manager (for assignment on larger projects) who will maintain the change control log, manage incoming change requests, monitor change evaluations, and oversee approved change implementations; this may include

authorization to collaborate on changes with the customer, in addition to negotiation of change requests with the customer.

QUANTITATIVE APPROACH TO SCOPE CHANGE MANAGEMENT

Quantitative approach to project scope change management gives an opportunity for measurement of data. It enables project scope changes to be expressed in numerical terms (Gibson, Roberts & Sydney, 2016). The benefits of quantitative techniques in scope change management include the ability to determine the weight of all identified project scope change. They help to provide a ranking of the scope change – based on their numerical weights, the quantified scope change can be prioritized. Also it helps managers to focus attention on high ranking project scope change – the high ranking scope change are those that have high weights. The high weights mean that mismanagement of them results in huge losses to the project.

However, Tyron (2016) has it that one limitation to using quantitative approaches to scope change problems is the very diverse nature of project scope changes. He added that Project requires different organizations, people, phases and physical entities which are interdependent and must be coordinated into a functioning whole. The blending process of all these various project components brings about various forms of changes which might be difficult to quantify.

PROBABILITY AND IMPACT MATRIX

Probability and Impact matrix (PIM) are also known as Risk Matrix. The use of a risk matrix in project scope change management can be better appreciated if it is understood that scope change management failures always manifest as risk events. Risk assessment is an effective means of identifying risks and determining the most cost-effective means to reduce risk (Atkinson, Crawford, & Ward, 2006).

Risk ranking uses a matrix that has ranges of consequence and likelihood as the axes. The combination of a consequence and likelihood range gives an estimate of risk or a risk ranking (Ozog, 2009).

The Probability and Impact Matrix overcomes the limitations identified above in quantitatively managing project scope changes. This is because it furnishes a common denominator for expressing all identified project scope changes. In the PIM the impact of the changes are measured in terms of cost to the project. Since the cost implication of any failure can be determined, all changes in the project can be quantitatively and objectively determined. The diverse nature of scope changes will not impede their quantification. Table 1.0 illustrates a simple Probability and Impact Matrix (PIM).

Table 1.0: Hypothetical Simple Probability and Impact Matrix (PIM)

	Impact (Consequence)		
Probability			

The probability and impact matrix come into play when the project manager or team members determine that a particular phase or activity within the project contains a certain amount of

risk. That risk needs to be quantified. Each risk is given two sets of criteria which are then viewed on the probability and impact matrix. Each potential event is rated based on the likelihood that it will occur. It is also separately rated regarding how much of a problem would be created if it were to occur. The probability and impact matrix is used because it allows a manager to merge both of these components onto the same scale.

The matrix is used to review both sets of criteria at the same time. The result is that each potential risk can be designated as a low risk, a medium level risk or a high risk and then handled accordingly. The probability that a particular event will happen is shown along the left side of the chart and the degree of impact is shown along the bottom.

If the probability level was very low (.10) and the potential impact was also low (.10), the score on the matrix would be a .01.

If the probability level was medium (.50) and the potential impact was medium (.20), the score on the matrix would be .10.

If the probability level was higher (.70) and the potential impact was higher (.40), the score on the matrix would be .28.

According to Ozog, (2009), the higher the matrix score, the higher the risk level associated with the item that is being analyzed.

3.0 MATERIALS AND METHOD

The study gathered from both primary and secondary sources. Questionnaire and personal discussions were the sources of primary data. Secondary data were obtained from documented project files from PUZO Construction Ltd. Abuja, journals, library and the internet, etc. The data collected include: names of projects, planned project duration, actual project duration, planned project cost, actual project cost, nature of scope changes, project status with scope changes and implications of scope changes on project time and cost. The objective is to determine the impact of the scope changes on the projects' performances in terms of cost and time.

DESIGN OF THE STUDY

Descriptive survey technique was adopted designed to be observational and analytical. This is considered necessary because it enabled the researcher to observe, determine and measure quantitatively the nature of scope changes that affect building projects. In addition to this, questionnaires were designed and administered to the personnel directly involved in the construction of the selected building projects. Their responses helped to quantitatively determine the implications of scope changes in building construction projects.

POPULATION DESCRIPTION

The population for this study covers ten (10) building projects constructed by PUZO Concepts Limited, a construction and real estate development company, located in Abuja, Nigeria. A total of fifty two (52) respondents also formed the population for this study. They include the architects, building engineers and the contractors which are the respondents selected for this study. Based on the population size, the study sampled all the 52 participants. This were done using judgmental

sampling technique in order to target only those directly involved in the 10 selected building projects for this study.

To validate the data collection instrument, the researcher did the following; first, this study utilized multiple sources of evidence to increase construct validity. Secondly, the research instrument was sent to experts familiar with the constructs to be measured to independently examine and validate the questionnaire constructs. Their responses show that the research instrument is valid both in content and framing.

The test-retest approach was used to test the reliability of the instrument and the correlation result of the two exercises show an r-value of 0.89, implying high reliability level of the research instrument in collecting data.

METHOD OF DATA ANALYSIS

In order to analyze the data collected from the survey, the Earned Value Analysis (EVA) model and the Probability and Impact Matrix (PIM) were used.

EVA model was adopted in analyzing the performance of the 10 selected building projects executed by PUZO Concepts Ltd, Abuja, Nigeria to determine the level of variations in the cost and time parameters of the projects.

Probability and Impact Matrix

PIM was adopted in analyzing the data collected from the target respondents. The objective was to quantify the impacts of scope change management failures. The data collected from the 52 respondents were used to plot the PIM. Mathematical averages were used to process the raw data collected before subjecting them to the PIM. This was done by summing each scope change score as scored by all respondents then divided by the number of respondents scoring the change. This supplies a single value for the scope change score were used in plotting the PIM. The result is a ranking of the identified scope changes, and this result can be used by management to direct efforts towards the scope change with the highest potential impacts.

The expected value (matrix score) which is the product of the probability and potential impact of the risk event are calculated. This will reveal the most important project scope change in terms of most significant potential impacts.

DECISION RULE

To establish the decision rule for the PIM, consequence levels and probability levels are first established.

The consequence levels established are as follow:

i. Disastrous consequences: above 50% of the total project cost.

ii. Serious consequences: between 41 – 50% of the total project cost.

iii. Moderate consequences: between 21 – 440% of the total project cost

iv. Minor consequences: between 6 – 20% of the total project cost.

v. Negligible consequences: 5% of the total project cost.

The five categories of probability of happenings also elaborated following the Portela (2005) model were:

i. 0 – 10%: very low probability risk level

ii. 11 – 40%: low probability risk level

iii. 41 – 60%: medium probability risk level

iv. 61 – 90%: high probability risk level

v. 91 – 100%: very high probability risk level.

Given the consequence level and the probability level of a scope change, any of three decisions can be made about a particular scope change (See Table 2.0):

i. Intolerable

ii. Tolerable

iii. Negligible

Table 2.0: Decision on Risk level

Consequence / Probability	Negligible (0 – 5%)	Minor (6 – 20%)	Moderate (21 – 40%)	Serious (41 – 50%)	Disastrous (Above 50%)
0 – 10%	Negligible	Negligible	Negligible	Tolerable	Tolerable
11 – 40%	Negligible	Negligible	Tolerable	Tolerable	Intolerable
41 – 60%	Negligible	Tolerable	Tolerable	Intolerable	Intolerable
61 – 90%	Tolerable	Tolerable	Intolerable	Intolerable	Intolerable
91 – 100%	Tolerable	Intolerable	Intolerable	Intolerable	Intolerable

From the decision rule table above, the following examples can be made;

If the probability of occurrence of a scope change issue is 5% and its impact is 10%, it is Negligible.

If the probability of occurrence is 20% and its impact is 45%, the scope change issue is Tolerable.

If the probability is 50% and its impact is 50%, the scope change issue is Intolerable.

RESULT AND DISCUSSIONS

The data for analyzing the impact of scope change with respect to cost and time variations of the surveyed building projects are as presented in Table 3.0 below. Table 3.0 shows the ten identified projects that were carried out by PUZO Concepts Ltd. indicating their durations (planned and actual) as well as their cost values (planned and actual), nature of scope changes and the implications of such scope changes. This will help to understand how each scope change impacted on the respective building project.

Table 3.0 The Performance Data of the Ten (10) Selected Projects from PUZO Concepts Ltd.

S/N	Name of project	Planned duration	Actual duration	Planned cost(m)	Actual cost(m)	Nature of scope change	Project status as a result of scope change	Implication of scope change on the project
1	Bolton White Hotels, Wise Zone 5,Abuja.	36 months	48 months	N500m	N600m	Introduction of basement floor due to the topology.	Was ongoing till completion	Increase in total cost and duration but more value was gained
2	Residential development for Chief Austin Okoro at Danube street, Maitama, Abuja	10 months	12 months	N50m	N70m	Reduction of the building size due to Government setback.	√	Extra cost was incurred. Also the value of the building was reduced.
3	Newton Park Hotel, Wise II, Abuja.	30 months	40 months	N200m	N400m	Conversion of an office block to a hotel apartment	√	Increase in cost and duration because of change of use
4	Remichris Hotels and Towers, Jabi, Abuja	52 months	72 months	N800m	N1.5b	Conversion of office block/mall and multipurpose use to Hotel/ Towers. Change of Foundation	√	Increase in cost duration. Strengthen the stability and integrity. Increased in value.
5	Witchgate Hotels, Mabushi, Abuja	24 months	32 months	N250m	N320m	Conversion of a multipurpose mix use building to Hotel	√	Extra cost and time incurred
6	Residential development for Chief Peter Oguebie at Rudolph Street, Maitama, Abuja	10 months	12 months	N80m	N100m	Introduction of pent floor, modification of foundation	√	Increase in cost of the project, duration and more value
7	Residential development for Mr. Idris Umar at Missouri Street, Maitama, Abuja	13 months	16 months	N200m	N350m	Introduction of Presidential car porch and a suspended swimming pool Bar on top of the pool	√	Extra cost incurred
8	Residential development for Engr. Ifeanyi Ndihibe's country home at Osumenyi, Anambra State.	8 months	16 months	N30m	N80m	Conversion of a bungalow to a one storey building by changing the foundation and introduction of another floor and a slab	√	The cost almost tripled. Increase in cost and time
9	Luxurious Flats/Apartments for Littlefield Investment Ltd at Guzape, besides Channels Television	36 months	50 months	N200m	N350m	Introduction of a sub-basementand an extra floor. Change of Foundation from Pad footing to Raft.	√	The cost almost doubled. Too much time spent on ratification with the supervising authorities
10	Residential development for Chief Fabian Nworah at Asokoro Extension, besides River State Governor Lodge	18 months	40 months	N150m	N350m	Conversion of a Duplex to Hotel Apartment, changing the partitions and realigning the structural members	√	More cost incurred. Almost doubled in both cost and time duration

Source: PUZO Concepts Ltd.

The planned and actual time and costs of the 10 building projects were analyzed in Table 4.0 to determine the level of variations with respect to their time and cost performances.

Table 4.0 Analysis of the Time and Cost Variances of the 10 Selected Building Projects

S/N	Project Title and Location	Project Time Variances (months)	% Time Variations	Project Cost Variances (₦-million)	% Cost Variations
1	Bolton White Hotels, Wise Zone 5, Abuja.	-12	-33.33%	-100	-20%
2	Residential development for Chief Austin Okoro at Danube street, Maitama, Abuja	-2	-20%	-20	-40%
3	Newton Park Hotel, Wise II, Abuja.	-10	-33.33%	-200	-100%
4	Remichris Hotels and Towers, Jabi, Abuja	-20	-38.46%	-700	-87.5%
5	Witchgate Hotels, Mabushi, Abuja	-8	-33.33%	-70	-28%
6	Residential development for Chief Peter Oguebie at Rudolph Street, Maitama, Abuja	-2	-20%	-20	-25%
7	Residential development for Mr. Idris Umar at Missouri Street, Maitama, Abuja	-3	-23.08%	-150	-75%
8	Residential development for Engr. Ifeanyi Ndihibe's country home at Osumenyi, Anambra State.	-8	-100%	-50	-166.67%
9	Luxurious Flats/Apartments for Littlefield Investment Ltd at Guzape, besides Channels Television	-14	-46.67%	-150	-75%
10	Residential development for Chief Fabian Nworah at Asokoro Extension, besides River State Governor Lodge	-22	-122.22%	-200	-133.33%

Source: Extracted from Table 3.0.

The project performance in terms of the project cost is evaluated using the earned value analysis.

Cost variance, $CV = \frac{(BCWP - ACWP)100}{BCWP}$ …….. 1

For an analysis, we substitute the planned cost and the actual cost of Bolton White Hotels building project respectively into equation one above; which produces the following result. Thus,

$CV = \frac{(500{,}000000 - 600{,}000000)100}{500{,}000000}$ = -20%

The result of the calculation above shows that the project suffered a 20% cost increase as at its completion. From Table 4.0, it indicates that all the building construction projects executed by PUZO Concepts Ltd. suffered fatigue as they experienced cost and time overrun given their negative values. It was further discovered that poor scope management exhibited by the construction firm contributed to the abysmal performance of these projects in Abuja and other parts of Nigeria.

Investigation on the selected building projects executed show that the following cases were contributory to the scope changes and cost overrun witnessed: designs to be synchronized were not interoperable, client and contractor scope change issues resulted into introduction of additional work to the original work package as contained in the plan, non-compliance to designs resulted in pulling down of constructed works, the client and contractor scope change issues manifested in disagreements when finalizing outstanding contracts. Project contractor's scope issues manifested

by the selection of incompetent project manager, Project Manager and client requirement issues manifested in a failure to incorporate certain client's requirements in the project scope, Project contractors and client scope issues relating to disputes over contractual terms, Client and contractor scope change issues resulted into introduction of additional work to the original work package as contained in the plan and Failure to act on recommendations of monitoring or safety offices leading to suspension of work are the level of significance of the scope changes.

Based on these findings, questionnaire were designed to collect data from the respondents on their perceptions on the probability of occurrence of project scope change management issues and their quantification of impact/ consequences. In the surveys, 52 questionnaires were delivered to the respondents comprising of 10 Architectural consultants, 14 Building Engineers, and 28 Building Project contractors and subcontractors. Forty eight (48) were retrieved representing a response rate of 92.3%. The data collected were analyzed using PIM technique.

Research Question One: At what stage of project can scope change affect building project?

Project scope changes were divided into five (5) broad categories representing the project process groups. The scope categories include: Scope changes at Initiation phase, Scope changes at Planning stage, Scope changes at Execution phase, Scope changes during Monitoring and control, and Scope changes at the Closing phase. Each category consist of specific scope change management issues whose probability of occurrence and impact the respondent were required to quantify.

Category 1: Project Scope changes at Initiation Phase

Here, four specific scope change management issues were identified under this category, labeled I_1 to I_4 as shown in Table 5.0 below:

I_1 – Wrongful interpretation of clients' requirements
I_2 – Project Manager and client requirement issues manifested in a failure to incorporate certain client's requirements in the project scope
I_3 – Project and Project contractor's scope issues manifested by selection of an incompetent project manager
I_4 – The project and preliminary studies scope issues manifested in errors in feasibility studies or project charters

Category 2: Project Scope changes at Planning Phase

Six specific scope change management issues were identified under this category, which are labeled P_1 to P_6 as shown in Table 6.0.

P_1 – Project consultant and planning data scope issues manifested in inadequate data collection for project estimates
P_2 – Project and the consultant scope change issues manifested in biased and overly optimistic projections
P_3 – Design clashes caused by wrong sequencing of task
P_4 – Designs to be synchronized are not interoperable
P_5 – Project contractors and client scope issues relating to disputes over contractual terms
P_6 – Scope change issues manifested in errors made in creating functional specifications

Category 3: Project Scope changes at Execution phase

Ten specific scope change management issues were identified under this category, labeled E_1 to E_{10} as shown in Table 7.0.

E_1 – Client and contractor scope change issues resulted into introduction of additional work to the original work package as contained in the plan
E_2 – Contractor and owner scope change issues resulted into conversion or change of use of the initial building project
E_3 – Project and Project Supervisor scope change issues manifested by poor supervision of works and its attendant consequences
E_4 – Regulatory body and client scope change issues manifested in reduction of building size
E_5 – Architectural design and contractor scope change issues manifested in use of inferior or substandard material mix in order to make gains
E_6 – Wrongful interpretation of drawings and designs
E_7 – Project and suppliers issues leading to late receipts of supplies and/ or materials
E_8 – Contractor and workers scope change issues manifested in delay of work and reduction in workforce in order to save money for self
E_9 – Project functional units scope change issues manifested in a lack of harmony between the different units, and a lack of synchronization of their deliverables
E_{10} – Poor information on the requirements for daily work packages often by the contractor.

Category 4: Project Scope changes During Monitoring and Control

Five specific scope change management issues were identified under this category, labeled M_1 to M_5 as shown in Table 8.0

M_1 – Contractor and regulatory agency scope change issues manifested in suspension of whole or part of work by regulatory agencies
M_2 – Regulatory agency and client scope change issues manifested in delay of work as a result of non-payment of statutory fees
M_3 – Non-compliance of designs resulted in pulling down of constructed works
M_4 – Failure to act on recommendations of monitoring or safety offices leading to suspension of work
M_5 – Contractor incompetence leading to legal issues with the regulatory agency.

Category 5: Project Scope change at Project Closure

Three specific scope change management issues were identified under this category, labeled C_1 to C_3 as shown in Table 9.0.

C_1 – The project and lessons learned documentation scope change issues manifested in not producing or wrongly documenting the lessons learned
C_2 – The client and contractor scope change issues manifested in disagreements when finalizing outstanding contracts
C_3 – The project and client scope change issues manifested in challenges met when transferring responsibility.

Research Question Two: What level of impacts can the identified scope changes have on the building projects?

To determine the impact that each scope change have on building projects, the study quantified the various scope changes. Tables 5.0 to 9.0 below show the quantification of the categorized building project scope changes. The quantification is based on determining the probability of occurrence of the scope issue, and the impact in terms of cost to the project in the event of occurrence.

Table 5.0: Quantification of building project scope changes at Initiation phase

S/No	I_1		I_2		I_3		I_4	
	P	I	P	I	P	I	P	I
1	10	60	20	60	55	30	30	20
2	15	50	10	70	60	15	20	20
3	20	50	15	50	55	40	40	30
4	30	75	20	40	40	35	40	15
5	10	100	30	40	55	30	50	20
6	20	80	40	50	75	10	30	10
7	15	55	20	80	60	25	20	15
8	30	65	10	70	45	40	30	5
9	25	55	30	30	80	10	40	20
10	40	90	10	60	70	15	30	10
11	20	55	15	80	60	20	50	10
12	15	40	25	50	80	10	30	20
13	10	30	40	40	75	15	30	5
14	15	50	30	50	45	20	25	5
15	5	100	10	90	65	25	20	10
16	10	75	30	40	60	20	20	15
17	25	60	5	70	55	30	20	10
18	30	30	15	40	50	25	20	10
19	20	45	30	30	50	30	20	20
20	15	60	25	60	60	20	30	20
21	20	35	10	80	65	15	25	10
22	35	40	30	50	60	20	20	15
23	20	50	15	40	50	25	20	5
24	25	70	5	100	65	20	30	10
25	15	65	10	50	60	30	25	20
26	10	80	30	30	60	20	20	20
27	5	55	20	55	55	30	30	20
28	5	40	40	40	60	25	30	15
29	10	40	5	60	65	20	40	5
30	35	50	30	70	55	35	20	10
31	40	60	10	60	80	10	20	10
32	30	55	45	50	60	15	20	20
33	15	20	15	60	65	20	25	15
34	10	35	30	30	70	10	30	5
35	20	30	5	90	45	35	30	20
36	25	40	30	50	70	20	30	10
37	30	35	25	60	55	20	40	35
38	5	30	10	80	60	25	30	20
39	20	20	15	70	55	20	25	15
40	25	60	30	30	80	10	30	5
41	20	70	25	100	50	25	20	5
42	35	40	20	60	60	20	30	10
43	20	45	15	50	65	20	40	5
44	5	30	10	60	70	15	30	20

45	10	40	30	90	60	15	20	10
46	20	50	15	70	55	20	10	10
47	35	40	20	60	60	25	30	20
48	10	40	30	30	55	20	20	15
$\bar{X}$	19	52	21	58	61	22	28	14

Within the Initiation category, it was discovered that I_2 (Project Manager and client scope change issues manifested in a failure to incorporate certain clients' requirement in the project scope) have the highest impact on building projects (estimated at 58% of project cost). The next impacting scope change in this category is I_1 (52%), while I_4 has the lowest impact at 14% project cost increase.

Table 6.0: Quantification of building project scope changes at Planning Phase

	P_1		P_2		P_3		P_4		P_5		P_6	
S/No	P	I	P	I	P	I	P	I	P	I	P	I
1	25	20	20	15	25	15	5	35	30	20	35	20
2	20	15	30	10	15	30	10	30	40	50	40	20
3	15	10	25	15	20	10	10	50	20	35	15	10
4	20	20	15	10	15	20	10	50	10	50	10	10
5	15	10	20	15	20	15	15	55	5	55	10	20
6	20	15	15	15	20	20	20	50	10	35	20	15
7	10	10	20	10	25	10	20	30	20	30	30	10
8	20	10	15	20	25	15	5	50	50	35	35	10
9	25	15	20	15	25	15	10	40	35	40	10	20
10	20	10	15	10	20	20	10	50	20	35	15	15
11	15	15	10	10	10	20	10	35	20	30	55	20
12	10	15	10	5	20	15	10	30	25	35	40	25
13	10	10	5	5	15	30	5	35	20	45	20	5
14	15	15	15	10	10	25	10	40	25	45	20	15
15	15	10	10	15	15	25	10	35	10	40	10	20
16	5	15	5	10	10	25	10	40	5	20	10	15
17	5	20	10	5	20	30	25	20	10	20	40	10
18	10	20	15	5	15	25	20	55	5	25	35	10
19	15	15	20	5	25	10	15	35	10	35	15	5
20	10	15	15	10	5	10	20	30	15	20	10	10
21	15	10	25	10	15	15	10	30	20	20	35	10
22	10	20	5	5	15	20	20	50	20	40	10	20
23	15	20	10	5	10	25	10	50	15	35	35	15
24	15	15	15	5	25	10	20	45	20	55	20	20
25	15	10	10	10	10	30	15	45	30	30	20	10
26	10	10	10	5	10	20	10	50	25	30	25	5
27	10	15	15	5	10	20	10	35	20	10	40	15
28	10	10	10	5	10	15	15	25	10	25	35	10
29	10	10	10	10	5	20	15	40	5	30	20	10
30	15	10	5	10	20	30	15	50	10	40	35	5
31	10	5	5	10	15	15	10	40	15	35	40	30
32	15	20	5	5	20	5	10	40	20	30	15	25
33	20	10	10	5	15	10	15	40	20	25	30	10
34	15	10	5	10	15	20	25	40	25	50	35	15
35	15	10	15	5	5	25	20	35	10	45	10	10
36	5	10	10	10	20	10	30	40	15	30	35	5
37	10	5	10	15	15	10	20	50	20	30	10	20
38	15	5	15	10	20	15	15	35	30	25	20	10
39	10	10	10	5	5	10	15	40	40	20	10	10

40	20	5	15	5	20	5	20	35	10	30	10	10
41	15	10	10	10	15	10	15	35	35	5	50	20
42	10	5	10	10	15	5	15	30	20	15	40	15
43	15	5	5	10	10	15	10	30	20	30	35	5
44	20	10	10	10	20	15	15	35	30	15	55	10
45	15	10	15	10	20	20	20	50	15	45	35	15
46	15	5	10	5	15	10	25	45	20	50	30	5
47	20	10	10	5	15	30	10	35	10	55	10	10
48	20	10	5	5	20	25	10	10	10	35	5	30
$\bar{X}$	15	12	13	9	16	18	14	39	19	32	26	14

Within the Planning category, P_4 have the highest impact on the project (estimated at a 39% cost increase in project initial cost). The next impacting scope change in this category is P_5 (32%), while P_2 has the lowest impact at 9% project cost increase.

Table 7.0: Quantification of building project scope changes at the Execution Phase

S/No	E_1		E_2		E_3		E_4		E_5		E_6		E_7		E_8		E_9		E_{10}	
	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I	P	I
1	35	80	30	55	70	15	50	10	35	30	10	70	45	5	80	10	10	50	60	35
2	30	65	40	45	40	35	45	10	20	20	15	60	50	5	60	20	15	65	55	25
3	20	50	35	60	45	30	40	15	50	35	10	50	60	5	75	20	20	30	35	40
4	50	30	20	50	60	20	60	20	50	30	5	55	55	5	60	25	10	30	65	15
5	40	60	20	30	65	25	50	15	30	35	5	40	40	10	80	15	5	80	70	20
6	35	90	25	35	45	30	50	10	25	30	10	65	30	5	50	10	15	60	80	10
7	45	80	40	30	70	20	60	20	40	10	15	50	25	10	60	5	20	55	50	30
8	30	100	30	40	35	40	55	15	30	20	20	90	30	10	40	30	35	40	75	15
9	25	75	20	35	55	30	50	20	35	15	10	65	40	5	55	20	30	50	30	25
10	50	50	45	30	45	35	45	15	20	20	5	70	30	5	70	5	10	40	60	20
11	45	70	30	25	55	20	40	20	20	30	10	65	50	5	80	10	5	30	40	30
12	40	60	30	30	60	30	35	10	15	25	15	75	70	15	65	5	10	35	45	25
13	25	40	50	60	70	15	55	20	30	20	10	65	50	10	50	10	20	45	60	20
14	30	80	25	90	40	30	50	20	35	25	15	55	40	5	60	30	20	60	70	20
15	40	70	30	65	55	20	55	25	40	50	10	40	50	5	55	25	15	30	80	10
16	35	90	45	80	60	25	50	10	35	20	10	40	45	10	50	25	10	35	60	20
17	40	75	35	60	65	15	40	10	20	25	5	45	30	5	70	10	5	30	70	30
18	30	85	20	60	70	10	30	5	15	20	5	35	35	10	55	25	40	70	50	35
19	45	65	35	55	60	20	30	10	30	10	5	30	20	5	60	10	20	65	60	25
20	60	120	45	30	50	30	25	5	25	5	10	50	25	15	40	10	10	65	55	30
21	65	100	40	50	65	25	55	5	30	10	15	60	20	15	65	10	20	70	70	15
22	50	85	35	30	60	20	35	10	20	15	10	40	15	10	70	5	25	55	65	20
23	40	70	30	30	55	30	40	5	15	20	5	35	40	10	70	20	30	40	70	15
24	35	50	20	50	60	25	50	20	10	5	5	30	30	5	85	15	10	40	55	20
25	50	60	35	65	55	20	55	15	20	15	10	40	25	15	40	15	5	45	70	25
26	35	45	30	80	60	25	40	20	10	25	5	60	30	15	50	10	20	30	55	30
27	25	50	25	65	70	15	45	10	15	25	10	55	20	10	35	5	20	35	65	30
28	40	55	20	50	60	20	30	10	20	25	15	30	50	5	40	15	20	70	45	20
29	55	90	40	45	55	25	35	5	20	15	20	80	40	5	45	10	10	60	55	20
30	60	40	30	50	60	20	35	10	15	10	15	45	65	5	55	10	10	40	70	15
31	50	30	20	70	70	15	45	15	10	5	10	30	55	10	60	5	5	55	60	20
32	70	80	35	60	65	20	40	20	10	15	20	30	45	5	60	20	15	60	50	20
33	55	50	35	55	55	15	50	25	15	20	5	35	30	10	45	10	20	35	60	25
34	60	40	25	45	60	20	40	15	20	25	10	40	35	10	30	5	10	20	80	10
35	40	70	15	50	50	25	35	10	20	20	5	40	60	10	35	20	10	40		
36	35	65	20	40	55	25	60	20	10	5	10	45	35	20	50	20	20	55		

37	50 85	50 45	60 15	55 15	20 15	15 30	45 15	60 15	15 85	60 20
38	35 90	55 50	70 10	25 5	30 15	15 35	50 20	35 25	20 50	45 30
39	30 50	30 50	60 20	40 20	35 20	10 35	30 15	55 10	25 40	65 20
40	40 50	40 55	70 15	55 10	40 10	20 40	35 15	30 15	10 50	55 25
41	30 60	30 35	80 10	50 25	30 20	15 45	65 5	40 10	20 35	60 20
42	60 75	30 40	45 25	35 10	25 5	10 60	45 5	70 10	10 60	70 10
43	65 85	35 60	55 25	40 15	20 10	5 50	40 10	65 15	20 40	60 20
44	50 65	35 50	65 20	35 15	30 10	10 40	50 10	80 15	25 45	70 15
45	40 40	30 40	55 25	50 10	20 25	5 45	55 5	50 20	10 50	55 25
46	60 70	20 70	60 20	50 20	15 20	10 30	30 20	40 15	15 65	45 35
47	35 100	40 65	60 25	40 15	35 10	20 30	35 20	35 10	20 45	80 10
48	40 65	30 55	70 15	40 10	20 15	15 35	50 5	60 10	15 50	60 20
										45 35
										55 25
$\bar{X}$	43 68	32 50	5922	44 14	25 19	11 48	41 10	56 15	16 49	60 22

Within the Execution category, E_1 have the highest impact on the project (estimated at 68% cost increase in total project cost). The next impacting interface in this category is E_2 (50%), while E_7 has the lowest impact at 10% project cost increase.

Table 8.0: Quantification of building scope changes during Monitoring and Control

S/No	M_1 P	I	M_2 P	I	M_3 P	I	M_4 P	I	M_5 P	I
1	40	30	10	30	20	60	75	25	40	30
2	50	20	15	30	10	90	80	10	30	40
3	30	25	5	25	10	100	60	15	30	20
4	40	10	10	20	5	100	50	25	35	40
5	50	20	10	15	10	150	65	30	30	35
6	35	10	5	10	5	80	55	25	30	30
7	20	10	5	30	10	90	65	40	40	35
8	20	20	5	35	5	120	55	30	30	50
9	40	10	5	40	10	100	40	35	20	30
10	30	50	10	20	20	70	55	20	40	20
11	40	35	20	20	20	80	65	35	35	40
12	30	20	20	15	10	60	60	30	30	30
13	30	35	15	30	20	50	50	20	20	30
14	15	10	5	20	5	70	60	30	30	25
15	40	30	10	10	30	50	55	20	45	30
16	35	30	5	10	20	60	40	30	40	20
17	30	20	5	15	10	80	45	25	30	50
18	50	30	10	15	15	60	60	20	30	40
19	30	20	20	15	20	40	70	15	30	35
20	30	10	30	30	20	50	50	20	20	30
21	40	15	20	30	10	60	60	25	50	30
22	60	20	5	40	20	50	50	20	20	35
23	30	50	10	30	15	60	45	35	30	25
24	30	10	10	25	5	90	50	25	20	25
25	30	25	15	20	20	60	55	20	20	40
26	40	15	10	30	10	60	60	25	30	30
27	30	20	5	25	20	80	80	10	40	35
28	40	20	5	30	10	100	70	15	35	50
29	50	30	20	40	10	70	50	20	15	60
30	30	30	20	30	20	30	60	15	20	40
31	35	10	20	20	30	80	50	25	20	30
32	40	20	10	15	30	60	55	30	15	30
33	20	10	15	20	20	70	70	15	30	40
34	30	20	5	20	20	65	65	20	25	30
35	20	30	10	20	10	40	55	25	20	50

36	30	30	20	20	20	60	60	25	30	20
37	40	25	40	20	10	90	75	20	20	20
38	20	25	30	25	10	70	65	30	40	30
39	40	20	15	20	5	60	70	20	30	20
40	35	15	30	25	5	70	60	30	40	30
41	50	10	20	30	10	80	55	25	30	30
42	20	20	30	20	15	50	50	30	20	30
43	30	10	35	15	10	60	70	20	40	40
44	10	10	20	20	20	70	50	30	10	30
45	20	15	50	30	30	50	55	20	20	50
46	20	25	30	20	10	60	60	15	30	40
47	40	20	20	10	30	70	65	20	30	30
48	15	20	5	10	10	80	45	30	40	30
$\bar{X}$	33	21	16	23	15	71	59	24	34	38

Within the Monitoring category, M_3 have the highest impact on the project (estimated at 71% cost increase in total project cost). The next impacting scope change in this category is M_5 (38%), while M_1 has the lowest impact at 21% project cost increase.

Table 9.0: Quantification of building scope changes at Closure Phase

S/No	C_1 P	I	C_2 P	I	C_3 P	I
1	30	15	20	15	30	5
2	25	25	35	20	20	10
3	20	10	20	15	30	10
4	25	5	25	10	20	10
5	20	20	15	25	20	5
6	10	10	10	10	30	5
7	10	5	15	15	20	20
8	15	5	20	20	20	10
9	20	5	15	10	40	10
10	30	10	20	20	30	5
11	20	5	20	15	30	10
12	15	5	30	15	50	5
13	10	10	20	20	40	5
14	20	10	25	10	30	10
15	10	10	25	5	20	10
16	10	10	25	10	25	10
17	20	10	10	5	30	5
18	10	5	25	20	20	15
19	20	5	20	35	30	5
20	30	10	25	20	20	10
21	10	5	10	5	10	5
22	25	10	15	5	10	10
23	10	15	20	15	20	15
24	15	10	15	20	20	15
25	20	5	10	5	30	5
26	15	10	15	15	20	10
27	10	5	15	20	10	10
28	15	10	20	15	10	5
29	15	20	20	10	10	5
30	15	15	30	25	10	10
31	10	10	20	20	20	10
32	15	15	25	25	30	5
33	20	5	10	15	20	10
34	10	10	15	15	10	5
35	10	15	30	20	30	20
36	45	10	25	15	20	15
37	15	20	25	10	20	10
38	25	5	15	5	20	5

39	20	10	10	5	30	10
40	20	10	25	5	10	10
41	30	10	15	10	30	5
42	20	15	20	10	25	15
43	35	15	30	20	20	10
44	25	5	25	15	30	5
45	10	10	20	20	20	10
46	10	10	10	10	10	10
47	15	15	35	10	10	5
48	25	5	10	20	20	5
$\bar{X}$	18	10	20	15	23	9

Within the Closing category, C_2 have the highest impact on the project (estimated at 15% cost increase). The next impacting scope change in this category is C_1 (10%), while C_3 has the lowest impact at 9% project cost increase.

RESEARCH QUESTION THREE: What could be the most significant identified scope changes in building projects?

The probability of occurrence and impact of the scope changes are used in determining which of the quantified scope changes is most significant; but first a ranking of the quantified scope change was done.

Table 10.0 below is a summary of the responses. The first column is a listing by category of the project scope changes investigated. The second and third columns are the mean of the responses to the probability and impact of each of the specified scope change issue. The fourth column is the matrix score (product of the probability and impact). The fifth column is a ranking of the scope changes within a category using their matrix score; while the last column is a general ranking of all the scope changes. Within each category, the scope change with the highest matrix score is most significant in that category.

Table 10.0: Ranking of specific scope changes

Interfaces (a)	Probability (b)	Impact (c)	Matrix Score (d) = (b)*(c)	Ranking within each Category (e)	Total Ranking (f)
I_1	19	52	988	3	10
I_2	21	58	1218	2	8
I_3	61	22	1342	1	4
I_4	28	14	392	4	20
P_1	15	12	180	5	26
P_2	13	9	117	6	28
P_3	16	18	288	4	24
P_4	14	39	546	2	16
P_5	19	32	608	1	15
P_6	26	14	364	3	22
E_1	43	68	2924	1	1
E_2	32	50	1600	2	2
E_3	59	22	1298	4	6
E_4	44	14	616	7	14
E_5	25	19	475	9	18
E_6	11	48	528	8	17
E_7	41	10	410	10	19

E_8	56	15	840	5	11
E_9	16	49	784	6	12
E_{10}	60	22	1320	3	5
M_1	33	21	693	4	13
M_2	16	23	368	5	21
M_3	15	71	1065	3	9
M_4	59	24	1416	1	3
M_5	34	38	1292	2	7
C_1	18	10	180	3	26
C_2	20	15	300	1	23
C_3	23	9	207	2	25

Within the Initiation category, I_3 (Project and Project contractor's scope problem manifested by selection of an incompetent project manager) is the most significant (ranked first) with a matrix score of 1342. This could be because the project manager has overall responsibility of the project; he makes critical decisions regarding resource allocation, and coordinates the various activities and individuals involved in the project. The selection of an incompetent project manager can only mean chaos to the project. With a matrix score of 1218, the second ranked scope change in this category is I_2 (Project Manager and client requirement problem manifested in a failure to incorporate certain client's requirements in the project scope). This means that the project manager should pay particular attention to clients' management.

Within the Planning category, P_5 (Project contractors and client scope change issues relating to disputes over contractual terms) is the highest ranking interface with a matrix score of 608. This underscores the impacts that contractual disputes can have on the project. The interoperability of designs (P_4) is the next significant interface within this group with a score of 546.

Within the execution category, the most significant interface is E_1 (Client and contractor scope change issues resulted into introduction of additional work to the original work package as contained in the plan) with a score of 2924. This scope change is very significant because, it usually constitutes most delay in delivery of projects as well as increases the project total cost and time. With a score of 1600, E_2 (Contractor and owner scope change issues resulted into conversion or change of use of the initial building project) is the next most significant interface in the category. This scope change type in no small measure also increases the total cost of executing building projects. The least significant interface in this category is E_7 (the project and project suppliers' changes).

The high matrix scores of the scope changes in the monitoring category relates to their significance. The highest ranked (with a score of 1416) is M_4 (Failure to act on recommendations of monitoring or safety offices), highlighting the importance of religiously heeding the recommendations of safety and/ or monitoring offices. Closely following M_4 is M_5 (Contractor incompetence leading to legal issues with the regulatory agency) and M_3 (Noncompliance of designs resulted in pulling down of constructed works) in third place.

Within the Closure category, C_1 (project and lessons learned documentation) is the lowest ranking and thus least significant scope change. This implies that documentation on lessons learned usually does not have any effect on the current project but future projects.

In general, ranking of the 28 identified scope change issues shows that the most significant is E_1 followed by E_2, while the least significant is P_2.

Ranking of building scope changes by Category

The summary presented in Table 11. below is a ranking of the categories of project scope changes studied. The first column is a listing of the categories of the scope changes. Columns 2 and 3 are the means of the probability and impact of the specific scope changes in each category.

Table 11.0: Ranking of building project scope changes by category

Scope change Categories (a)	Probability (b)	Impact (c)	Matrix score (d)	Ranking (e)
I	32.3	36.5	985	3
P	17.2	20.6	350.5	4
E	38.7	31.7	1079.5	1
M	31.4	35.4	966.8	2
C	20.3	11.3	229	5

Table 11.0 shows the ranking of the project scope change categories. The scope changes in the execution category have the highest average matrix score (1079.5) and is therefore the highest ranking or most significant category. The Monitoring category with a matrix of 966.8 is ranked second in significance, while the Initiation category (985) and the Planning category (350.5) are ranked third and fourth respectively. The least ranked category is the closing category with an average matrix score of 229, and is therefore the lowest ranking of the five categories. This summary means that the project manager should pay particular attention to the scope changes encountered in the execution phase of a project, since this is the stage where the project cost increases mostly occur.

RESEARCH QUESTION FOUR: How can the Probability and Impact Matrix be applied in mitigating identified scope change problems?

In quantifying the building project scope changes identified, two parameters were used: the probability of their occurrence, and the impact. This provided the matrix score which was then used in ranking the scope changes and determining their degree of significance. With this, the probability and impact matrix (PIM) was applied to quantitatively manage building project scope changes, by identifying most significant scope changes and directing management attention towards them.

In deciding on the risk level of the scope changes, we need only to enter the data for the probability and impact already determined in Table 10.0 into the PIM of Table 2.0 to produce Table 12.0 below.

Table 12.0: Probability and Impact Matrix (PIM)

Consequence / Probability	Negligible 0 – 5%	Low 6 – 20%	Moderate 21 – 40%	Serious 41 – 50%	Disastrous Above 50%
0 – 10%					
11 – 40%		I_4 C_1, C_2, C_3 P_1, P_2, P_3, P_6 E_5,	P_4, P_5 M_1, M_2, M_5	E_2, E_6, E_9	M_3 I_2 I_1 E_2
41 – 60%		E_4, E_7, E_8	E_3, E_{10} M_4		E_1
61 – 90%			E_3		
91 – 100%					

Table 12.0 is obtained using the result of the analysis to plot a Probability Impact Matrix (PIM). Based on the decision rule, it can be seen that only five of the scope changes (I_2, I_3, E_1, E_2 and M_3) are intolerable, meaning that serious actions must be taken to tackle them and prevent their occurrence. Nine of the scope changes (I_4, P_1, P_2, P_3, P_6, E_5, C_1, C_2, and C_3) can be considered negligible, while the others are tolerable.

The background colours show the cost implication of the scope change problems. Those with green background, are between negligible to serious consequence/impact while the red background indicates disastrous consequence. The implication of this is that the scope change issues with green background can be managed even as their impact on cost are below 50%. Those with red background however requires strong and committed plan and effort in managing them

since their impact on project cost are so high that they can take up to 50% or more of the project cost. In addition, these scope change issues with disastrous implication can also led to schedule extension often recorded by some building projects. The findings of this study are in line with the findings of Fageha and Aibinu (2013) who stated that adequate front-end project placing with clear project scope definition can alleviate the potential for cost overrun and inadequate project planning. Poor scope definition can lead to expensive changes, delays, rework, cost overruns and project failure.

4.0 CONCLUSION

In order to mitigate the impacts of scope change management problem on building or any construction projects, project managers, contractors and other project operators should employ the Earned Value Analysis (EVA) model in order to determine the extent of cost variations incurred by the projects. In addition to it, Probability and Impact Matrix (PIM) should equally be employed in the management of project scope changes.

Employing the PIM as a quantitative technique in scope change management will assist in preparing a list of all the scope changes experienced in the management of projects and categorize them base on project life cycle. With this grouping and the set decision rule, each identified scope change can be analyzed to determine their probabilities of occurrence and impacts (consequences). This will enable the manager to rank the scope changes for proper management attention in order to successfully deliver the projects will be contribute to national development.

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