EXPLORATION OF BENEFITS OF DESIGN CHANGES IN BUILDING CONSTRUCTION PROJECTS

Romwald R. Byarugaba

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Romwald R. Byarugaba

A Dissertation Submitted in Partial Fulfilment of the Requirement for the Award of Master of Science Degree (Construction Economics and Management) of Ardhi University.

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CERTIFICATION

This report has been presented as a dissertation in partial fulfillment of the requirements for the award of the Master of Science Degree in Construction Economics and Management of Ardhi University. The undersigned certifies that he has read and hereby recommends for acceptance by Ardhi University a dissertation titled: “Exploration of Benefits of Design Changes in Building Construction Projects”

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Dr. Khalfan, Amour K.

(Supervisor)

Date: …….

DECLARATION AND COPYRIGHT

I, **Byarugaba, Romwald R**, hereby declare that the contents of this report are the results of my own study and findings and to the best of my knowledge, they have not been presented elsewhere for a diploma, degree or any professional award in any institution of higher learning.

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Byarugaba, Romwald R.

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DEDICATION

I dedicate this research work to my beloved daughter Rolin Byela, sons Jordan Mwanuzi & Eli Mbelwa, lovely wife Linda and my mother Cecilia

Blessed are their endless love, encouragement, understanding, devotions and moral support.

ABSTRACT

There exists a general understanding in the building construction practice that any design change to the project will logically be beneficial to the project. Based on that premise, this study aimed to explore benefits obtained through design changes instituted in the building construction projects. It was objectively set out to identify the types and causes, their targets as well as the resulting benefits of the design changes instituted in the course of execution of building construction projects.

To this effect, four case projects were evaluated through documentary reviews. In-depth interviews were also conducted with stakeholders such as project Architects, Engineers, Project Managers and Quantity Surveyors involved in those projects to correlate and corroborate as well as comprehend data obtained through documentary reviews. Data were collected and recorded electronically, transcribed and analyzed by using computer software. Qualitative data were analyzed using MAXQDA program. On the other hand, the Microsoft excel software was used to produce charts and tables for some of the numerical data gathered.

Findings indicated that design changes originated from the inadequate detailing of works, inexperience in specialty works, laxity in managing design and construction works, lack of understanding of design works and uncertainty related to project requirements. The benefits obtained through design changes instituted included improvement of the projects performance, enhancement of both the clients' and end-user satisfaction, reduction of the project's construction and whole life costs. However, these benefits were hampered by the higher expenses incurred in attaining them. Higher expenses were due to late institution of design changes in the course of construction of the case projects. Indisputably, design changes would be more beneficial if instituted up to the scheme design stage as long as both the consulting team and the client play their roles accordingly. Beyond that, it would be very difficult to control their reactive effects which are evidently very expensive and disruptive.

However, Value Engineering (VE) applied after the scheme design stage and before commencement of the project detailing stage can highly be used to limit the number of adverse design changes in the subsequent stages of construction projects. The notable benefits of design change in construction project highly depend on the stage at which they are initiated and instituted. Design Changes instituted at early stages of design involves less personnel and result into less or no extra payment to consultants, lead to less material and time waste and therefore are deemed to be more beneficial.

The study recommends that design changes should be controlled at early design stages of the project through diligent design and detailing works. It also recommends application of value concepts such as Value Engineering (VE) and Value Audit (VA) as early as the scheme design stage of works is completed and before commencement of detailing works of the same. That would tremendously limit likely and unnecessary design changes, costs escalations, material wastes as well as lead to enhancement of project performance and quality.

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ACRONYMS AND ABBREVIATIONS

3D	Three Dimension
4D	Four Dimension
AC	Air Condition
AQRB	Architects and Quantity Surveyors Registration Board
Arch.	Architect
BIM	Building Information Modeling
BoQ	Bills of Quantity
CABE	Chartered Association of Building Engineers
CAD	Computer Aided Design
CBD	Central Business District
CPD	Continuing Professional Development
DAAD	Duetscher Akademischer Austusch Dieust
DUCE	Dar es Salaam University College of Education
ERB	Engineers Registration Board
IT	Information Technology
LAPF	Local Authority Pensions Fund
MEP	Mechanical Electrical and Plumbing
MOI	Muhimbili Orthopedic Institute
NAO	National Audit Office
NCR	NonConformance Report

NHC	National Housing Corporation
NMB	National Microfinance Bank
NSSF	National Social Security Fund
PC	Prime Cost
PII	Professional Indemnity Insurance
PPF	Parastatal Pension Fund
PSPF	Public Service Pensions Fund
Qs	Quantity Surveyor
RERA	Real Estate Regulatory Authority
RFA	Request for Approval
RFI	Request for Information
RIBA	Royal Institute of British Architects
TAM	Total Asset Management
TOR	Terms of Reference
VA	Value Audit
VE	Value Engineering
VECP	Value Engineering Change Proposal
VfM	Value for money
VM	Value Management

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Construction as a process involves *seven stages*[1] which are divided into two groups known as the pre-contract and post contract stages. The pre-contract stage includes the first four stages known as a strategic definition, preparation and brief, concept design, developed or scheme design and detailed or technical design while the post contract stage includes the last three stages known as construction, handover and closeout, and in-use. The success of any building construction project greatly depends on the complete and diligence execution of the design works done in the design stages followed by the construction works done in the post contract stages.

1.2 Building construction overview

Tanzania, especially its largest city known as Dar es Salaam has been experiencing building construction boom in the past two decades. The country has seen the construction of high rise and complex buildings such as the PSPF commercial towers, which are said to be the tallest in East Africa and ranked fifth among the top ten beautiful and tallest buildings in Africa. The country has also witnessed the construction of the whole new University of Dodoma in its designated capital of Dodoma, the Ngurudoto resort hotel complex in Arusha which is said to be the five-star hotel and a lot more hotel complexes and office buildings in Dar es Salaam.

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1 https://www.architecture.com/files/ribaprofessionalservices/practice/ribaplanofwork2013template.pdf -accessed on 09/11/2015

Moreover, major clients and financiers of most of the large and complex building projects in the country are the public agencies such as the pension funds. These key clients include the Public Service Pensions Fund (PSPF), National Social Security Fund (NSSF), PPF and LAPF (Local Authority Pensions Fund). The National Housing Corporation(NHC) have also been one of the key clients of the largest projects such as the Morocco hotel and apartment complex and other multi-storey housing and office buildings in Dar es Salaam and in other towns such as Dodoma, Mtwara, Arusha, Mwanza, and Mbeya. Private developers have been highly involved in small and medium sized construction.

The building construction project in the country is still traditionally managed. Traditionally, the industry involves the two-way procurement systems, which involve selection of the consulting team to undertake design works and then contractor to undertake the construction works. The main consultants in the design process include an architect as a team leader together with the service, structural engineers and Quantity Surveyors (QS) as cost consultants. The design of specialty or complex projects such as hospital and skyscraper design may require specialist designers. Architects act as team leader and coordinator of works done by other consultants in the traditional system of building construction undertaking.

However, the Tanzanian building construction industry has been experiencing many challenges as it grows. One of these challenges of the building construction industry in the country has been the excessive design changes that have resulted in greater number of variation orders (Kikwasi, 2012). Design changes have been resulting in cost difficulties and untimely completion of projects. Stakeholders have been expressing varying opinions on the causes and benefits of changes in the building construction projects. These opinions are divided in two groups, one that believes that design changes are generally beneficial and necessary to construction projects despite the subsequent cost and time escalations

with the other group being in the opposition. That called for an in-depth review of the completed works to find out what kind and magnitude of benefits have been attained due to changes instituted in those projects.

In view of Sunday (2010), unfinished works as well as the lack of thoroughness (attention to details) and understandings of the design itself may lead to detrimental effects on the construction process through a number of design changes or construction changes. Design changes[2] and construction changes are used interchangeably to represent amendments or alteration of the original project plans, specifications or methods of executions. Design changes in the construction industry are documented as change orders which according to Parvan *et al* (2012); these are official documents attached to the original contract as an addendum after modifications. These are normally attached with the explanation and reasons on their originality, responsibility, costs and legal facet (Ibid)

1.3 Overview of the design changes

Although researchers such as Sunday, (2010); Parvan *et al* (2012); Anees et al (2013); Ibbs *et al* (2001) and Charles *et al* (2015) have concluded that design changes do occur in both the design stages and construction stages of the building construction projects. However; It is in the construction stages where these design changes seem to be excessively instituted in projects executed in Tanzania despite the availability of considerable knowledge on the detrimental effects of making changes in these stages in line with Sunday, (2010). In the design buildings[3] (2015), a construction knowledge base; it is, however, advised that design changes in their entirety should be kept at a minimum level as they might end up disrupting the project and impact the project time, cost and quality. In general, the latter is

2 Design or construction changes refer to work state, practices, or methods that diverge from the original construction plan(s) or specifications.

3 http://www.designingbuildings.co.uk/wiki/Building_design

the stage in the development of the project that changes occur, the greater are the negative impacts and fewer savings and eventually less or no value additions are likely to be (Ibid).

In Tanzanian building construction works; a lot of changes are occurring during the construction (post contract) stages of the projects. A thorough documentary review on a number of notable and public funded projects revealed that design change resulted in varied and noteworthy project cost variations, an extension of time as well as other direct and indirect effects. Good examples of the public funded projects that seem to have had remarkable cost variations due to a number of design changes are the construction of Sub-treasurer offices in Dodoma which had an addition of Tsh 4.3bn Tshs to its original estimate of Tshs 12.5bn Tshs and the construction of PSPF Commercial Building in Dar es salaam which has had Tshs 7bn Tshs as addition to its original estimate of Tshs 132bn Tshs. Other projects that have experienced higher cost and time variations due to excessive design changes include the NHC place and the MOI phase III projects while the NMB project is said to be one of the few projects finished on time and under budget.

Albeit the additional or savings figures described in some of the building projects, it is worth understanding their root causes and eventual benefits obtained. Designs should be probed to find out why they were gradually changed by evaluation of the design process in relation to consideration of value addition, the reasons, and significance of design changes suggested by the clients, the designers, and the project value considerations in suggesting and making these changes.

1.4 Statement of the Problem

In a great number of building construction projects in Tanzania, notable chunk of design changes are instituted after completion of design works with the value addition being the prominent reason for these changes. That is done notwithstanding the availability of

narrow knowledge base on the effects of design changes made beyond the design stages of the building construction projects. A number of previous researchers in this field such as Mazlan(1999), Ma & Tam(2013) and NAO (2004) indicates that if project design works were precisely and completely done then we would not have excessive design changes during the project's construction stage. Ideally, most of the necessary and beneficial changes would have been made and dealt with during the design stages. However, a lot of design changes have continued to be instituted in the building construction projects, especially during the construction stage with stakeholders involved in initiation and institution of design changes claiming that there are notable benefits obtained through these changes. That is done notwithstanding the available limited knowledge base to support their assertions. Although there is a lot previous research done concerning design changes, only a single research done by Charles et al (2015) has been found to have included discussion on the total monetary value of design changes. The author mentions the reduction of schedule and degree of difficulty as well as reduction of the project cost as being some of the benefits that can be obtained through design changes instituted in the building construction projects but provides no clear details of the mentioned benefits or other possible benefits. The continued practices of making excessive design changes during construction stage which eventually leads to a greater number of building construction projects to exceed budgets, construction time frame and in some cases compromising of the clients' expectations and requirements; necessitates researching on the causes, circumstances of occurrence and eventual benefits obtained through institution of these design changes building construction projects. Availing the benefits obtained through design changes provides greater comprehension on the necessity of design changes made and eventual effects on clients, construction stakeholders and the public as a whole.

1.5 Research Objectives

1.1.1 Main Objective

The main objective is to explore the benefits obtained through design changes made in building construction projects.

1.1.1.1 Specific Objective

i. To identify design changes and their causes in the building construction projects
ii. To examine the targets of design changes made in the building construction projects
iii. To ascertain the benefits that are being obtained from design changes
iv. To recommend situations that can make design changes beneficial in building construction works.

1.1.1.2 Research questions

i. What are the types and causes of design changes in building construction works?
ii. What influences design changes in building construction projects?
iii. What are benefits obtained by making design changes in building construction works?
iv. What are the beneficial design changes in building construction works?
v. What makes design changes beneficial?
vi. How can design changes be more beneficial?

1.6 Significance of the study

In order to have a *successful building design*[4], is imperative to identify as early as possible, the probable causes that are likely to lead to changes and establish their effects(both positive and negative) in the event that changes happen. Therefore; this study is expected to impact the building construction practice by;

i) Providing better platform and procedures that could be used by clients and professionals in the construction industry.

ii) Helping professionals such as architects, quantity surveyors, engineers and other related persons to know the best practice and procedures before making design changes during the design stages of a building construction project and ensure that the clients' interest, the building performance, and user expectations are enhanced through those changes.

iii) This research is also expected to contribute to the broad knowledge base related to the impact of design changes by providing exemplary literature on the benefits and value addition to building construction projects.

iv) Providing a measure of which both the public and the government will be able to know if the taxpayers' money is well spent, that is if it is an aspect of value for money is taken into account and if not pinpoint the areas of concern which should be addressed to rectify the situation as far as design changes are concerned.

1.7 Scope and limitation of the study

The study focused on the causes, circumstances of institution and effects of design changes done on the case projects evaluated. It was influenced by the excessive design changes that

4 A successful building design is expected to bring up a highly performing building in terms of its construction and operational costs, environmental friendly, sustainable, enhances health and safety of its users and satisfies its owners and end users expectations.

have been observed in most of the building construction projects in Tanzania. Time and cost constraints limited this work to be conducted broadly since only few case projects were evaluated. All the case projects used in this study have been constructed in Dar es Salaam and projects stakeholders involved reside or work in the city. Time was also a limiting factor since some of the respondents interviewed wanted to be given ample time for deliberations before in-depth. Despite the limitations, the findings are sufficiently expected to be broadly generalizable to cases of the same nature and context.

1.8 Layout of the dissertation

This research has been arranged in such way that the background of the research which includes an extensive literature review precedes the case study method selection wherein four suitable projects were chosen to explore the benefits obtained through design changes made in the course of their execution. Documentary reviews of these four projects were done. In-depth interview of stakeholders involved in those project were conducted to ascertain information obtained in the documentary review. Findings were then analysed by using cross-case analysis and discussion before reaching conclusion and recommendation of the study. The followings are the chronological order of the layout of this study;

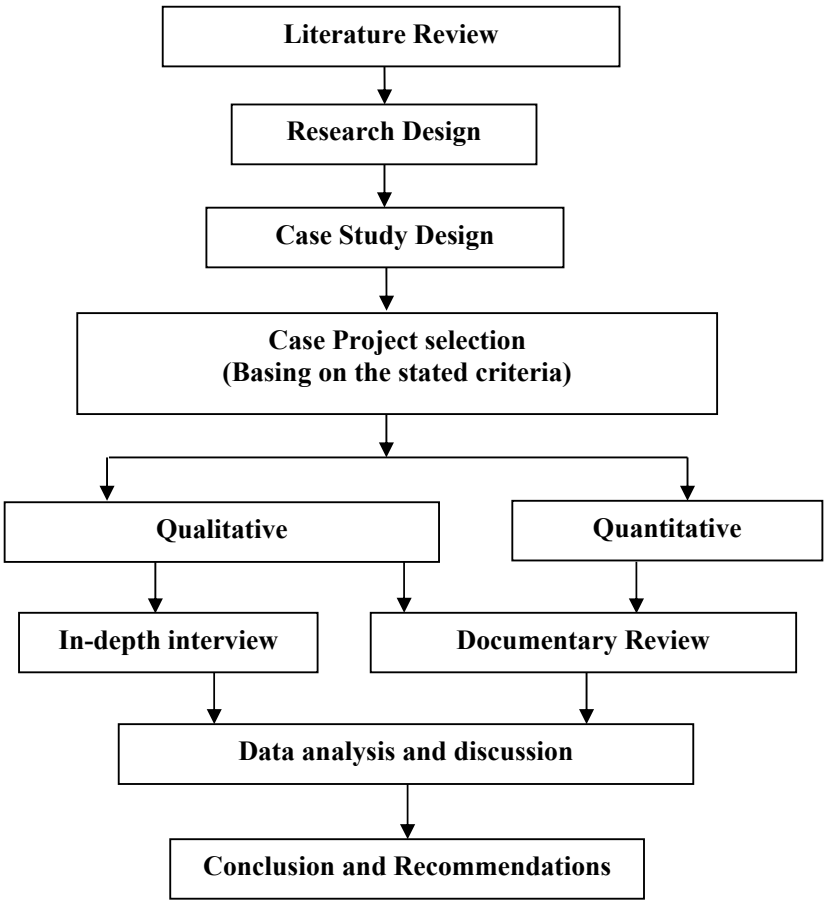

Figure 1: Framework of the study (adopted from Mikapagaro, 2015)

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter provides a gist of what previous scholar and researchers have so far documented about design changes in building construction projects, their causes, and categorization and potential effects. The chapter involves a review of journal articles or conference proceedings dating from the year 1995 to 2015.Besides that, the chapter includes reviews of the empirical literature. It finally winds up with a subsection pinpointing the knowledge gap that the current study endeavored to bridge.

2.4 Design stages of building construction projects

Execution of any building construction project runs through seven stages as per RIBA plans of works[5]. The first four steps which include the preparation and briefing outline or concept design proposal, the development or scheme design proposal and technical or detail design proposal falls in the pre-contract category. The last three stages which include the construction stage, handover, and closeout, as well as the in-use stage, form the post contract category. The success of the stages in the post-contract greatly depends among other factors, on the diligent completion of the first stages in the pre-contract category. In the following sections and sub-sections, the relations between design and construction works from various references have been reviewed and presented basing on the objectives of the study.

[5] https://www.architecture.com/files/ribaprofessionalservices/practice/ribaplanofwork2013template.pdf as accessed on 09/11/2015

2.5 Effects of a good design on quality and functional performance of a project

A good design is not only a question of elegance and taste but also an adherence to pre-set milestones (time) and includes sustainability, lifetime costing, structural integrity, flexibility and functional efficiency as well as enhancement of beauty and aesthetic of the site on which it is to sit. In this light, Sir John Bourn, in the NAO guidelines (2004)[6] insisted that "It is crucial for auditors to recognize that good design can significantly enhance long-term value for money in construction projects." In general, a good design does not cost more when measured across the lifecycle of the building although it might have a higher initial cost.

According to the United Kingdom's Audit Guidelines (NAO, 2004)[7]; a design represents a minute proportion of a building's life cycle cost. However, if flawlessly done, it has a disproportionate impact on how well the building performs relative to its surroundings. A good design can also contribute to staff retention (if deemed to be appealing and satisfying), motivation and operational performance, issues that increase value for money across the project's life cycle. Therefore; necessary changes to the project that aim at enhancing its life cycle operational performance should always be encouraged because the goal of value for money in building construction has always been more than delivering projects on time, cost and specified quality (Ibid). In consideration of Charles *et al* (2015), the total monetary value of proactive changes due to proactive causes that aim to enhance the project operational performance is normally higher than the value of changes due to reactive causes. This means that beneficial changes if proactively done can always result in

[6] The National Audit Office (NAO) guidelines namely as "*Getting Value for Money from Construction Projects through Design*"

[7] National Audit Office (NAO) guidelines namely as "*Getting Value for Money from Construction Projects through Design*"

improvement of user satisfaction, sustainability, and improvement of life cycle value. Interestingly; according to Charles *et al* (2015); most of the proactive changes that aim at increasing the project value are initiated by the client or owner while other stakeholders' contribution in initiating this kind of changes is hardly evident.

2.6 Design management effect on the quality and performance of a project

In view of Knotten *et al* (2015), the biggest challenge in managing building design works is when designers (architects or engineers) try to balance between the output (drawings) and creativity. While complete and timely output is very important in any project, creativity, on the other hand, is of extreme important as it ensures that clients' and future users' requirements and expectations are met. Poor management of the building design works has proved to be the source of document deficiency, reworks and eventual design changes (Ibid). Mismanagement of the building design works and the eventual deficiencies in the resulting design have been causing a lot of negative effects to the relevant building construction projects through increased costs, reduced productivity and leading to clients not realizing what they really wanted and needed (Thyssen et al, 2010). Designers need to better understand and interpret the client's requirements in order to enable the latter to realize their expectations and benefits of their investments (value for money).

2.7 Design management and Value Creation in Construction Projects

Many projects are not able to realize their potential value as a result of managerial problems in design phases, the main reason being the complexity of the design phases, especially in the early design phases where a number of iterations are essential for value creation in any project (Hansen & Olsson, 2011; Ballard, 2000). It is in the early stages of building design works where value creation is expected to be high due to the cost of making changes being the lowest. Changes made at the early stages of the design works

will result in more savings being made as compared to those made in the construction stages in which the cost of making those changes tend to be high(Samset, 2008 in Knotten *et al*, 2015).

2.8 Relationship between project design, value creation and Value for money

In consideration of assertions by Lipton, CABE Chairman (2001)[8]; design represents a minute proportion of the whole-life cost of the building, normally less than 1%. However, if it is precisely done, tends to have a disproportionate impact on how well the building and its surroundings perform. In a nutshell, a good design can increase the value for money that the building provides across its whole life (Ibid). That indicates that there is a tremendous affiliation between value creation during the course of project execution and value for money attained for that project.

The concept of Value has been described as the function of the relationship between the 'satisfaction of needs' (the project's business benefits and requirements) and the resources required attaining them. In other words, value = Benefits/Resources. The providing value indicates maximizing the benefits delivered by a project or projects through satisfaction or exceeding the required limit by numerous stakeholders while ensuring sustainable use or consumption of resources such as energy, water, money. In the context of construction, the value is normally expressed as the comparison or ratio of the resources required to accomplish a certain design goal and the whole life-cycle of that design. Erdogan *et al* (2005), recommend that value in the building construction projects can be increased by improving the functional performance or reducing whole life costs. On the other hand, Value for money (VfM), relates to the optimum between the anticipated benefits of a

[8] Sir Stuart Lipton, was Chairman of the Chartered Association of Building Engineers (CABE) which is an Incorporation of Association of Architects and Surveyors in the United Kingdom

construction project or its part and the resources consumed in its accomplishment (NAO, 2004).

According to SAVE international, a leading professional organization for Value Management, value or gains obtained by making necessary design changes at the earliest stages of project design are higher as compared to ones that would have been obtained by making the same design changes at later stages such as construction stages as shown. In the same context, Rangelova & Traykova (2014) and Tam & Ma (2013) asserts that value studies such as value management or Value Engineering done as early as the project design stages result in higher benefits in terms of net cost savings.

2.7.1 Value Engineering (VE) and its procedural undertaking

According to designingbuildings[9] and Rangelova & Traykova (2014); Value Engineering is used to solve problems, identify and eliminate unwanted materials and costs while improving functional performance and quality of a project. VE's main target has always been to increase the value of projects and improving the project's functional performance and requirements at the lowest possible cost. In building construction works, proper Value Engineering involves sustainable consideration of the availability of materials, site limitations or restrictions, construction methods, logistic matters, and costs as well as possible profits. However, it is advised in TAM (2004) that the 40-hour plan for undertaking VE is necessary for ensuring anticipated benefits are attained. The 40-hour plan includes stages such as information gathering, functional analysis, idea creation, evaluation, action plan and as well as analysis and reporting. Benefits that can be delivered through VE include a reduction in life cycle costs, enhancement in quality and health and

[9] http://www.designingbuildings.co.uk/wiki/Value_engineering_in_building_design_and_construction

safety as well as reduction of possible environmental impacts due to project implementation.

The benefits and cost savings from design changes due to Value Engineering or management in building construction projects will always depend on the stage at which those changes are initiated and executed. Figures 3 and 4 below indicates that there are vast potential savings from design changes initiated and executed before the detailing stage of project works and vice versa. Savings also decreases as the project design works progress to construction stage as shown in figure 4. Design changes brought up during construction stages will lead to a net loss due to greater time and cost incurred in implementing them.

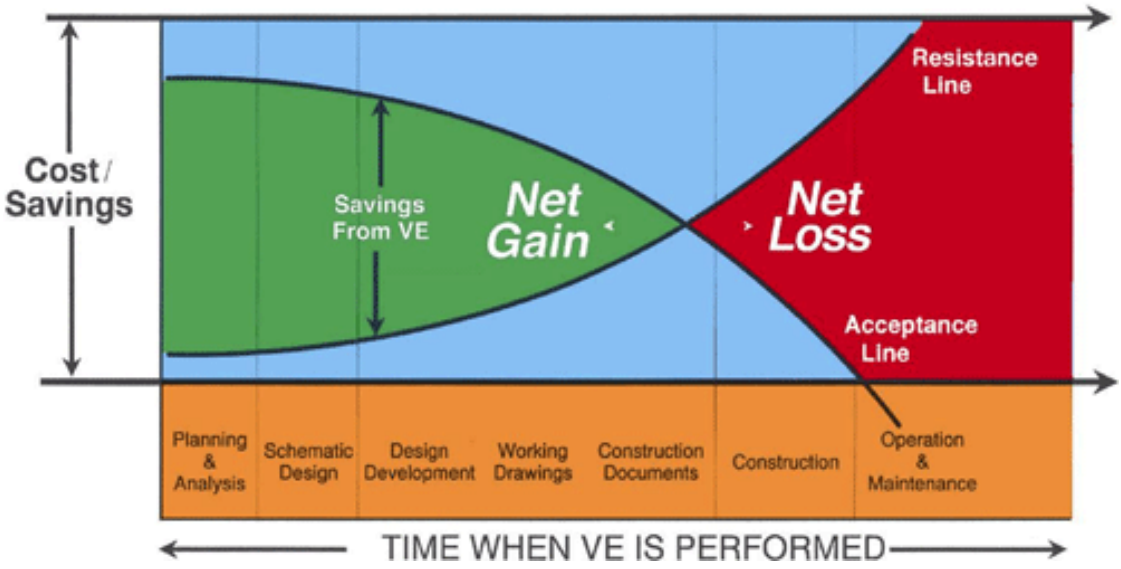

Figure 2 : Potential savings due to design changes due to Value Engineering done at various stages of project execution (Adopted from Whole Building Design Guide, 2016)

Ma & Tam (2013) elucidates that Value Engineering should start at project inception or as soon as there are rational design works where the benefits can be greatest. However, the contractor can still be given a chance to bring up alternative design that might lead to

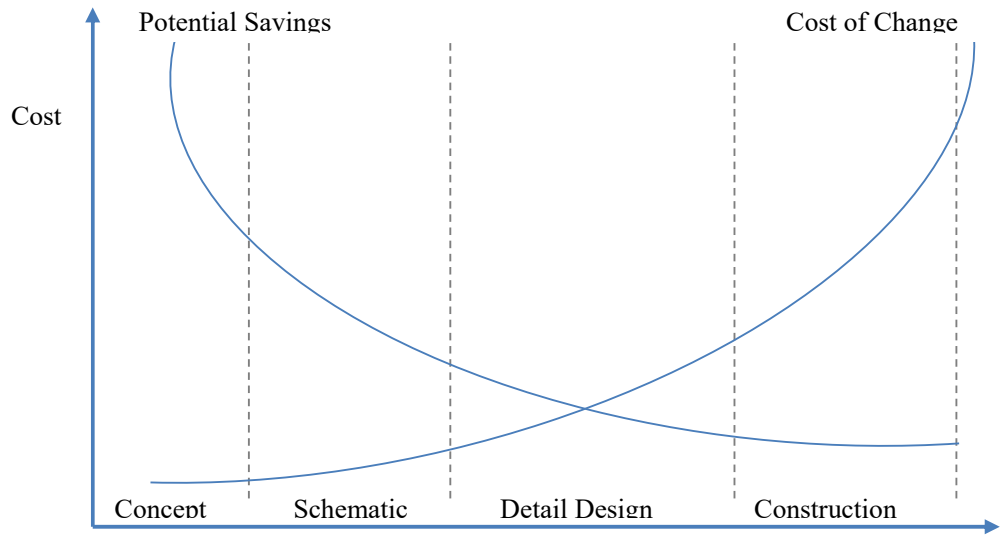

Figure 3: Stages of project and potential saving (Mazlan, 1999 in Ma & Tam, 2013)

savings and improvement of the functional performance through Value Engineering Change Proposal (VECP) as long as the effect of design changes brought up do not significantly affect the project's timescales, milestone or lead to additional costs that may outweigh the savings offered (Ibid).

In countries such as Australia, application of value management or value engineering is mandatory on public funded projects that cost $5 million and above. In the same line, Ma & Tam (2013) and Rangelova & Traykova (2014) recommend that VE would be more beneficial and necessary in the following categories of projects;

2.7.2 Complex and unique projects

These are projects that require expert opinion other than architectural, structural and service skills. Experts' opinion and contributions are of paramount as early as the inception

stage of project works. Complex projects include laboratories and other chemical projects and hospital facilities.

2.8 Sources of design changes

Clients and members of the design team (consultants) are said to be the main sources of the design changes and the main reason being that clients lack visualization of the design through detailed drawings until they realize them during or after construction (Ndihokubwayo *et al*, 2009; Mohamad *et al*, 2012). On the other hand, design changes by consultants may result from lack of coordination between the design team, and issuance of incomplete detailed drawings (Ndihokubwayo *et al*, 2009; Mohamad *et al*, 2012; Muhwezi *et al*, 2014). Lack of experience and competence may lead to the consultants' failure to prepare adequate and detailed clients brief and in turn cause unnecessary and/or excessive design changes (Ndihokubwayo *et al*, 2009; Mohamad *et al*, 2012; Kikwasi, 2012; Muhwezi *et al*, 2014;).

2.9 Categories of changes

As proposed by Charles *et al* (2015), design changes and their subsequent design orders can be categorized into two groups either proactive changes or reactive changes. The following paragraphs elucidate this contention.

2.9.1 Proactive changes

These are changes that might be introduced to the project with the aim of improving its performance beyond the initially targeted ones. In this case, their causes can be called "proactive change causes" (Charles *et al*, 2015). Proactive changes intend to improve the performance of projects beyond the initial expectations or targets(Ibid).The Value

Engineering Change Proposal (VECP)[10] can be one of the best example of the causes of these changes in which the contractor is given a chance of bringing in change proposal to the project that will either lower lifecycle cost while improving project performance, maintaining project life cycle cost while improving project performance or lowering project lifecycle costs while maintaining project performance. However, it should be noted that proactive changes will still have reactive impact on the project's initial capital cost and project duration although they will have positive impact on the project life cycle cost through reductions of the same and improvement of the project value (Charles *et al*, 2015)

2.9.2 Reactive changes

Reactive changes emerge as the result of reactive causes such as changing design or part of it to curb slow progress of works on site or on a certain section of works (Charles *et al*, 2015). They tend to place construction projects at a level that was initially conceived and at a targeted performance (Ibid). These kinds of changes might result in negative impacts by slowing work progress while waiting for details of design changes, agreement to be reached on costs in case there are new works the rate of which might be unknown, wasting of materials in cases is change in material specifications, disputes between project stakeholders and higher project's life cycle costs (Ndihokubwayo *et al,* 2009; Kikwasi, 2012; Parvan *et al*, 2012).

2.9.3 Comparison of changes due to proactive and reactive causes

Charles *et al* (2015); elucidates that changes from reactive changes causes are more frequent (67-70%) than proactive change causes (30-33%). In an analysis of causes of changes in some cases, it has been pointed out that changes due to reactive causes are

[10] http://www.wbdg.org/resources/value_engineering.php

frequently the result of inaccuracy in the design brief, detailing of the design and construction works (Ibid). Reactive changes also include additional works, rework to correct errors and design changes, to ensure the clients' requirements are achieved accordingly. Proactive changes are always associated with extra works and design changes to enhance the quality, user satisfaction, sustainability and operational performance of the project (Ibid).

2.10 Causes of Changes

A number of researchers have classified and grouped the causes of design changes and the eventual change orders basing on their sources or initiators. For instance; basing on sources of design changes and the subsequent change orders; O'Brien (1998) and Olsen et al (2012) listed down the causes of changes as follows;

Unforeseen conditions

Circumstances such as differing conditions in the field of work that do not match expectations in the contract documents may result in a number of design changes.

Incompleteness of plans and specifications

These are changes that result from mistakes or omissions done during the design process to the extent that implementations of the plans or specifications will result into undesirable outcome or the result will not operate as per the owners' expectations**.**

Change of scope (additions or enhancement by owner)

This happens when the owner(s) add up to or remove work from the original extent of the project. The additions or omissions might be due to extra funding becoming available from unanticipated sources or loss of expected funding respectively. This might still be a result

of receiving favorable bids or Value Engineering Change Proposal (VECP) which make the extra fund available as savings to enable the addition of works.

Force majeure

These are changes resulting from delays due to circumstances such as fire, flooding, work stoppage or strikes and extreme weather which tend to be beyond the control of the parties involved in a project.

Need for acceleration of work

These are client's initiated changes that target completion of the project earlier than previously planned or recover time lost through no contractor's liability.

Moreover, basing on initiators; Mincks and Johnson (2004) in Olsen et al (2012) categorized design changes and the eventual change orders as

Owners directed changes and Constructive changes

These are changes that result when the owner instructs and confirms amendments to the original design works. On the other hand, constructive changes are changes that result when the architect or owners' agent instructs the contractor to perform works beyond the original contract. This can be a result of defective specifications or incompleteness of design works.

Consequential changes

These are changes that develop from amendments in other related parts of works or project. These are normally the direct consequence of both the constructive change and owner directed change of scope; evident when there is rework, delays or rescheduling.

Changes due to differing site conditions.

These result from the sub-surface and existing conditions issues especially in renovation works in which the designers might not have full details of original construction works.

Changes due to product substitution

These might be a result of lack of thorough investigation on the availability of a certain specified material by the designers which later on necessitate a need for replacing the specified materials and sometimes redesigning of the affected spaces in case the substitute cannot function as the original ones.

Changes due to code revision

These changes occur when the contract is awarded and signed before the drawings and other documents have been approved by the regulatory or local authorities. The authorities might require changes to the project to ensure that their codes are adhered to and this might either increase or decrease the scope of the project.

After comparing the classifications of sources of changes as discussed in Mincks and Johnson (2004) in Olsen et al (2012) and O'Brien(1998) in Olsen et al (2012); blending of the two seem to be necessary in order to get an ideal synthesis and suitable categorization of design changes which may be practically applicable in the Tanzanian construction industry.

2.11 Effects of Design Changes

Peansupap & Cheang (2015) unequivocally asserts that changes in construction are often unwanted due to their negative effects on the project performance. Incidentally, design changes are widely acknowledged by clients and contractors as having detrimental effects

and being tricky to quantify; which eventually leads to undesirable disputes. However, the same authors still acknowledge that changes can still be beneficial since they factor positively in improvements of the client's requirements and vital goals. Hand in hand with this, it has aptly been suggested that the amount and timing of design changes are the major significant factors that affect the project costs, potential savings and labor productivity (Ibbs et al, 2007).

2.11.1 Extent of effects of design changes

Design changes may affect other areas of work for which a particular change order is not accounted to (Jones, 2001 in Ibbs *et al*, 2007). When a change is demanded by the design team member or the contractor or is initiated and confirmed by the client, it may affect the working area of one or more project parties (Charkhakan & Heravi, 2012). There are always both foreseeable and unforeseeable or cumulative disruptions resulting from any change (Ibbs *et al*, 2007). The former are likely to occur at the same time and within the same resource as the changed work while the latter may occur at the time or place or within resources which are different from the changed works. Parvan *et al* (2012) describe impacts of design changes as being both positive and negative. The positive changes may be beneficial to the project in the manner that they may result in cost savings, time and on the quality improvements while the negative changes result in the deterioration of the project outcomes. Almost all of the notable design changes are accompanied by variation orders which can adversely affect both of project final cost and completion time. Delay in issuance of variation orders by consultants and sluggish approval by clients may result in schedule slippage and excessive variations (Kikwasi, 2012).

2.11.2 Negative effects

Koskela et al, (2002) emphasize that; incomplete design works done in the design phases can be a major source of problems for the subsequent phases, even to the extent that it can undermine systematic management during the construction stage. These negative influences can be vastly transmitted through excessive design changes and may lead to irregular preparation and execution of both the procurement and construction works (Ibid). The negative effects of design changes include rework, revision, extra work, time loss, design revisions, increase in cost of the project, disputes and claims, loss of productivity, loss of rhythm, unbalanced gangs and resource allocations, change in cash floor, increased risks of coordination failures and errors, lower morale of the work force, loss of float and reduction of the project value. (Ibbs *et al*, 2007; Kikwasi, 2012; Parvan *et al*, 2012; Charles *et al*, 2015)

Olsen *et al* (2012) noted that change or variation orders can sometimes be extremely expensive and may negatively affect the project schedule, affect project costs, increase project execution period and to a certain extent sour the working and business relations in the project. All stakeholders do benefit from limited change orders and it should be the ultimate goal of all to restrain the occurrence of unnecessary change orders (Ibid). Major changes might increase the cost of the project, overhead expenses of all or some of the parties concerned, decrease work morale, labor productivity and additional payments to a certain party (Peansupap & Cheang, 2015).

Senaratne and Sexton (2008) concluded that *rework*[11] due to reactive (unplanned) changes can cost between 10% to 15% of the contract sum and that more harmful effects can lead to unnecessary and costly disputes between the client and the contractor especially if the contractor feels that there is loss of earnings or decrease in the profit margin due to changes proposed by the designers or the client. Changes can also lead to reactive impacts such as loss of labor productivity (idling), loss of rhythm (momentum) and impact on resource planning and cash flow (Charles *et al*, 2015).

2.12 Benefits of early iterations

According to the whole *Buildingdesignguide and* Ma & Tam (2013) design changes instituted as early as the design stage are normally beneficial due to reasons such as;

i) Any changes to the program of works or project parts at early stages have very little (if any) impact on schedule, time and redesign costs.

ii) Early iterations will enable development of projects with fewer changes, redesigns, and a greater understanding by all parties of what is the required and targeted spaces and their functions.

iii) Design stages involve a lot creative minded personnel who are able to balance between making changes with the focus on output such as drawings as a product and creativity, which is the realization of both clients' expectations and user requirements (Koskela *et al,* 2002).

[11] Reworking is re-doing a process or activity that was incorrectly implemented in the first place and be created by defects or variations (Ming *et al*, 2006). In most cases the scope of work is always the same as the original work

2.13 Benefits and Monetary Value of Changes

2.10.1 Reduction of the project cost

Charles *et al* (2015) opine that design changes may result in beneficial effects such as project cost reduction and simplification of works as well as cost and material savings. However, cost reduction must be done without compromising the quality and functional performance of that project and all that shall be better considered during the design stage (NAO, 2004).

2.10.2 Reduction of schedule and degree of difficulty

Simplification of works can be done through changes in execution methodologies or redesign of some parts of the project design. It yields more, better and positive results as long as it is done at the earliest stages of works such as at design stages but can still have better impacts if done also at the commencement of the construction stages through the Value Engineering change proposal (Erdogan et al, 2005).

2.10.3 Identified knowledge gap in the literature

Almost all of the previous works cited have shown that design changes done in the project have more detrimental effects on the project than beneficial effects. A mention of the beneficial effects of design changes can to a limited extent be found in Charles *et al* (2015). The author mentions the reduction of schedule and degree of difficulty as well as reduction of the project cost as being some of the benefits that can be obtained through design changes instituted in the building construction projects. There are very limited clarifications of the mentioned benefits and that is why the study was conducted to explore the possible benefits of changes instituted in building construction project in Tanzania.

2.2 Chapter Summary

The chapter has provided a brief description of research works done concerning on the concept of design changes. It has also shown the knowledge gap that necessitated this study to be conducted. It introduces some concepts pertaining to design changes including the sources, initiators, and effects of changes done in other construction works. This chapter also provides bases for theories and frameworks to be discussed in the next chapter.

CHAPTER THREE

THEORETICAL AND CONCEPTUAL FRAMEWORK

3.1 Overview

This chapter presents a discussion on relevant theories emanating from the literature review as well as the conceptual framework used in the study.

3.2 Theoretical Framework

Kumar (2011) argues that the theoretical framework stems from the literature review done in relationship to the topic in question. It includes aspects that have direct or indirect bearings on the research study being sought and these aspects should act as a base of the theoretical framework of that study(Ibid).Three theories were identified as relevant for this study as discussed hereunder;

3.2.1 Building Design and Management Theory

The Design management theory is concerned with the administering of the design process which is often divided into several stages or phases such as inception (includes preparation, feasibility, & briefing), outline, scheme, detailing and production of information. The theory emphasizes on managing people and resources involved in the design process. Generally, the design management deals with managing people such as architects, engineers, client's representatives and other relevant construction stakeholders as well as managing information (deliverables) such as contracts, drawings and any other relevant documents to the project (Emmitt & Ruikar, 2013).

It is easier to manage deliverables such as drawings and models than to manage ideas or evolving creativity concepts from designers, hence the building design management

complexity as compared to other industries such the production industry where works follows a chain; starting of latter stage depends on the completion of the previous one (Ibid). Bell and Kozolowski (2002) point out that design decisions are normally negotiated among teams and groups involved in the design process which mean that any successful design management requires proper and closer coordination due to the iterative nature of the design process. Therefore, arguments on the design works of the projects to be dealt with as cases were based on design management theory and the design process in the building construction industry.

3.2.2 Value Management Theory

The value management theory bases on the assumptions that the project value is accumulated over the course of that project lifecycle or whole life. It involves diligent analysis of functions as appraised by the client and yields better and maximum value if considerations are over the wide context. It is a combination of the considerations of the project's whole life cycle costs, material, and energy sustainability, enhancement of the clients and end user requirements and expectations as well as augmentation of the health and safety over the whole life of the project (Venkataraman & Pinto, 2008).

In Value management theory, the maximum value of a project is equal to the maximum returns that can be obtained by combining elements such as costs over the whole lifecycle of that project. The theory also advances that some aspects of value management studies will always result in more value creation if done as early as the project inceptions. According to the designbuildings[12], one of the prominent knowledge base on building construction in the UK; value management studies involve three widely known techniques, namely as Value Planning (VP) which is applied during the planning phase of the project,

[12] http://www.designingbuildings.co.uk/wiki/Value_engineering_in_building_design_and_construction

Value Engineering (VE) which is applied during design phase of the project and Value Analysis (VA) which is a retrospective study or audit to the completed project.

Consequently, the value management theory was applied in this study to explain evaluation of the design changes done in the case projects in order to find out the extent to which value creation and enhancement was a cause of action. For instance, the extent at which Value studies such as Value Engineering (VE) is understood and applied in the building design and construction process.

3.2.3 Value for Money Theory

Lipton (2001) in NAO (2004) and designbuilding[10] defines Value for Money (VfM), as a concept that, "relates to the optimum balance between the benefits expected of a project and the resources expended in its delivery". In the Value for money theory; any building design will offer greater value for money when the benefits resulting from it considerably exceed its whole life costs. However; benefits have always been the result of the building functions rather than the building itself. Wherever there are additional features that have not been derived from the client's stated objectives and that adds excess costs; this means there will be no resulting benefits from additional costs and the overall project value end up being degraded. Likewise, cost- effective projects that fall short of the client's objectives and targets do not offer greater value, regardless of being completed within budget. In order to ensure value for money, the project design team must clearly define the client's objectives and requirements especially during the briefing phase, avoid as much as possible unnecessary expenditure and make sure there is an optimum balance between cost, time, quality and aesthetic. Therefore; the project team has considerable influence over cost, project duration and quality of construction and can ensure that the client gets

the value for money by diligently providing a good design that offers an optimum balance between projects whole life costs and performance.

3.2.4 Relationship between Theories

Lipton (2001) in NAO (2004) elucidates that although design represents a minute proportion of the whole-life cost of the building, normally less than 1%; it tends to have a disproportionate impact on how well the building and its surroundings perform if it is precisely done. In short, a good design can increase the value for money that the building provides across its whole life. While clients want to achieve the value for money, that is maximum return from their investments, end users will always want products or building designs that ultimately meets their expectations and needs. Value management will surely provide the client with the best project and that the project is rightly executed through Value Engineering by ensuring a cost effective and well-performing design for the project is provided for their money. Therefore, in this research, we will have to work and use all the three theories concurrently as it is ultimately difficult to deal with only one among the three discussed theories or separating them as they function in unison.

3.3 Conceptual Framework

Design changes can be conceptualized as a result of the design process whose completion or incompletion is deep rooted in the successful and diligent participation of the design team, the client representatives or owner as well as the appropriate incorporation of other relevant regulations, statute, and requirements of the law. Shortcomings of the design process form the basis for targets, aims, goals and reasons for making design changes; the benefits of which depend on among other attributes, the period or phase or stage of the project in which these changes are made. Ideally and conceptually, design changes are always expected to lead to better outcome such as enhanced project's functional

performance, client requirements, end user expectations, health and safety, maintainability, material durability, indoor environment, exterior outlook (aesthetic), reduction of the project's whole life cycle costs as compared to its anticipated performance, costs and milestone if the original design was implemented without those changes. Incorporation of change in technology, acceleration of the project's works, uncertainty in project performance, inadequate funding, lifecycle costs as well as lack of proper participation of the client's representatives and poor interpretation of the client's requirements during briefing stages by the design team are among the reasons that may lead to design changes.

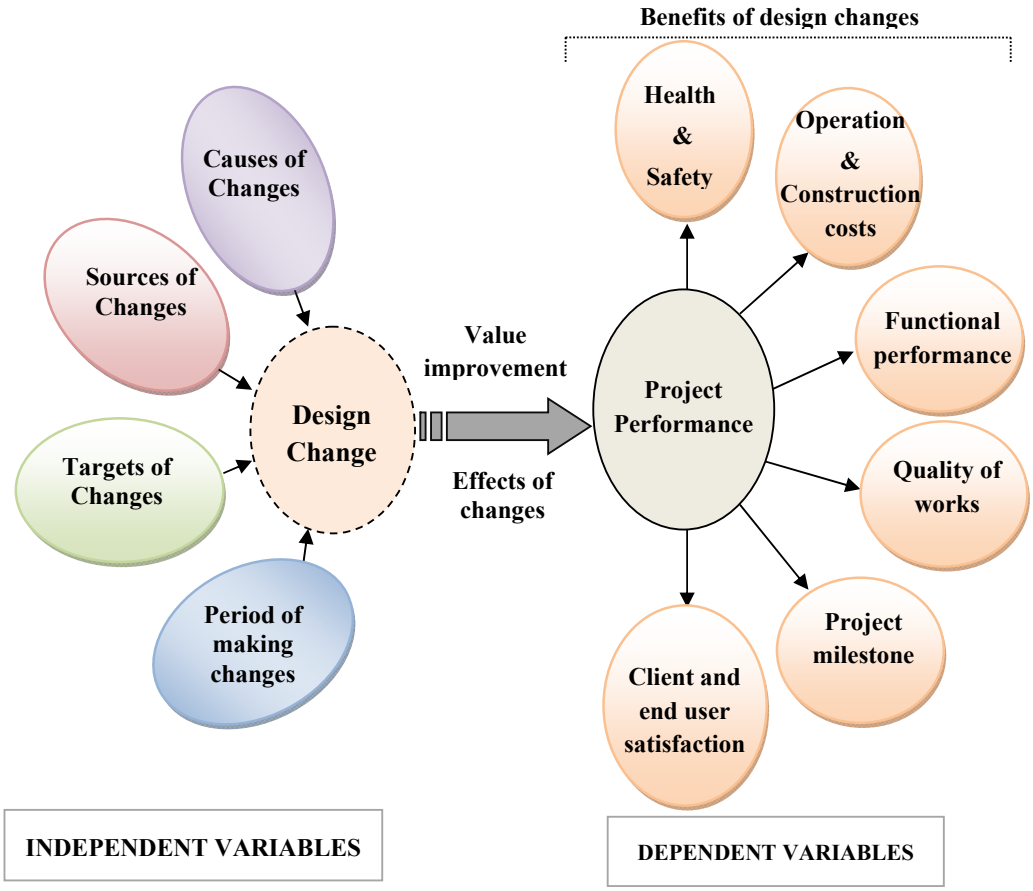

Fig. 3.1: Conceptual framework of the study (Source; Author's construct, 2016)

Figure 3.1 show the conceptual framework of the research and indicate that possible benefits of the design changes made in building construction depend on their causes,

targets, period or phase of the project in which these design changes are made as well as their direct and indirect effects on that project performance. Project performance can be evaluated through attributes such as health and safety of users of the project, operation and construction costs, its functional performance, quality of works, achievement of the project pre-set milestone and both the client and end-user satisfaction. The mentioned attributes are the dependent variables of the study.

3.4 Chapter summary

This aimed at introducing brief explanations of theories that are relevant to this study as well providing explanations on the conceptual framework of the study pertaining to the benefits of design changes in the building construction projects. Theories and concepts discussed show the link between the sources of design changes, causes, targets as well as possible effects of those design changes. The next chapter introduces the research design, methodology as well methods and instruments to be used in the collection of data as well as explaining how data collected were analyzed.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Overview

Kothari (2004) defines research methodology as a way or science of studying how to scientifically or systematically solve the research problem. It involves the logical adoption of steps and methods or techniques used to study the research problem. This chapter contains the research design and methodology used by the researcher in data collection, processing, and analysis.

4.2 Research Design

Kothari (2004) describes research design as an advance setting up of the methods and techniques to be used for collecting and analyzing the relevant data, keeping in mind the objectives of the research and the available resources such as money, time and personnel. The research design is essential and required to facilitate the smooth performance of the numerous research processes while enabling research to be as efficient as possible by yielding maximum information within a limited amount of expenditure of money, time and effort (Ibid).

4.2.1 Study Areas

In this instance, the case study design was adopted as the base for exhaustive and in-depth exploration of the possible benefits of design changes in building construction projects. Kothari (2004) suggests that the case study design is based mainly on the postulation that the case being studied is unique and peculiar as compared to other cases of the same nature and that lone case can provide an insight into the events and situations common in a cluster

where the case has been extracted from. Kumar (2011) emphasizes that the case study type of research design is of enormous relevance when the main target of the research is on the extensive exploration and understanding of issue rather than quantifying and confirmation. In this type of design, it is not important to select a random sample but to choose a case that can yield the maximum information relevant to the problem under study (Ibid).

In this case, six case projects were considered for this study. These included the MOI Phase III project, PSPF commercial project, NHC place, DUCE teaching Centre, NMB building, Millennium Towers phase II projects and the Sub-treasury building. All the mentioned projects are found in Dar es Salaam with an exception of the Sub-Treasury building which is found in Dodoma. However, because of the preliminary data inquiry was done, the Sub-treasury and DUCE teaching Centre projects were dropped from the list of cases to be dealt with because of difficulties in accessing project documents and interviews with the stakeholders involved in those projects. A brief introduction to the cases used in this study has been given below.

4.2.2.1 MOI-phase II project in Dar es Salaam

This project involved the extension of **M**uhimbili **O**rthopaedic **I**nstitute (MOI) at the **M**uhimbili **N**ational **H**ospital (MNH) in Dar es Salaam. The project result being the hospital facility so far makes it unique in the manner that it required special attentions to details, specifications of materials for construction and insurance to the quality of construction works. A public building such as a hospital facility would likely attract greater attention and opinion on its design and construction as well as the fulfillment of expectations of both the client and end-user who are in this case the public at large.

Its design commenced in the early months of 2012 and PSM architects Ltd was selected as the leading consultant and architects for the project whose budget was around 17.5bn Tshs

but its cost escalated to about 24.5bn Tshs. Construction of this project was supposed to take fifty-six (56) weeks to be completed but instead was delayed by up to three years. The delay is said to have developed from design changes made in the course of execution of this project and the lack of additional funds to complete the essential parts of the project which totaled up to about 7bn Tshs.

4.2.2.2 PSPF Commercial Building project in Dar es Salaam

The PSPF commercial building famously known as the PSPF twin towers, located at the junction of Mission street and Sokoine Avenue in Dar es salaam, Tanzania is currently one of the two tallest (152m high) buildings in the East and Central Africa and the "5th ranked among the top ten most beautiful"[13] buildings in Africa. The 32 storey complex is owned by PSPF and was designed in a joint venture between the Ardhi University's Department of Architecture and Al Hatmy Engineering and constructed by Estim Construction Co. Ltd between early 2011 and the end of 2015. The structure is the mixed use building that contains functional spaces such as banking spaces, restaurants, apartments, office spaces, gymnasia, outdoor swimming pool and four floors dedicated for parking use.

The building was originally designed to have two towers, one to include 138 luxurious apartments while rest was designed to provide open plan office spaces. The top half of the residential tower was changed into office spaces during construction. Each tower is serviced by four lifts and other necessary engineering and safety installations and requirements. The building contains 73,000 square meters of built up area and was estimated to cost 133bn Tshs up to its completion. Apartments in the residential tower are said to be among the most expensive in Tanzania as a duplex apartment cost at least 0.45million dollars. The building is said to have had cost variation of at least 3bn Tshs

[13] http://www.africaranking.com/most-beautiful-buildings-in-africa/5/

which is equivalent to 3% of the original construction cost due to design changes instituted in the course of its construction.

4.2.2.3 NMB Building- Dar es Salaam

The new NMB headquarter building is located at the junction of Ohio and Ali Hassan Mwinyi roads in Dar es Salaam. The project design commenced in 2006 and its construction work took 97 weeks between 2012 and 2013, at the construction cost of about 1.5million dollars. The building has a floor space of about 13,000 square meters; constructed for banking purposes as both the bank's Headquarters and branch offices. The building contains two basement floors, a ground floor that is subdivided between branch and headquarters offices, a mezzanine floor plus five other floors spaces used as offices for the bank's headquarters. Originally, the building was supposed to have eight-floor spaces above the mezzanine floor but had to be reduced due to an abrupt change in the urban regulations guiding the development of all areas with the Dar es Salaam's CBD. This building is among few structural complex constructed under budget and whose construction works were completed with the estimated construction period.

4.2.2.4 NHC Headquarters

The NHC headquarters building famously known as the NHC Place is located at the junction of Agha Khan and Ali Hassan Mwinyi road in Dar es Salaam and was constructed and owned by the National Housing Corporation (NHC). The building is the result of the design project undertaken by Arqes Africa Ltd, a local architectural and Interior Design Company and constructed by Group Six International, a Chinese construction company located in Dar es, Salaam. It took about a year and approximately 20bn Tshs budget to construct this building that houses the offices and headquarters of its owners despite the fact that it was designed for commercial leasing. The building consists of eight floors that

include the ground floor plus one semi-basement and a full basement, both used as parking floors. Uniquely, this is the only certified green building in Tanzania to date.

4.2.3 Rationale of Case Study Design

Since this research sought to explore the benefits of design changes in the building construction projects; the case study type of research design was appropriate due to the fact that the research intention was to discover ideas and insights. Case studies are also very useful where exploration of an area in which there is limited knowledge or where there is a general understanding of the situation. It has been widely used in most of the previous study pertaining to design and construction works. This type of research design together with various flexible methods of data collection; can be considered to be adaptable enough to permit greater deliberation of various aspects of the issue under study (Kothari, 2004 and Kumar, 2011).

4.2.4 Criteria for selection case project

The following were the main criteria for case selection

i. A building construction project completed in the last 10 years. This was chosen so that to check data against the knowledge base created in the last 15 to 20 years.
ii. A complex, notable or specialty project constructed in or within the vicinity of the city Centre and which has at least five stories and construction cost of at least 5bn Tshs.
iii. Public or semi-public owned projects to ensure availability of records and correspondences.
iv. Projects designed and constructed by prominent designers who could contribute to the study.

v. Projects that had experienced an exessive and a limited number of design changes.

4.2.5 Data Collection Methods and methodology

In this course of conducting this study, data collection methods such as in-depth interviews and project document reviews were employed in gathering both primary and secondary data. Multiple applications of data collection methods in case studies have been emphasized in a number of previous publications as the base for obtaining relevant, reliable and valid data. A very exemplary example of that insistence is in the publications by Kumar (2011) who affirmed that although a single method can be used in the collection of relevant data, the use of multiple methods cannot be overemphasized as it is a vital aspect of the case study.

4.3 Instruments for Data Collection

Concerning primary data collection, especially in case study type of research design; Kothari, 2004; elucidates that it is of great importance to apply experience survey in which people with immense practical and professional experience pertaining to the issues under study and substantial involvements in the case projects are sought and interviewed. In this case; competent professionals and practitioners such as architects, engineers, project manager and quantity surveyors who could provide ideas that contributed to the understanding of the benefits of the design changes in building construction projects were carefully selected. Selection of respondents for in-depth interviews was done basing on respondents' involvement in the case projects, and their professional experience in the building construction works. Selected respondents were then invited for an in-depth interview.

4.3.1 Personal and unstructured interview

Interviews were used as a complement to project document reviews so that to collate, corroborate and acquire further explanations of issues pertaining to the project construction that transpired but was not well documented or required extra clarifications. The interview guide questions(ref. shown on Appendix-I) were prepared then sent to respondents such as architects, quantity surveyors, engineers and project managers prior to the scheduled interview. The interview was chosen because it allows flexibility and ability to ask questions or correct misconceptions or ambiguities.

Interviews involved personal investigation in which data were collected by the interviewer personally through notes taking and electronic recordings which were later on transcribed. The interviews conducted were semi-structured meaning that some questions were objective while a few were subjective in order to obtain as much information as possible. Semi structuring of questions was set to allow flexibility and greater freedom.

The targeted number of respondents of 75% was achieved. All architects, quantity surveyors, and project managers targeted were interviewed as shown in Table 1. There was exceptional of service engineers who 3 out 4 declined to be interviewed or provided time space that was out of tolerable period. Interviewed respondents were all senior members of staff involved in the case projects as shown in Table 2. That means that information obtained through interview contains experiences of professionals who have been in the industry.

Table 1 : Number of Respondents Interviewed

Name of case project	Respondents	Number of Interviews		
		Targeted	Actual	Success (%)
NMB building	Architect/Engineer/Project Manager	3	2	75
PSPF Commercial	Architect/Engineer/QS	3	2	75
MOI Phase III	Architect/Engineer/QS	3	2	75
NHC Place	Architect/Engineer/QS	3	3	100
Total		**12**	**8**	**75**

Source: Author (2016)

Table 2 : Experience of Respondents

Respondents profession	Experience(years)	Number of Interviews		
		Targeted	Actual	Success (%)
Architect	10 and above	4	4	100
Quantity surveyors	10 and above	3	3	100
Project manager	5 and above	1	1	100
Total		**8**	**8**	**100**

Source: Author (2016)

4.3.2 Types of Data Collected

Secondary data were collected through project document reviews which were aimed at determining, documenting and categorizing types, sources, causes, and targets of the design changes that were done to original projects design works of the case projects. Review of the project documents involved studying minutes of site meetings, revised drawings, and specifications, reports such as progress reports, non-conformance reports (NCR), variations orders, instructions issued by designers, request for information (RFI), request for approvals (RFA) and correspondences between stakeholders involved in the case projects.

Document reviews of four case projects were done and data collected were recorded basing on the pre-structured themes that were developed from the literature review. There was flexibility on how the pre-structured themes were applied. More themes were added basing on the findings of individual projects. Depending on the individual project, in some cases, document review was done after interviews were conducted with stakeholders to ensure that the study was not hindered by a delay in being granted permission to access project document review by clients or stakeholders involved. In some instances, permission could not be granted and therefore the researcher had to find access through as many stakeholders as possible. That is why in some projects, more than three stakeholders were interviewed and asked for access to documents while in other cases only architect or engineer was interviewed as per the plan.

4.4 Data processing, analysis and presentation of findings

The data collected from document reviews were collated and combined with information obtained through an interview by using the MAXQDA v10.4 computer software. Data collected were processed by following steps shown in Figure 4 .Analyses of findings were done by first identifying key themes through content analysis of gathered information. Initial information was analyzed manually by grouping them into themes that were formed through literature review. More themes were then formed as analysis of data for a specific case project was being performed. The documents containing analyzed data for each case project were then analyzed together to form a cross-case analysis of data.

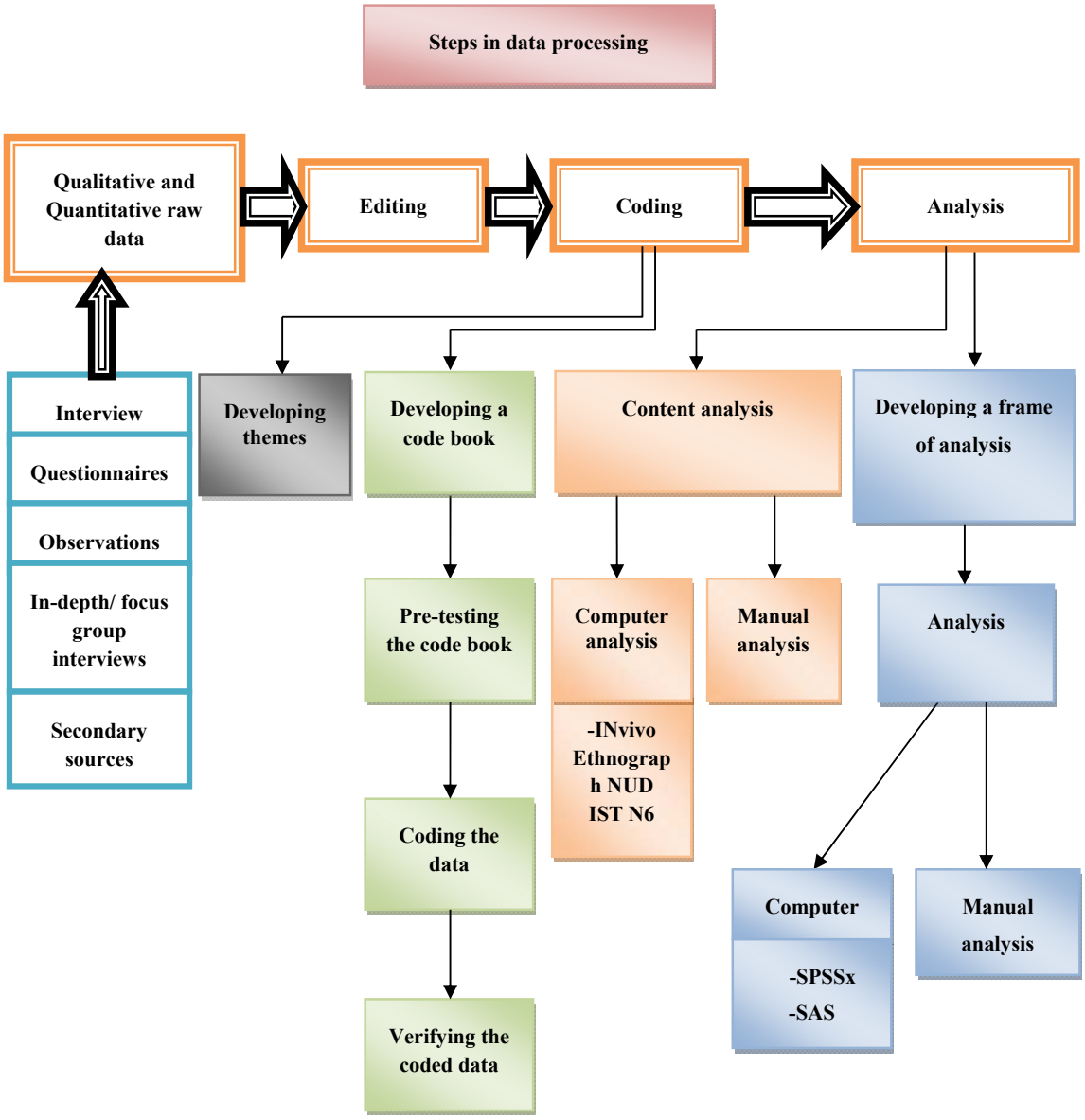

Figure 4 : Steps in Data Processing path as adopted from Kumar (2004)

4.4.1 Qualitative analysis

Qualitative data were analyzed by using computer software known as MAXQDA v10.4 through coding of information gathered in individual case projects. The process started by the creation of themes and sub-themes that were developed from the literature review and through content analysis of collected raw data as shown in Figure 4. The coding system that

included main themes and sub-themes was then created in software and coding of raw data collected from each case project was implemented. The coded information was then extracted for further discussion and interpretation in Chapter Six.

4.4.2 Quantitative analysis

Numerical data obtained from case projects were analyzed manually and using *Microsoft excel* software basing on the themes created through content analysis. The analyzed data were either tabulated and then charts created to illustrate tabulated information. Both tables and 2D and 3D charts have been used for presentation of qualitative data. Charts and tables were then used for discussion and interpretation of data gathered from the case projects as shown in Chapter Six.

4.5 Delimitations and Limitations of the study

This study was delimited to four case projects that were anticipated to provide enough information that can be replicated to general practice in the building construction projects. However, the information gathered from the document reviews might be influenced by authors and probably may not present actual practice of what happened on sites. Most of the respondents somehow were afraid of revealing exactly what happened on site and that might limit the accuracy of this research. Nevertheless, information obtained from individuals were thoroughly checked for corroboration either through other respondents who had been involved in the relevant project or through documentary review.

Moreover, the study was supposed to be finished within six months which is the time given for masters' dissertation. Interview and documents review requires substantial time to be diligently performed and therefore the given time influenced and limited the extent of inquiries made and accuracy of the study. It should be noted though that every effort was

dedicated to making this research as accurate as possible by ensuring information gathered were verified through different channels and sources.

4.6 Chapter summary

This chapter has a discussion about the type of research design selected, criteria and rationally for research design selection, methodology as well as the type of methods and instruments used in collecting intended data. Consequently, various sources of data such as interview and document review that were used to obtain primary and secondary data as well as collection and analytical methods both qualitative and quantitative findings have been explained. The next chapter includes discussion and interpretation of data for each case project and cross-case analysis of such data.

CHAPTER FIVE

DATA ANALYSIS, FINDINGS, AND DISCUSSION

This chapter contains two parts, namely part 'A' includes the presentation of findings from the case projects and part 'B' which consists of discussion and interpretation of the cross-cutting issues emerging from findings presented in part 'A'.

PART A: FINDINGS FROM CASE PROJECTS

This part of the chapter contains interpretation of analyzed findings from each of the four case projects evaluated. The presentation is organized chronologically in line with the research objectives

5.1 Findings from the PSPF Commercial Building Project

5.1.1 Types of design changes and their initiators

Both the client and the design team members were responsible for the initiation of design changes in this project. The extent of involvement is described below;

5.1.1.1 Design changes initiated by the client

The client initiated one notable change by demanding conversion of part of the residential spaces to the office to enhance the project's financial viability as shown in Figure 5. Eleven apartment floor spaces were converted into open office floor spaces. This led to a substantial extension of time due to the time taken to make adjustments and accommodation of the demanded changes by the design team. As a result of this change, contractors claimed about 765million shillings (about 0.6% of the original contract sum) as

compensation for loss of profit and unused materials). The number of design changes, their initiators and cost effects of these changes has been illustrated in Figure 5.

It is undisputable fact that there would have been substantial savings had these changes been made before the commencement of the construction process. Space conversion from apartment spaces to offices also led to a number of reactive changes. One of the significant reactive changes is the introduction of operable windows to provide flexibility and the possibility of natural air entrance when needed. There was an option of introducing a fresh air system in the converted system but the design team opted for a less expensive decision of having operable windows installed instead. This to some extent compromised the quality of office spaces created if compared with those in the commercial tower of the same project in which there is a fresh air system type of AC.

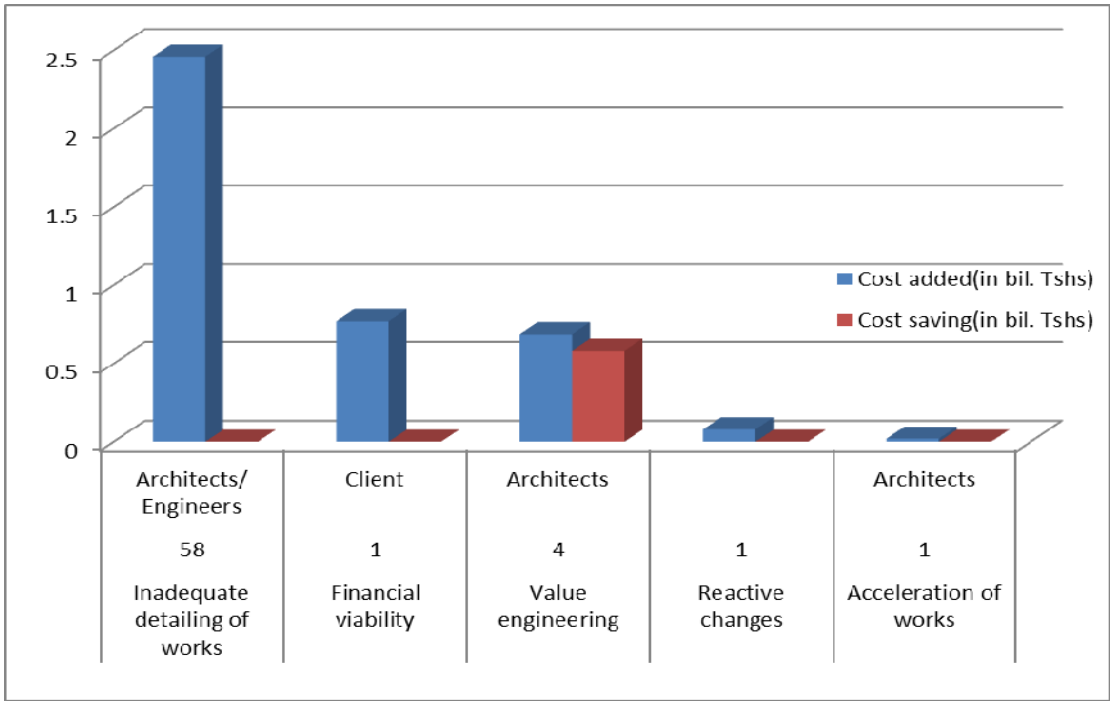

Figure 5 : Quantity and reasons for initiation of design changes by various stakeholders in the PSPF Commercial project

5.1.1.2 Design changes initiated by the design team members

The design team members were the main initiators of design changes in this project. Sixty-three (63) out of sixty-five (65) of the design changes that were made in this project were initiated by the design team members due to various reasons as shown in Figure 5. Service engineers initiated most of the design changes, followed by the architects and lastly the structural engineers. The cost addition due these design changes by both architects and service engineers are almost the same with that added by the structural changes being substantially lower although the cost per change of the latter is much higher as compared to both that of architectural and services changes. The structural changes were much more expensive (83million shillings per change) as compared to both the architectural and service changes which were 52 and 43 million per change respectively.

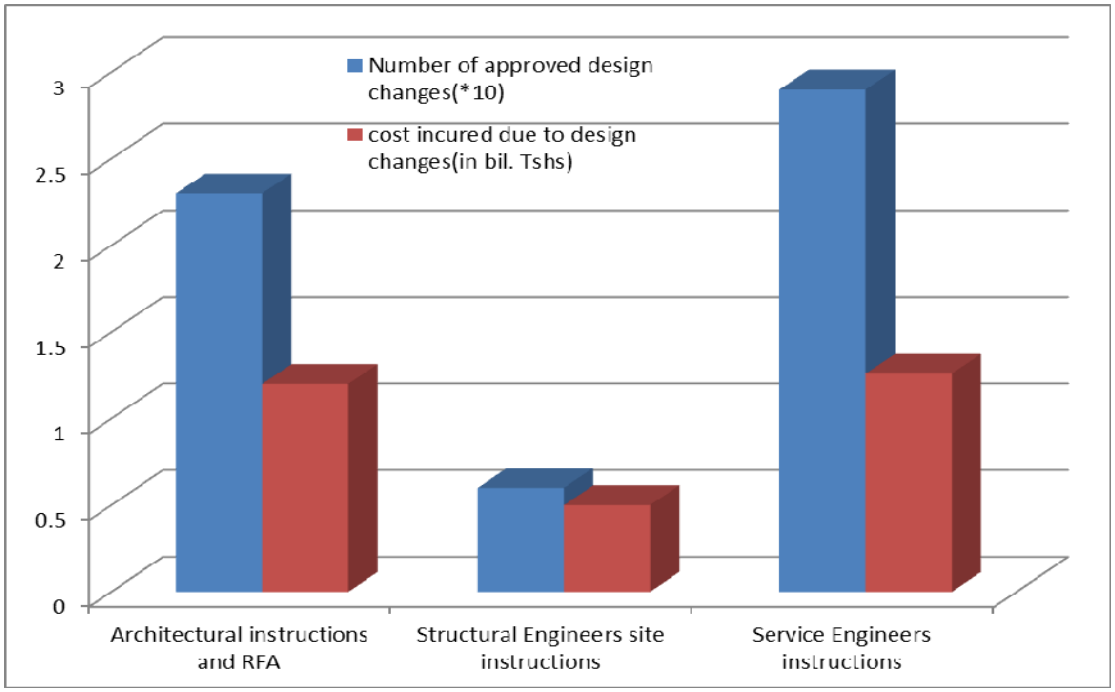

Figure 6 : The sources of design changes against the number of changes made and the cost incurred due to changes

5.1.1.3 Specialist subcontractor/supplier

Glass curtains specialist subcontractors were also responsible for one of the notable design changes in this project by requiring a change in specifications of glass curtain wall materials to provide suitable conditions (enhancement of the functional performance) for buildings in Dar es Salaam. Apparently, there were discrepancies between specified materials and design works. This change can be attributed to the inappropriate specification of materials and some sort of Value Engineering conducted after the commencement of construction works that aimed at enhancing the functional and technical performance as well as the aesthetic outlook of the building. This change resulted in additional cost totaling 449million Tshs (0.34% of the original construction sum).

5.1.2 Causes for design changes

Findings indicate that causes of design changes in this project included the client's uncertainty on the financial viability of the project, inadequate detailing of works, some sort of value engineering study, mismanagement of design and construction works, designers' unconsciousness to cost and time and financial needs. Further explanations of the causes have been offered below;

5.1.2.1 Client's uncertainty on financial viability of the project

The client is said to have been worried about the financial viability of the project when they decided to ask for half of the residential tower of this project to change from a luxurious apartment into office spaces. Although they made only one notable change as shown in Figure 5; that change added seven hundred sixty million Tshs to the original project sum. It can still be argued that the client's representatives failed to oversee the cost and time impact of some of the proactive changes such as conversion of apartment spaces

into office spaces or that their uncertainty leads to cost adverse effects of those changes on the project.

5.1.2.2 Inadequate detailing of works

The project document review showed that 58 out of 65 (ref. Figure 5) of design changes made in the PSPF Commercial project was due to the inadequate detailing of works. Works by the service engineers were far less detailed as compared to works by other design team members and that prompted both the contractor and the sub-contractors responsible for electrical and data system, security and fire systems, as well as drainage, works to issue a lot of RFI and RFA . The service engineers provided mainly general drawings and claimed that construction should base on details provided through shop-drawings provided by suppliers. There were also a lot of reckless omissions due to the careless detailing of service works and that involved exclusion of spaces for escalators and lifts stabilizer. The architectural works were satisfactorily detailed but also not complete. Design changes, in this case, seem to root on the nature and complexity of the project as well as failure in the coordination of works done by other consultants.

5.1.2.3 Value Engineering

Four of the design changes done in this project are said to have been the result of Value Engineering performed by architects during the construction works. The project documentary review also indicates that two other changes can still be attributed to Value Engineering, inadvertently done by architects. These changes include removal of all granite subframes on all doors in this project and replacing Aluminium balustrades in the escape staircases with Mild steel one that is said to be better fire resistant and cheaper. However, it was noted that the kind of Value Engineering performed did not follow procedures set out as guidelines for value studies such as the Value Engineering workshop.

Value studies were conducted up to the last quarter of the construction process. Table 3 shows that the difference between costs savings and cost incurred due to changes made on this projects as a result of Value Engineering (VE) are almost the same. Since document reviewed and interviews conducted shows that these changes were instituted during and even in the late stage of construction; that means that the timing had a greater impact on the cost savings due to those changes. VE conducted in the evaluated projects such as the PSPF commercial project, involved only individual consultants for specific type of work instead of being done in groups as the normal procedure for VE workshops requires. The client paid a lot of compensation and claims because of contractual obligations during the construction process and that reduced the net gain due to those changes.

Table 3: Type of Design Changes, cost incurred and net saving obtained due to Value Engineering

Design Change due to Value Engineering	**cost incurred ($x10^6$ Tshs)**	**Net saving ($x10^6$ Tshs)**
Reduction of the building height	29	*71*
Replacement of metallic ceiling with gypsum	0	*20*
Escape staircase material specifications	0	260
Removal of granite subframe on all doors	0	234
Waterproofing on roof slab	95	0
Curtain walling	449	0
Total	**573**	**585**

5.1.2.4 Mismanagement of both the design and construction works

Having reviewed the project's documents and interviewed architects and quantity surveyors involved in this project, it is evident that there were lapses on the management of design changes made in this project and how they were initiated. Some consultants seem to have had the liberty of deciding on what to change because of their understanding of a

certain type of works. Service engineers, for instance, continued to institute changes up to the late stages of construction knowing that their authority could not be challenged regardless of the cost variations and time they were adding on the project by excessive changes. Architects who were the project team leaders did not do enough contractually to deter institution of excessive design changes by ensuring better coordination of the works done by other consultants especially during the design stages.

5.1.2.5 Financial & Investment needs

The PSPF commercial building project was originally designed as the two tower complex, with one whole tower allocated for residential apartments for sale while the rest had been designed as a commercial tower with office spaces to let. But, in the third quarter of the construction phase, the client wanted and asked the design team to convert the 22nd to 31st-floor spaces of the residential tower from apartment use to office spaces to enhance the financial viability of the project. That instruction resulted in additional costs of up to 765million Tshs due to claims of loss of profit by the contractor and idle materials which had already been procured before issuance of the respective instructions and change order.

5.1.2.6 Designers unconsciousness to cost and time

It has been observed in this project that some members of the design team had the least concern for the project time and cost incurred due to design changes they initiated. It was like design works were being done on site as instructions continued to be issued up until the project handing over. This was done despite the fact there had been a delay in approving some of the change orders previously instituted by the design team members.

The service engineering works were the highly affected parts of the project by the delay in approving some of the change orders that resulted in a considerable amount of extension of

time. The service engineering works for this project were the least designed works and had literally very few details, an evident source of RFI and RFA. Document review showed that the main contractor and subcontractor for this project were the main sources of detail works for this project instead of consultants, something that raises concerns on the capability and consciousness of the latter.

5.1.3 Timing of design change

All notable design changes in this project were done during the construction stage and that to greater extent led to an escalation of the costs of the project. Changes such as conversion of functional use of half of the residential tower were instituted the second half of the construction process and that shows why the costs of instituting those changes were very high despite their good intentions. Timing had a greater bearing on the overall effects of the design made as it made the benefits achieved look limited.

5.1.4 Targets of design change

Some of the targets of the design changes made in this project included enhancement of the functional performance of the project, reduction of the project maintenance cycles, removal of unnecessary materials, cost savings without compromising the expected quality of the project and acceleration of construction works. Following the mentioned targets, epoxy waterproofing materials were applied to enable adequate waterproofing of the building roof slab, granite sub-frames were removed from all doors to save costs as they were deem unnecessary and Aluminum balustrades in all four escape staircases were replaced by the mild steel materials that were deemed cheaper and better fire resistant. Materials and construction details for the internal staircases in the department were also changed to accelerate their construction and enhance the interior aesthetic. In that case,

concrete staircases were replaced with the timber staircases with a central stringer that were easily and fast fabricated on site.

5.1.5 Benefits of Design Changes made in this project

Most of the changes done on this project can undoubtedly be said to be beneficial as they enhanced the functional performance spaces reviewed through improvement of interior finishes, spaces links, and use, lighting quality, reduction of maintenance cycles, client's expectation and above all the end-user satisfaction as the building was aimed at selling of spaces. However, the mentioned benefits were achieved at high expense and that means limited gain to the project and the client as the cost of construction escalated due the changes made. Cost savings due to the design changes made were very limited and adversely affected the possible benefits that would have obtained through design changes instituted.

Most members of the design team believe that most changes could have been avoided or minimized through diligent design and detailing works. An exhaustive and well-informed decision from the client and the design team could have led to prevention of the risk of design changes such as the conversion of half of the residential tower that cost more than hundred sixty thousand million Tshs despite its targets of enhancing the financial viability of the project. Stakeholders interviewed such as architects in this project believe that changes made in this project were necessary and could not be avoided unless there was a Real Estate Regulatory Authority that would have established a reference index for estate development.

5.2 FINDINGS FROM THE MOI PHASE III PROJECT

5.2.1 *Types of design change made*

There were two groups of design changes in this project done after tendering actions had been completed. All of the two main changes were initiated by the client, either directly through hospital executives or through the client's special advisors on hospital design hired from South Africa. The two main changes were aimed at enhancing the functional performance of the hospital and clients' as well as end user satisfaction as it seems that design works used as tender documents were not the expected standard of the hospital facilities. These two main changes escalated the cost of construction of the building by up to 35% of the original contract sum with 5% of the original contract sum added up due to minor modifications which led to the delay of more than two years. A project that was expected to have construction completed within fifty-six (56) weeks from November 2012 was completed in mid-2016 due to lack of fund to complete works on time. The two main design changes can be described as;

5.2.1.1 Redesigning of whole interior works

This was triggered by the client's special representatives from South Africa hired to help them ensure that the design of the new building block is up to the expected standards of hospital design. Unfortunately, their intervention came after tender actions were completed and the contractor chosen and led to delay in commencement of the project as the whole interior works had to be redesigned with some of the functions expanded and relocated. The external fabric of the designed building remained unchanged except for the expansion of the spaces previously left as terrace and restaurant on the top floor.

5.2.1.2 Redesign and relocation of some of the functions

This group of design changes is said to have been initiated by the hospital executives as they realized some things were not right during the routine and daily inspections of the construction works. At some point, there were instructions to ensure that medical gas facilities were to be increased in all earmarked areas and that escalated the project costs by almost 1bn Tshs. Decisions to change part of the designed work were mainly made by medical executives at the hospital after seeing the constructed parts and that shows that they did not understand the designed works before construction had commenced. To a large extent, this type of decision making affected the project milestone and budget as there was no single command from which all conclusions to make design changes could be received from.

5.2.2 Causes of Design Changes

Findings indicate that design changes were caused by the client's uncertainty over the project's requirements, designers'' lack of required experience and expertise, mismanagement of the design and construction works, inadequate detailing of design works and architects' lack of scrutiny and coordination of design works done by other consultants. Further explanations of the mentioned causes have been offered as follows;

5.2.2.1 Client's uncertainty on their requirements

The first signs of the client's uncertainty on what they wanted can be seen through the project requirement list given to architects for design works to commence. The list continued to change and grow as the project progressed through design stages, unfortunately up to the project construction stages. The clients seemed not to realize that the design stages had passed and the design team members did not ensure there was a cut-

off point between design works and construction ones. Uncertainty on what should be included in the new building block led to redesigning of spaces and reallocation of functions right after tendering works and award had been done.

5.2.2.2 Lack of expert knowledge for hospital design

The architects involved in the design of this hospital building seem to have had limited expertise on specialty works such as the ortho-pediatric facilities required by MOI and that to great extent led to their works being redesigned right after. Unfortunately, despite the lack of the required skills, the architects performed design works on their own without involving experts on hospital design up until the tendering actions had been completed when the client hired a special consultant as a value engineer to help the scrutinize design works done.

5.2.2.3 Mismanagement of both the design and construction works

The architects seem to have had less control of the design and construction works. The uneasy relationship between design team members could have also led to poor management of the construction works because the quantity surveyors believed that the architect was not better equipped to lead the project and to some extent they might be right. The architect had limited required experience and expertise to design a hospital of that standard. It seems that little was done by either the architectural consultant or the client to ensure that experts with proper knowledge on hospital design were involved right from the project inception.

The clients seem to have believed that the architects would diligently perform, given their limited involvement. Despite the fact that design drawings were submitted to the client at every stage of the design works by the architects for scrutiny, the former could not see

shortcomings, probably because they did not understand design works or because they were less concerned. Clients of this project had enough experience on what should be done as they had been involved in the construction of other two phases of the hospital, the difference being that the two building blocks in the previous phases were designed by foreign designers and supervised by local consultants.

5.2.2.4 Inadequate detailing of works

It has become so evident that both architects and engineers, especially service engineers have become so reliant on the application of both the PC and provisional sums in the building construction projects. The good aim of providing those sums in the BOQ has become a loophole for inadequate detailing works, deliberately or otherwise. There were very few adequate details provided for specific or parts of works of this project. This led to a lot of request for information (RFI) or approval (RFA) from the contractor.

Both the PC and provisional sums provided in the BoQ were not enough to cater for works which were not well detailed prior to tendering actions of this project. That indicates that either designer did not diligently scrutinize the extent of works to be covered by those sums or failed to properly manage them during the implementation stage of the project. It is clear that the lack of expert knowledge highly influenced decisions when it came to the detailing of works and provision as well as the use of the Provisional and PC sums in this project.

The quantity surveyors (QS) for this project believe that designers should have at least ensured that 99% of the project works were adequately detailed contrary to what was done in the MOI phase III project in which works were in some parts partially or not detailed to the boredom of the QS.

5.2.2.5 Lack of scrutiny and coordination of works done by sub-consultants

There were a lot of discrepancies between the architectural drawings, BoQ, and drawings done by other consultants such as the service and structural engineers instigated by lack scrutiny and coordination from the architects before the commencement of the construction process. Architects as project team leaders seem to have had little control of what other consultant had done and that led to a lot of request for information (RFI) and RFA.

Architects on the side believe that lack of coordination and scrutiny of the design works by other consultants is the result of the little time given for design works to be completed. But, that cannot be enough of an excuse for lapses because that cost the client a lot of money due to amendments did during the implementation of the project design works.

5.2.3 Initiators of design change

The client was the main initiators of two main design changes instituted in this project, whether directly or indirectly. Directly, the client through the hospital executives, doctors, caretakers and nurses, voiced their opinions on the space and functional arrangements in the building which were eventually instituted as design changes in cases where views and opinions were against what was being constructed. The hospital personnel seems to have had less understanding of the design works before realizing it during the construction process. Indirectly, the client initiated design changes through the hospital specialist to review the design works before the commencement of the construction process. That review prompted redesign and reallocation of most of the interior spaces except for the building fabric which remained intact. The two groups of design changes initiated by the client increased the cost of the project by about 7bn Tshs which is approximately 35% of the original contract sum.

5.2.4 Timing of instituting design change

The value engineer hired by the client came in very late, right after tendering actions had been completed and the contract awarded. The late involvement of the specialists cost the project by delaying commencement of the construction works although the original cost estimates were maintained except for the added works. Apparently, delays and claims for additional works by consultants would have been avoided had the value studies performed before detailing of the original design works. On the other hand, design changes were done during construction process despite the fact the helped enhance the functional performance and end-user satisfaction; they were achieved at higher expense.

5.2.5 Targets of design change

The major targets found to have been set for design changes made in this project include the enhancement of the functional performance of the project and improvement of the client's and end-user satisfaction. Further explanations of the mentioned targets have been offered below.

5.2.5.1 Enhancements of the functional performance

Design changes introduced by the clients' value engineer right after completion of the tendering actions, were aimed at improving the functional performance of the project and so were those brought up by the hospital executives, caretakers, and nurses during the construction process of the building. Unfortunately, most of them seem to have failed to understand the design works before construction had started. Definitely; the functional performance of the building would have been a mess hadn't this target been set before instituting the corresponding design changes.

A very illustrative example is the introduction of the medical gas facility in spaces which were earmarked as essential by doctors and experts in hospitals, done during the construction process. Although the introduction of the mentioned facilities added up about 1bn Tshs on the project's construction costs, their omission would have rendered the facility incomplete and probably cost more in the future to install them.

5.2.5.2 Improvement of both the client's and end-user expectations

Hospital staffs such as medical specialists, nurses, caretakers and doctors were highly involved in the construction stage of the MOI phase III project. They were also allowed to air their dissatisfaction and suggest an improvement be done. Execution of design changes demanded by the medical experts and staff from MOI means that the targeted client and end-user satisfaction was achieved.

5.2.6 Benefits obtained from Design Changes made

It cannot be disputed that institution and execution of the design changes brought up by the client's specially hired experts on hospital design and by the hospital executives such as nurses, caretakers, and doctors; considerably improved the functional performance, health and safety and satisfaction of both the service providers and end-users of the MOI phase III project. However, one could ask at what cost was the benefits achieved. The additional 7bn on the original contract sum and more than three years of delay in delivering the project due to inconveniences caused by design changes made and the lack of funding to complete essential parts of the project; makes the benefits obtained seem very limited and tainted. They could have been achieved at lower expense had they been instituted at early stages of the design works.

5.3 FINDINGS FROM THE NHC PLACE PROJECT

5.3.1 Types of design change

Changes did on this project mainly involved redesigning of the building fabric with the aim of ensuring that the building achieves the green certification after construction. This involved redesigning and ensuring that curtain walls, windows, and other exterior elements would allow installation of the green certified materials. Specifications of most of the materials done before tendering actions were changed to achieve green certification. Thanks to Value Engineering done concurrently with redesigning, the cost of new specified materials was kept as originally estimated.

5.3.2 Causes of Design Change

Design changes instituted by in this project were mainly caused by the client's uncertainty on the requirement and functional use of the building, the need for green certification of the project and the change of use of the original design. Advance explanations of the three main causes of design changes done in this project have been offered below;

5.3.2.1 Client's uncertainty on their requirements

The client was not certain of should to include and scope of works in the project. This explains why just before construction of this project, it was decided that the building to be constructed would become their headquarters instead of being used for commercial leasing. The uncertainty and indecision on space functional use and required performance led to the project delay of about six (6) months due to time used by the design team to amend drawings to accommodate required design changes and that used to settle claims between the client and the contractor due to those changes.

5.3.2.2 Need for Green Certification

Although the green design was a pre-set target in the project TOR, the project seems to have missed that target and the client wanted to ensure that the building was green certified. The client brought in a green specialist for review of the design works after the tender actions had been completed and contract signed. Review of the design and drawings used in tender actions resulted in a redesign of some parts of the building fabric and change of the specification of most of the materials that were previously specified and used for bidding. Green certification of the building indicates that the certified facility efficiently utilizes resources such as electrical energy and water.

5.3.2.3 Change of use of the Building

The client's change of mind on how the building would be used after construction led to most of the changes on this project. The building was previously designed to be used for commercial leasing but the client, later on, wanted it to be their headquarters, which required a lot of restructuring of some of the interior spaces. Spaces had to be designed according to the client's required departments and that led to reallocation and addition of ducts, utility spaces, and wet areas.

5.3.3 Main initiators of design change

The client was the main initiator of all of the significant changes made on this project. Most of the significant changes were made before the commencement of the construction works because the client wanted changes in the functional use of the building and the same building to be green certified. However, the design team especially the architect and service engineers cannot deny to part of the initiation of changes in this project because of

the project TOR, regardless of their lack of clarity; wanted the building to be green qualified.

5.3.4 Timing of design changes

Design changes made on this project were instituted after the tender action had been completed. That put hindered the achievements made through these changes as they led to about six (6) months delay in the project completion time. Clients were also fortunate that the Chinese contractor in charge of construction this project was a bit lenient on raising claims due to time added by these changes to the project; otherwise, that could have added costs to the project contract sum.

5.3.5 Targets for Design Changes

All design changes made on this project were aimed at reducing the operation costs and improving the functional performance of the project. To achieve, lower operational costs; the client decided to seek green certification which required the installation of the green certified materials. The following is the brief explanation of the two main targets of the design changes made on this project.

5.3.5.1 Reduction of the project's operational costs

Through the reduction of the amount of electrical power consumption, water and air condition and changing specification of most of the materials used in the construction of this project, the project managed to achieve green certification for limited consumption of resources during its operations. That is the quality that could not have been attained had the project been construction in the original state.

5.3.5.2 Improvement of the project's functional performance

The building use was changed from the first target of commercial leasing to accommodation the client's headquarters and this necessitated redesigning and relocating function in some parts of the building. The biggest challenge was to ensure that the project costs would remain the same and that necessitated carrying out Value Engineering although no information on how it was carried out was found. This target is said to have been more than 99% successful as the costs of the first contract that involved designing construction of the building, excluding the fit-out works was completed with the same budget except for the cost for additional works. Unfortunately, because of the late institution of the design changes and misunderstanding between the contractor and the client concerning execution of the initiated design changes, the completion time of the project was delayed by about six months.

5.3.6 Benefits of design changes made on this project

The building was awarded a green certificate due to its limited consumption of resources during operations. Better consumption of resources such as electrical power and water was achieved through redesigning and installation of materials such as glass, air condition system, lifts, paints, waterproofing, electrical and sanitary fittings, toilet cisterns as well as the floor, ceiling and wall finishing materials that are green certified. The positive aspect on how targets of design changes were achieved in this project is the fact that it was attained at almost the same original construct sum, despite the delay in its completion time.

5.4 FINDINGS FROM THE NMB HEADQUARTERS PROJECT

5.4.1 Inevitability and effects of design change

Regardless of its intention or targets, any design change will inevitably result in reactive changes; lead to project time and cost escalation, claims from team members and contractors and potential disputes. It requires the team members to spend their resources in activities that were not planned. The opportunity costs of making design changes are very high and both the client and the design must realize that before instituting design changes. The project architect for the NMB building project; indicated that design changes were avoided as much as possible during the course of construction that project because of the possible detrimental effects.

5.4.2 Diligent Design management

Clients in which IPA architects are chosen as team leaders and architects are normally informed during the first stages of any design work that strict procedure on design management will be followed. Clients' representatives are encouraged to dedicate enough time on scrutinizing design works submitted to them and then bring up queries, required amendments, and additions(if any). NMB building project works were thoroughly designed and detailed. Changes were only permissible up to the scheme design although one the main design change was instituted beyond that stage. That change was a result of amended urban redevelopment guidelines for the CBD.

5.4.3 Timing of design changes

Changes should better be done in the "first three key stages"[14] of the project because the design is normally quite loose and fluid in those stages, any suggested change will have less impact on the project milestone and budget. IPA architects encourage clients to fully participate in the early stages up to scheme design stage so that to understand and scrutinize the design works and eventually bring up any required amendments on the design.

Modification are allowed up to the scheme design stage because any changes made up to that stage will involve amending very few available drawings while introducing changes in the stages beyond the scheme design will require amending drawings such as structural, service as well as architectural works which in those stages has already evolved into a lot detailed drawings.

Changes or modifications brought up before the scheme design works have been approved and signed by the client, do not lead to any additional charges and in most cases lead to cost savings. The typical example is the removal of the suspended floor design in the NMB project due to Value Engineering performed by the client's advisor from the Netherland in which up to 0.6 of a million dollars was saved without incurring further costs of design modifications. Savings would have been limited if Value Engineering was done during construction stage or after tendering as the contractors would have probably claimed loss of profit, idling of labor force or unused materials as well as the extra payments to the consultants due to additional works in the implementation of the of those changes.

[14] The first key stages of the project design include the inception stage, the outline stage and the scheme design stage

5.4.4 Types of design change

5.4.4.1 Replacement of the suspended floor design with the flat slab design

This was one of the two main changes made in the course of execution of this project and originated from the Value Engineering recommendation performed by the client's advisors from the Netherlands. The recommendations required replacing the originally designed suspended floor panels design with the flat slab design. The architects had designed the suspended floor panels so that to enable flexible use of the building by allowing easy passage of both electrical and IT cables as well as drainage systems underneath the suspended panels while; the recommended flat slab design would require passing the drainage system and some of electrical and IT cables underneath the flat slab or through the additional trunk system which implies that there are in most cases, additional cost involved.

The Value Engineering recommendations were implemented despite the architects' objections which based on the assertions that the possible cost implications during the finishing and installation stages which were not part of the original contract. Finally, the architect's assertions were vindicated by higher construction costs during the installation works of the IT works in the second contract which resulted in a lot of chasing and drilling to acquire vertical access for drainage works and installation of the trunk system for IT works contrary to the original design.

There was an additional cost of about 0.8million dollars in the installation of IT and electrical works as compared to the cost savings for replacing the suspended floor panels with the flat slab design. The additional costs on the original estimates together with the additional payments incurred by the client extra works done by the design team through implementation of recommendations given by their advisors as a result of Value

Engineering; implies that the client incurred loss due to the cost management recommendations that only took into account the initial cost savings instead of proper Value Engineering that would have taken into account the project's whole life costs.

5.4.4.2 Reduction of the original building height

The building height was the main block into acquiring the building permit from the Ilala Municipal authority when the client submitted scheme drawings to for scrutiny and permission to implement the project in the respective site. The Municipal authority refused to issue the building permit despite having previously issued the planning consent for the same plot. Instead, the client was asked to reduce the building height by removing four floors from the original design so that to comply with the newly issued directives on the urban developments in the Dar es Salaam's Central Business District (CBD) by the Ministry of Land, Housing, and Human settlements. The new directives covering the urban developments of all areas within the CBD by the ministry was meant to ensure the safety and security of the State House in Kuvukoni. That means the plot in which the project had to be built was to be affected too.

Reduction of the building's height was done right after the detail works of the project had started and involved a lot of modification to the whole building by redesigning the whole project to accommodate functions that that had been located on the upper floors to be removed. The architects asserted that despite the vast changes required to modify the design in order to reduce the building height and the additional payments involved; the cost and work done would have been much higher if the same design changes had been done after completion of detail works or commencement of the construction works. That means that the time for the implementations of these design changes allowed the client to evade

much loss that would have accumulated had the same been done in the latter stages of the project.

5.4.5 Causes for Design Changes

Most of the design changes are said to originate from superficial design works, mismanagement of the construction works and contract, statutory requirements and other circumstances that are beyond the control of both the client and the design team. Causes for the two main design changes in the NMB building project are as discussed below;

5.4.5.1 New urban development conditions for the CBD

An abrupt change in the urban development guidelines for the Dar es Salaam's Central Business District led to one of the two main changes in the NMB building project. The building height had to be reduced by four stories as the main condition for issuing the building permit despite the fact that the same relevant authority had earlier issued a building consent for developing the same area with different conditions. Reduction of a number of stories resulted in vast reactive changes which included enlarging the building to accommodate functions that were had previously located in the removed upper floors but had limited effects in terms of cost implications because it was done soon after the client had accepted the scheme design works.

5.4.5.2 Value Engineering

Value study done by the client's advisors from the Netherlands resulted in the replacement of the suspended floor panels design with the flat slab design. Suspended floor design was meant to provide flexible use of spaces by providing easy passage for both electrical and IT cables as well as drainage system underneath the removable suspended floor panels while the flat floor slab would allow the same activities to pass underneath the slab with

some of the cables being embedded in the slab but also led to chasing and drilling works to provide vertical paths and trunk works for both electrical and IT installations meaning that the latter would lead to higher costs.

The client failed to heed to the architects' advice that replacing the suspended floor panels would lead to higher costs of installations. The architects' claims that the suggestions to replace the suspended floor were not good enough were based on the fact that the study was based on cost management in which cost savings is the main target instead of value management in which the whole cycle cost evaluation is done without compromising the functional performance of the project. Apart from that, Arch. John Kelly thinks that excessive design changes in building construction projects undertaken by another architectural firm can be attributed to;

a) Inappropriate management of design works

Most design works are neither thoroughly done nor completed during the design stages leading to the same to continue during the post-contract stage. In most of the projects, there is no difference between the design stages and the construction stages as the former continue into the latter. There is normally no cut-off point for design works which mean that consultants continue to institute changes as if they are still in the concept stage where the design project is loose and can be easily amended without resulting into cost escalations.

NMB building project's architect asserted that architects and engineers in other projects; either due to inexperience or lack of proper management skills on the design management; fail to diligently perform their design and detailing works. This eventually causes excessive design changes during the construction stage of the project. In most cases, the so-called tendering drawings are general scheme design works, with very few details

contrary to the usual situations in which tendering drawings are supposed to be well detailed, normally beyond 200 drawings of A1 size of architectural works as it was done in the NMB building project. More detailed works will mean very few design changes during the construction stage and a very limited amount set for both PC and provisional Sums in the BoQ for the same project.

Architects as team leaders in most of the projects should also be able to scrutinize their fellow consultants' works as those will eventually affect the whole design works. Failure to coordinate works by other consultants will most likely create chaos and anarchy during the implementation stage of works through excessive changes that could have been avoided.

b) Failure to charge for extra works done due to design changes

Architects cannot ask or insist on being paid for the new works done due to design changes introduced by the client if they did not diligently perform their duties during design stages. Clients hardly see any difficulty to introduce design changes if they do not incur extra payments for additional works done due to the introduced design changes. Consultants are prone to succumbing to pressure put on them by the client and eventually end up mismanaging the project by allowing the projects' cost to escalate, miss project milestone and incurred greater opportunity costs.

In projects such as the NMB building project, IPA tends to ask to be paid for extra works or design changes introduced beyond the scheme design stage. Clients normally agreed to pay extra amounts because they were made aware of the consequences of introducing those changes, were given ample time to scrutinize the design works before signing acceptance of the scheme drawings and most importantly because of architects in this case IPA; performs their duties accordingly.

5.4.6 Benefits of Design changes made in the project

The benefits of design changes are usually determined by the period in which they are made and their targets. It is an indisputable fact that the two main changes are done in the course of design and construction of the NMB building projects greatly benefited the project and the client through the cost savings obtained by making them before tender actions had commenced. Despite the fact that reduction of the building height brought up no cost savings, initiating it before the tendering actions imply that possible claims by both the contractor and the design team members as well as disputes that would have risen were avoided as compared to if that change had been made during the construction stage.

Replacement of the suspended floor panels design with the flat slab design due to Value Engineering performed by the client's advisors brought up very limited benefits to the client. Apart from satisfying the clients' wishes of having cost savings on initial costs of design works, that change resulted in higher costs of installation for IT, electrical and drainage works. It also affected the flexible functional performance or use of the building.

Moreover, the NMB building project's architect insists that changes no matter how good their targets are, they will have negative effects on the project and stakeholders in terms of costs, time and opportunity incurred in the course of implementing changes. They advise that it is better to limit the possibility of their occurrence by dedicating enough time and diligently carrying out design works.

PART B: CROSS CASE ANALYSIS

5.5 Overview

This part of the chapter contains discussion and interpretation of cross-cutting issues emerging from design changes, drawing inferences from the four cases studied. For clarity, some of the themes used in the analysis of individual cases have been used together with new or merged themes in this cross-case analysis. It also provides conclusions as well as recommendations for each discussed part of the study. The discussion to be presented is organized chronologically in line with the research objectives

5.6 Types of design change

In line with the assertions by Erdogan et al (2005); Charles *et al* (2015), clients were also responsible for most of the main design changes instituted in both the NHC place and the MOI phase III projects. In the latter case project, the hospital design specialist hired by the client were principally responsible for instituting the main design changes, leading to the relocation of some of the functional spaces and redesigning of almost the whole project. Design changes were mainly done in order to enhance the quality and functional performance of the project.

Moreover, design changes initiated by the client for case projects such as the NMB building, NHC place and the MOI phase III seem to have been largely aimed at enhancing the project value while being sensitive to project costs in concurrence with claims by ; Parvan *et al* (2012) and Charles *et al* (2015). For instance, a client for the NHC place wanted to ensure the design to be implemented would allow sustainable consumptions of resources such as energy and water and eventually be awarded a green certificate while that of the NMB building projects wanted to reduce project initial costs. Although the

targets of cost savings through design changes done in the NMB building project were achieved, they, later on, resulted in higher costs during the fit-out stage of the project works. That ridiculed an inattentive Value Engineering done by the client's advisors for that project.

Design team members were also liable for most of the design changes made in the PSPF commercial project. That added about 3bn Tshs on the project's initial contract sum. They were responsible for 63 of 65 design changes made on that project. Most of those changes originated from inadequate detailing works which indicate that design works were neither complete nor diligently detailed. The service engineering works were the least detailed among other work trades. That resulted in higher number of design changes being instituted by the service engineers as compared to other design team members. Design changes resulting from service design works continued to be instituted up to the testing and commissioning stage of the construction works. Consequently, that raises questions about the consultants' consciousness on time and cost implication of design changes being instituted.

On the other hand, proactively instituted changes on the NMB building project were implemented at the very limited expense. That could be probably because there were few drawings that required amendments. Design changes instituted in the other three cases evaluate seemed to have been implemented at very high cost. The Higher cost of design changes in the three case projects might be attributed to the fact that they were implemented in the latter stages of construction or beyond the contract award.

5.7 Causes of design change

Basing on the cross case analysis of the findings from the four case projects evaluated, design changes originated from inadequate detailing of design works, inexperience and

lack of expertise for specialty works, poor coordination of design works done by sub-consultants, value studies such as Value Engineering, designers unconsciousness to time and cost implications of design changes. Other causes were the client's uncertainty on the projects' requirements and laxity on both the design management and contract administration. Further discussion of the mentioned causes for design changes in the four case projects has been given below.

5.7.1 Inadequate Detailing of Design Works

Findings indicate that most of the design changes instituted in the PSPF commercial project were a result of inadequate detailing of design works comparing to the other three case projects evaluated. The excessive quantities of RFA and RFI for both the architectural and service works are clear evidence that works in this project were incomplete and contractors required a lot of clarifications to implement the project design. The inadequacy of detail works is also shown by the continued design works camouflaged as necessary improvement of the technical requirement of parts of service works. That is consistent with Koskela *et al* (2002) who emphasized that; incomplete design works done in the design phases is a major source of excessive design changes and related detrimental effects for the subsequent phases, even to the extent that it can undermine systematic management during the construction stage. Findings also indicated that 58 out of 65 of the main design changes instituted in the PSPF commercial project resulted from inadequate detailing or incomplete design works.

In that case, service works seem to have been the least detailed as compared to architectural and structural works. Documentary review and interviews conducted with design team members for this project indicated that design works were done within three months. That is very alarming for the project of 73,000m^2 and whose initial construction

cost was estimated to be 133bn Tshs. The time given was very limited as compared to the magnitude and complexity of the project and if compared to the time spent on the design for the NMB building project, whose detailing period took up to two months. Design team members for the NMB concur that a limited number of design changes in that project was due to the architectural consultants' provision of diligently detailed design works as well as proper coordination of works done by other consultants.

Moreover, inadequate detailing or incompletion of design works might also be attributed to lack of proper value studies such as the Value Engineering, value audit, value planning and most of all value management which is said to be essential in such complex project like the PSPF commercial building project (Ma & Tam, 2013). Although Value Engineering seems to have been partially applied in some parts of the design works, the thorough application would have definitely provided more benefits at lower cost than the one obtained in the cases cited.

5.7.2 Acceleration of works

Contrary to O'Brien (1998) definition of project acceleration which according to him "refers to an owner-initiated change order that is an attempt to expedite completion to a date earlier than agreed upon or regain time previously lost through no fault of the contractor"; need for acceleration was found to have been mainly brought up by consultants in the PSPF commercial project. Despite the possible good motive of wanting the project to be completed on time, that could also indicate that the client was not attentive to the project's works or that the architects were not certain of their design, works. The architects' uncertainty might also indicate that they did exhaust all possible design alternatives either due to hasty or lack of attention to details. In any diligent design

works, changing any part design works is inconceivable especially when the acceleration construction of that part of work is given by the architect or engineer who designed it.

5.7.3 Inexperience and lack of required expertise for specialty works

Inexperience and lack of proper expertise do not mean the inability to perform a certain type of work but a need to team up with more experienced firms or individual. It is a myth to think that architects know better and can design any works as long as it is building design works. Architects need to collaborate and invite participation of skilled individuals or professionals in specialty works. The design of specialty facilities such as the MOI phase III project requires the full engagement of specialist in such kind of design works. Participation of such expertise would better start as early as the project inception stages or scheme design stage. That is a stage at which the design works are rational, tangible and in which space arrangements can be clearly defined. Amendments and engagement of value studies such as Value Engineering at early stages up to the scheme design stages would not be costly as compared to those done beyond that stage (Ma & Tam, 2013; TAM, 2004)

Late involvements of experts will most likely lead to possible excessive design changes and eventual cost escalations, project delays, claims and even disputes (Rangelova & Traykova, 2014; Charles *et al*, 2015). That is what happened in the MOI phase III project in which the tender drawings had to be redesigned due to the corrections and expert opinion by the value engineer hired by the client right after tender actions and contract award had been completed. Clients should always consider inclusion of Value Engineering in their TOR for complex and specialty project works such as hospital and high-rise buildings (Rangelova & Traykova, 2014).

5.7.4 Poor coordination of design works

Architects as team leaders and chief designers of buildings are traditionally assigned with the liability of ensuring that works done by other consultants are coordinated and scrutinized to ensure that they do not compromise the project performance, architectural and aesthetic outlook of the design as well as the client and end-user expectations of the final project work. As chief designers, architects are supposed to ensure that works by other consultants are diligently done and up to the professional expectations contrary to what was observed in both the PSPF commercial, NHC place and MOI phase III projects in which designers such as service engineers seemed to have been free in issuing design changes up to the late stage of the construction process.

The architects for the NMB building project appeared to have been in full control of the project design and construction process. That was probably because they had properly coordinated works done by service and structural engineers contrary to what seem to have been the situation for both MOI phase III and PSPF commercial projects. In the PSPF commercial project, for instance, there appeared some conflicts and discrepancies between architectural works and service as well as structural works. In line with Rangelova & Traykova (2014), application of BIM and CAD to produce illustrative 3D and 4D models in a complex project such as the case projects used in this study could make conflicts between works done by different consultants more detectable. That could also eventually enable better merging between works of different trades such as architectural works and service which often tend to collide.

Findings also indicated that in the case of NMB building project; sub-consultants were advised to ensure that their part of design work was thoroughly designed and detailed to prevent unnecessary design changes, otherwise punitive actions such as cost penalties

would be applied to compensate for any additional cost incurred due to their negligence. Strong scrutiny of works such as the structural and services design by team leaders in the NMB building project seem to have encouraged exhaustive designs and eventually restricted occurrence of excessive and unnecessary design changes during the construction stage.

5.7.5 Value studies in the building construction project

Findings indicate that Value Engineering (VE) was applied in almost all the cases cited though in some cases it was inaccurately or unwittingly applied. It was used six times as justification for making design changes in the PSPF Commercial project as shown in Table 4; used once in replacing the suspended floor design with flat slab design in the NMB Building project and inadvertently applied in redesigning of some medical and service spaces for the MOI phase III project. The net cost savings and cost incurred due to design changes in Table 4 are almost the same. That indicates that the cost benefits obtained through the institution of design changes were very limited probably because these changes were lately instituted in the project.

Table 4: Cost effects Relative to design changes caused by application of VE in the PSPF Commercial project

Design Change due to Value Engineering	**cost incurred(x10^6 Tshs)**	**Net saving(x10^6 Tshs)**
Reduction of the building height	29	71
Replacement of Metallic ceiling with gypsum	0	20
Escape staircase material specifications	0	260
Removal of granite subframe on all doors	0	234
Waterproofing on roof slab	95	0
Curtain walling	449	0
Total	**573**	**585**

Source: Author's construct

It was noted that Value Engineering was inappropriately and often accidently applied in all of the three cases evaluated. In most cases except in the case of the NMB Building; Value Engineering was done during the construction stage and sometimes in the last quarter of that stage. For instance, all design changes done as a result of Value Engineering in the PSPF commercial buildings were done during the construction stage. Changes such as the reduction of the building height in the same project were done in the last quarter of the construction stage. The effects of the late application of Value Engineering in this project can be easily seen when comparing the cost savings obtained with the cost incurred due to its application. The difference is almost negligible and concurs with Mazlan (1999) in Ma & Tam (2013) claims which indicate that the potential cost savings diminish as the design changes due to Value Engineering applied in the late stages of the construction projects execution due to high cost instituting design changes.

In some cases, Value Engineering was also not diligently applied. That is because of the detrimental effects such as higher fit-out costs incurred due to design changes made in the early stages of the project design. For instance; in the NMB Building project the decision to replace the suspended floor design which was meant to provide flexibility and paths for anticipated vast data and electrical cabling; with the flat slab, design resulted into higher cost of construction for the same works. Although there was saving of about 1.3billion Tshs after the institution of design changes due to Value Engineering, the cost for fit-outs of the vast IT and electrical cabling increased to about 1.7billion Tshs during the fit-out stage. One would argue that what was done in that case was not Value Engineering in the real sense of the word but Cost management with cost savings as the main target. Initial cost savings achieved unfortunately led to a future increase of about 33% of the saved costs during final stages of the construction process. The balance between cost, quality and functional performance which are the goals of Value Engineering was ignored despite the

architects' appeal to the client not to implement the so-called Value Engineering result carried out by the client's advisors.

It may be recommended that both the consultants and the client must ensure that they clearly understand the value management techniques such as Value Engineering and the proper procedures required to implement them. Although the cost of carrying out value studies might be high, their benefits seem to be enormous as compared to the current practice where consultants inappropriately or do not apply those studies resulting into projects' cost escalations, compromise of quality of works, delays, claims that might lead to additional costs, disputes between stakeholders, material wastes and often loss of earnings to the clients due to untimely completion of those projects. Complex projects such as the PSPF commercial building project would have benefited more through value audit and Value Engineering and perhaps most the design changes in such projects could have been avoided.

5.7.6 Designers unconsciousness to cost and time

It was observed through project document review that in case projects such as the PSPF commercial project, some of the design team members were less sensitive to cost and time implications of design changes they were instituting. It was also noted that the design changes initiated by service engineers in the PSPF commercial project continued up to the finishing and fit-out stage of the construction process. That indicates that consultants were at liberty to initiate design changes regardless of their cost and time implication. The reverse was the case in the NMB building project in which designers were mindful of the cost of executing changes as well as the opportunity cost that would have been incurred by the design team members in the process of amending drawings so that to implement the relevant design changes. Cost and time consciousness made designers in the NMB building

project to ensure that both the design and the detail works were diligently done and complete.

5.7.7 Client's uncertainty on their requirements

Client uncertainty on the project requirements could be easily seen in three of the four cases evaluated. Design changes made by the client in the case projects to a greater extent altered their budgets and execution timeframe due to higher cost additions and time required to execute changes during construction. Figure 7 indicates the time and cost additions incurred due to design changes instituted due to clients' uncertainty on their projects' requirements. The MOI phase III project seem to have been affected more in terms of time as compared to other three projects probably because its client's financially expenditure greatly depends on the Government budgets. On the other hand, the NHC place seems to have had higher additional costs due to design changes as compared to the MOI phase III, PSPF commercial, and NMB building projects. The NMB building project had no cost addition but cost savings on its initial contract sum, probably because of there were no major design changes instituted in the course of its construction. All major changes in this project were implemented before tendering actions had commenced.

In three of the four cases cited, clients were not certain on what should be the contents of the final product of the project works. There was a change of mind on how the buildings could be used for the NHC place, PSPF commercial, and MOI phase III projects. Client for the NMB project was certain and firm on the project's requirements which might be attributed to their meticulous involvement in the stage by stage design works submitted to them.

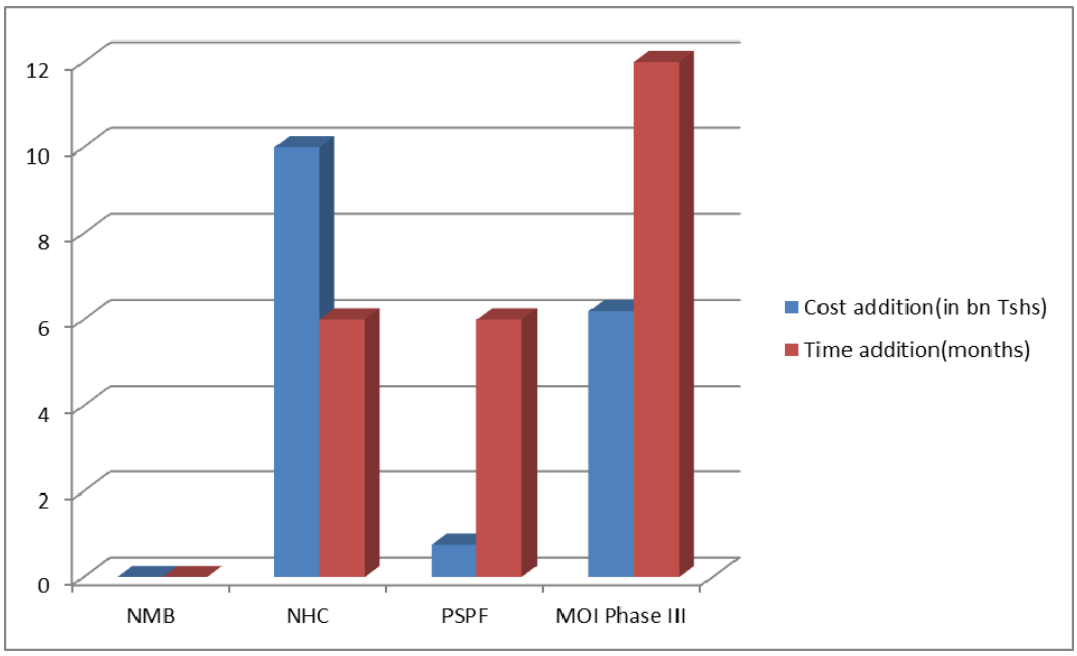

Figure 7 : The cost and time effects of design changes due to client's uncertainty

In the NHC place project for instance; the building which had been designed for commercial leasing was belatedly changed into the client's Headquarters. That required a lot of restructuring of some of the interior spaces. In the same project, election to seek the green certification also led to design changes which to some extent required redesign of part of the building fabric, space arrangements and interior elements and fixtures. Both groups of design changes, in this case, led to about six months of the project delay. However, green certification had considerable benefits to the project and the client. It was aimed at limiting consumption of resources such as power, water, and mechanical

ventilation during operation stage of the project.

On the other hand, in the PSPF commercial project; client's anxiety regarding the project contents in terms of space functions, though justified as adjustments to enhance the financial viability of the project, it led to cost addition of about 0.76bn Tshs (equal to 0.6% of the contract sum). Although they made only one notable change; that change added 0.76bn Tshs to the original project sum. It can still be argued that the client's representatives failed to oversee the cost and time impact of some of the proactive changes such as conversion of apartment spaces into office spaces or that their uncertainties were detrimental in terms of cost and time effects on the project.

Through the reduction of the amount of electrical power consumption, water and air condition and changing specification of most of the materials used in the construction of this project, the project managed to achieve green certification for limited consumption of resources during its operations. That is the quality that could not have been attained had the project been constructed in the original state.

In the case of MOI phase III project, the first signs of the client's uncertainty on what they wanted can be seen through the project requirement list that was given to architects as TOR for design works to commence. The clients seem to have had no proper consultation on what should have been the contents of their project. The list continued to change and grow as the project progressed through design stages, regrettably up to the project construction stages. That led to the projected growth to the extent at which the original cost estimates and budget could not sustain complete construction of the project. A very clear example is the introduction of the medical gas facilities and equipment which are said to be the very essential part of the surgical rooms; in spaces which were earmarked as essential by doctors and experts in hospitals during the construction process. The introduction of

essential facilities as such could not be avoided at later stages but that should have been part of the original requirements in terms of their number and location. This is where the importance of involving experts such as experienced hospital designers and doctors could not be over-emphasised.

Notably, in all three cases, client anxiety and uncertainty could have been avoided through proper consultations before the commencement of the project design and construction. In the MOI phase III, the involvement of the highly experienced designers at least as the client advisors or value engineers would have prevented a lot of anxiety and excessive design changes prior and during the construction stage. Though conversion of functional spaces in the PSPF commercial project is said to have been done to enhance the project financial viability, that could have been still being avoided through the diligent scrutiny of the project design works and feasibility design.

5.7.8 Laxity in Design management

It has been observed that there are two types of design management in practice in the cases cited. In the NMB Building projects, for instance; the architects as the team leader evidently and procedurally seem to have been in control and well exercising their team leadership. There was a well-controlled and thoroughness in planning and designing this project to the extent that the client was involved in ensuring that there is proper scrutiny of design works at every stage of design. The client was requested to sign acceptance of works done after every stage, especially the scheme design stage beyond which detail works commenced. That also indicates that architects put themselves and other associated team members into the task of ensuring that there was diligence execution of their duties.

The NMB Building project is extraordinary in the sense that among the evaluated cases because it had "proactive"[15] and the fewest design changes made in its course of construction. The project was completed within the pre-set milestone and below the estimated project budget. Completion below estimated costs was due to unused project provisional and PC sums. Both the client and the architects attributed the cost savings and timely completion to the good planning and design during the design stages and compelling professionalism in which excuses for lapses were rigorously rejected by the architects in charge of this project. This seems to be the main reason why in this projects there was no evidence of changes due to lack of proper detailing of works, the inadvertent omission of elements or parts of design works and additional design works. Clients knew that they would pay dearly for any design changes they ought to make. The team members also had to thoroughly ensure their parts of design works were complete to avoid paying the penalty for their lapses. The architect as a team leader played their roles well to ensure there was proper coordination of design works done by other consultants and avoid future discrepancies between them during the construction stage.

On the other hand, both the PSPF Commercial building and the MOI phase III projects experienced excessive and uncontrolled design changes. Most of the notable design changes (63 out of 65) were brought up by the design team members for the PSPF commercial building project while one among the two major changes in the MOI phase III originated from the architect's limited experience and probably lack of exposure on hospital design. That is in line with assertions by Sunday, (2010) and Parvan *et al* (2012) which asserts that consultants inexperience or lack expertise on the certain part of works may lead to design changes in building construction projects. The MOI phase III projects

[15] Proactive changes in the case of this research mean changes done before tendering actions of a specific project.

seem to have suffered more from excessive design changes as it had an additional cost of almost 7.5bn TShs (43%) to its contract sum. The main reason for most of the changes in the two projects is the inability to control and well manage the design works especially those done by other consultants.

Both the architectural and service works were not diligently detailed and there seem to have no demarcation between design and construction works as parts of design works such as the services continued even beyond the third quarter of the construction stage. Design team members attributed their management failures in designing and detailing works to the hasty and short time given for the design stages. However, there is no doubt that there were lapses in managing works by the project manager and coordinators during the construction stage.

5.7.9 Laxity in Construction Contract administration

Although contracts in the construction stage involve the contractor and the client with the architects acting as an intermediary, the latter has greater input in ensuring that contract is well administered by diligently producing complete contract drawings and details as well as ensuring that works by other consultants are better coordinated to adhere to the project design philosophy. Lapses in the coordination of works done by other consultants were observed in both the PSPF commercial building and MOI phase III projects in which the works done by other consultants necessitated amendments or the building exterior and interior works during construction. For instance; in the PSPF Commercial project; location of the generator exhaust ducts completely changes the outlook of one of its main façades and affected the aesthetic appeal of that part of the building.

That means to some extent, that the change degraded the value of the building by reducing its appeal to the public and potential customers. The architects as team leaders of the

project design team were not strict enough to deter excessive changes during the design works and construction stage. Service engineers had the liberty of bringing up design changes up to the last quarters of the construction stage. That is contrary to the practice in the NMB building project in which the architects were in control of all works during the design stages and construction process. Consultants and the client knew that they would pay for new works or design changes brought up due to their negligence and lack of thoroughness in their works and that to a greater extent deterred the unnecessary occurrence of design changes. That shows that when punitive actions can make individuals to have a more disciplined professional practice.

5.8 Timing of design change

Findings indicate that design changes done in the four case projects evaluated were instituted in a varied period of the design and construction process. The main changes done in the NMB building project were proactively instituted before production of the construction drawings which averted additional costs that could have been incurred if those changes were implemented in the latter stage. Design changes made in the NHC place, PSPF commercial and MOI phase III projects were reactively instituted, resulting in limited cost savings and in some cases high-cost additions.

The difference in timing of making design changes can be attributed to a number of reasons that include clients' inability to understand the design works presented to them during the design stages, the design team's failure to thoroughly grasp the client's requirements and the architects' lack of experience or required expertise concerning the project's requirements. Norton *et al* (1995) in Rangelova & Traykova (2013) point out that design changes made in the early stages of the project design will always be more beneficial to the project though high net savings made .That means that the changes

brought up and taken care of during the design stages would have brought up more benefits through cost savings and avoiding unnecessary project cost escalations, claims, disputes, delays in project delivery, opportunity costs on the designers as well as possible loss through loss of earnings by the client due to project delay. That would have been in concurrence with the assertions by Ibbs *et al* (2007) that the benefits in terms of cost savings and time of design changes will depend on the institution period of those changes as well their amount.

Design changes such those carried out in the NMB Building project which was done before the tendering stage of the project resulted in greater savings as compared to those done in both the PSPF Commercial and MOI phase III projects, which were carried out beyond the tendering stage and resulted in the respective project's cost and time escalation. The replacement of the suspended floor with the flat slab design in the NMB Building project due to "Value Engineering"[16] which were carried out before tendering action, saved about 1.3bn Tshs from the estimated projects' construction costs. The reverse was a case in the conversion of part of the residential tower into office space in the PSPF Commercial project to enhance financial and investment viability, which was carried out in the last quarter of the construction stage and added up about 0.76bn Tshs onto the projects' construction costs due to the contractors' claims originating from loss of profits and unused materials, and that resulted in no cost savings.

5.9 Inevitability of changes

Even in more detailed works such as the NMB building project, minor changes will inevitably appear due to site conditions and construction methods used. Since design and

[16] Value Engineering carried out in this case can still be questioned as the proper procedures and considerations were not followed which led to cost escalation during fit-out stage of the project

detail works cannot be standardized due to unique nature of projects, which imply changes cannot be completely avoided. However, architects, as team leaders should always ensure works done by consultants such as service engineers, are diligently detailed contrary to what was done in the PSPF commercial project in which those works were left to be detailed through shop drawings. It was evident there was a misuse of both PC and provisional sum in PSPF commercial and MOI phase III project in which the same amount of money were applied to works that should have been adequately detailed during the detailing design stage.

It should be noted in with Charles *et al* (2015), there is no design change that does not have a negative effect attached to it, whether directly or as reactive change that can derail the project from its smooth path or expectations. It is in this context that makes John Kelly, the Architect, and design team leader for the NMB Building project believes that "Design changes no matter how good their targets are, should be avoided as much as it is necessary and as early as possible". Changes can have positive impacts that will more than often be outweighed by their negative effects and eventually result in limited benefit depending on the period in which those changes were instituted.

5.10 Targets of design change

The cross-case analysis of findings indicated that targets of design changes made in the three of four case projects evaluated included enhancement of the project functional performance, acceleration for part of the project works, enhancement of the financial viability of the project spaces, reduction of operation costs and sustainable use of resources as well as enhancement of the clients' and end-user satisfaction. The design changes made in the NMB building project had unique targets that did not appear in other cases and that include cost savings and fulfillment of the new statutory directives. The design works of

the NMB building project seem to have exhausted all of the targets of design changes instated in the PSPF commercial, MOI phase III and NHC project during the design stage of the project.

5.11 Initiators of Design changes

It has been observed in this the case projects evaluated that both the client and the team members have to a varied extent initiated design changes. Clients were more active in construction projects that contain spaces that directly affect their daily works or practice as compared to design works that do not directly affect their careers. The NMB Building and MOI phase III projects are illustrative examples in which three (3) out of four (4) major changes done were either directly or indirectly initiated by the client. Only one major design change can be said to have been initiated by the client in the PSPF Commercial project.

However, the effects of design changes initiated by the client on both the projects' budget and milestone vary depending on the timing of those changes. All of the notable changes made in the NMB Building project were carried out before the tendering stage and led to cost savings of about 1.3bn Tshs (40% of the initial project contract sum) as compared to those done in the MOI phase III and PSPF Commercial project which were carried out beyond the tendering stage and resulted in the cost additions of about 6.2bn Tshs and 0.76bn Tshs respectively. One of the two changes in the MOI phase III project was carried out soon after the tendering works were completed, under the advice of the client's special advisor on hospital design from South Africa while the remaining major change was carried during construction and so was the only design change done in the PSPF Commercial project. High initiations of proactive design changes in the case projects evaluated are consistent with the proclamations by Charles *et al* (2015) that most of the

proactive changes that aim at increasing the project value are initiated by the client or owner while team members tend to initiate most of the reactive changes

Overall, clients seem to have had late involvement in the majority of the case projects evaluated except in the NMB building project in which the architects involved are known for their strict adherence to the design works during construction. Late involvement of the client in scrutinizing design works by a consultant to a certain extent led to the same clients getting a loss and limited benefits due to design changes instituted in the latter stage of construction of the PSPF commercial project, the MOI Phase III, and NHC place.

Greater participation of the client in the NMB building project can be attributed to the client's need to ensure that the design works and that eventual facility are up to their expectations and desire. That can still be associated with the architects' strict procedures in carrying out the design and construction works in which parties were advised to diligently perform their duties, otherwise, face the consequences of their negligence. On the other hand; less involvement in other projects such as the MOI phase III, PSPF commercial and NHC place might be associated with lack of clear interpretation of design works before project implementation and inattention to project details and investment cost.

5.12 Effects of design change

Effects of design changes determined in the cross case analysis of findings include the cost escalation and extension of time for the projects, enhancement of the functional performance of the projects, cost savings, time savings through acceleration of works, improvement of client and end-user satisfaction and reduction of the projects operation costs. An in-depth discussion of the mentioned effects of design changes has been given below

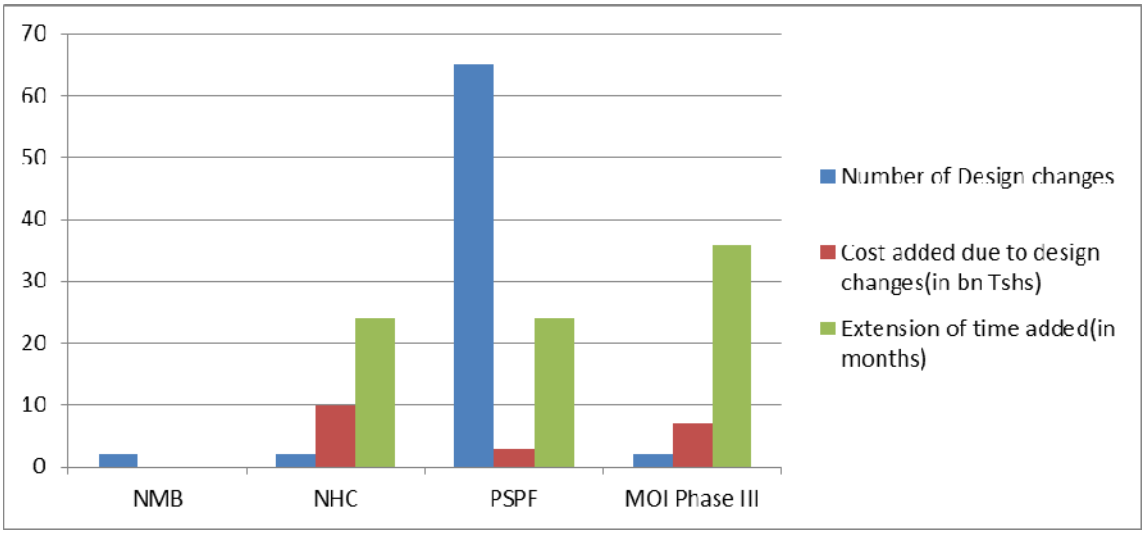

Figure 8 : Extension of time, cost incurred and additional time required to implement design changes instituted in the NMB building, NHC place, PSPF Commercial and MOI phase III projects

5.12.1 Cost escalation and extension of time

Findings from the four cases show that design changes made in the three out of four case projects among other effects resulted in cost escalation of the construction work as shown in Figure 8. The PSPF commercial project which had a higher number of design changes as compared to the other three projects seem to have had an extension of time almost equal to the NHC project and less than the MOI phase III project. That might be because the cost addition for MOI Phase III project escalated beyond budget and the client had to wait for additional funds from the Government. Cost escalation due to excessive design changes is consistent with assertions by Olsen *et al* (2012) that too much change or variation orders can sometimes be extremely expensive and may negatively affect the project schedule, affects project costs, increase project execution period.

Findings also show that the NMB building project is the only undertaking that was completed within estimated time. All of the design changes in the NMB building project were instituted within the design stage. This is the only project among the four cases

evaluated that was completed under budget. The cost savings on the initial contract sum was due to unused PC and provisional sum in that project.

5.12.2 Enhancement of the functional performance of projects

Findings show that enhancement of project functional performance is the dominant effect among the effects of design changes done in all four cases cited. Most changes were either aimed at improving functional spaces within the projects or part of the project that eventually would negatively affect the functional performance of the project if modification were not done to those parts. All design changes that were instituted due to Value Engineering in the PSPF commercial, NHC place, and MOI phase III projects were aimed at improving the functional performance of the spaces within those projects.

On the other hand, one of the two main functions done in the NMB project is said to have compromised the flexible the functional performance of most the spaces within that building. Elimination of flexible use of spaces in this project was the main reason why the designers for this project were reluctant to accept the result of the Value Engineering performed in the project. That implies that the Value Engineering performed neglected the flexible use of space which was one of the main concepts of design for the NMB building project. That raises questions about the appropriateness of Value Engineering done.

5.12.3 Cost savings

Some of the design changes in both the PSPF Commercial and the NMB Building projects produced varied "net cost savings"[17] notwithstanding at the cost of raising reactive changes, compromise of quality of final works and claims due to loss of profit and delay in

[17] The net cost savings in this case is the difference between the cost incurred due to design changes made and the cost saved for making the same.

completion of the projects. The cost savings made by making design changes in the course of execution of the projects cited, undoubtedly be said to be limited and expected to have been more had these design changes made during the design stages. In some instances such as in the NMB building project, where there were cost savings of up to 1.3bn Tshs; savings were tarnished by the manner in which it was obtained without proper consideration of the future functional project performance and the running costs of the project. In that case; cost savings were obtained through cost management in which the project initial costs were aimed to be kept low instead of the application of diligent Value Engineering in which cost savings would have been sought without compromising the functional performance and life-cycle costs of the project (Rangelova and Traykova, 2014). The MOI phase III project, on the other hand, had no cost savings but cost escalations due to excessive design changes are done in the course of its execution.

It cannot be an overemphasis to suggest that, design changes that target cost savings should have been brought up during the design stages, nearly up to the scheme design or through Value studies such as Value Engineering performed after the scheme design stage and before detailing works of the project had been done. That would have helped to avoid unnecessary delays, cost escalations due to claims for compensation by parties in the contracts after tendering stages had been completed and claims for additional payments by team members due to opportunity costs incurred in amending completed works.

5.12.4 Time-saving through acceleration of works

Findings have shown that; acceleration of works appeared twice (2) as a reason for making design changes in the course of construction of the PSPF Commercial building project. Materials and design of both the internal staircases in the duplex apartments as well as that of the balustrades for the escape staircases were the changes aimed at speeding up

construction of the relevant part of work. In the course of construction of the PSPF Commercial building project; reinforced concrete staircases were replaced by timber staircases supported by the central stringers in order to speed up works in the installation of the internal staircases in duplex apartments. The concrete walls in the lift shafts were replaced with steel beam separators; albeit at a combined additional costs of up to 140 million Tshs (about 0.1% of the total contract sum).

Acceleration of works did not appear in other two cases cited especially in the NMB Building project which had very limited design changes due to its better management of the design and construction works. However, it is also very difficult to talk of acceleration of works without associating it with cost implication, claims, and disputes. For instance, in the PSPF Commercial building, replacements of the concrete walls in the lift shafts with steel beams led to a prolonged misunderstanding between the design team members and the subcontractors on one side and the client on the other side due to the latter's delay and refusal in approving the associated variation orders.

The benefits obtained through time saved through the institution of these changes, in any case, are inherently tainted by the cost incurred due to their implementations. That means that there would have been significant benefits in terms of time for project execution and completion; had these design changes been preconceived during design stages.

5.12.5 Improvements of end-user and client satisfaction

Implementation of changes suggested by clients and their employee projects such as the MOI phase III, NHC place and PSPF commercial indicates that both the client and their end-user satisfaction targets were achieved. Conversion of functional spaces such as apartments into office use in the PSPF commercial project means that the clients' worries on the project's financial viability were averted and so were the need raised by hospital

employees and executives to increase the number of medical gas facilities in the MOI phase III project. However, implementations of the client representatives' wishes in projects such as MOI phase III and PSPF commercial building appears to have been very costly to those project by adding the cost of up to 6.2 and 0.76 billion shillings respectively. Application of value management which is said to cost up to 1% of the total construction of cost , as early as the projects' inceptions would have helped avert the cost incurred due to the institution of design changes aimed at improving the functional performance, the client, and end-user satisfaction.

5.12.6 Reduction of operation cost of the project

Findings have indicated that through reduction of the amount of electrical power consumption, water and air condition and changing specification of most of the materials used in the construction of the NHC place project, the project managed to achieve green certification for its targeted limited consumption of resources during its operations. That is the quality that could not have been attained had the project been constructed in the original state and without the application of Value Engineering. However; one can still and rightly argue that assurances for low consumption of resources during operation of the project could have been obtained through incorporation of the same requirement for green building in the design stage of the project without additional costs and time contrary to what was done in the course of construction of the NHC place.

5.13 Benefits of design change

The benefits of design changes usually depend on the period in which they are made and their targets. Benefits obtained vary depending on the period in which the design changes were instituted in the course of design and construction of a certain project. Consistent with Ibbs *et al* (2007) assertions that any design change can have both foreseeable and

unforeseeable or cumulative disruptions resulting, it is an indisputable fact that the main changes done in the course of design and construction of the case projects evaluated; to a certain extent were beneficial to those projects and the client through cost savings and improvements or corrections made.

However, these benefits would have definitely been greater had these changes made proactively as it was done in the case of NMB building project. That would have been in line with assertions by Charles *et al* (2015) that the monetary benefits of design changes greatly depend on the magnitude of changes, the period in which they are made as well as their targets. Changes instituted as early as the scheme design of any project will result in greater savings (Ibid). Inconsistency with Ibbs *et al* (2007) and Charles *et al* (2015), all of the main design changes made in the PSPF commercial project were carried out in the varied quarters of construction stage. That to a certain extent limited benefits obtained through design changes regardless of their targets which included enhancement of functional performance and acceleration of works as well as the enhancement of the financial viability of the spaces in that project. For instance, despite the fact that the client's desires were achieved in the conversion of spaces in the residential tower of the PSPF commercial project, it was attained at the cost of about 0.76bn Tshs. That cost would have been avoided or minimized had the same change been foreseen and instituted as early as design stage of that project.

In line with Charles *et al* (2015) and Erdogan *et al* (2005), benefits such as the reduction of the degree of difficulty and initial project cost in the PSPF commercial and NMB building projects respectively, would have had greater value and magnitude had they been achieved at lower expense.

5.14 Chapter summary

This chapter has a discussion about the findings from the four case projects evaluated. Data obtained through project documentary review and correlated as well as enhanced through personal in-depth interviews have been presented and discussed for all of the four cases. The chapter also includes the cross-case analysis of data obtained from the four case projects which show that both the client and design team members have to a various extent been the source of design changes. However, clients have been the major source of design changes in all three out four case projects evaluated. Some of the reasons for design changes include laxity in design and construction management, clients uncertainty of their project requirements, inadequate detailing of design works, poor coordination of design works, design team members unconsciousness to cost and time, value studies such VE and VM as well as the need for acceleration of works. It has been shown that the benefits obtained through design changes include cost savings, improvement in the projects' functional performance, health, and safety. The analysis and discussion of findings have also shown that the obtained benefits were obtained at a high expense which has rendered them to be limited. The next chapter concludes and presents recommendation of the study.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

This study has established that the benefits of design changes in building construction projects are largely a paradoxical issue as far as their benefits are concerned. Design changes can be initiated by either the client or members of the design team depending on the concern and need for that change. Specialist designers or advisors to a varied extent have been involved in the initiation of design changes that have had varied effects on building construction projects. Early involvement of specialist or advisors has proven to have positive effects on the project while the delay of such involvement resulted in limited benefits due to higher cost associated with the implementation of their advice. Enhanced participation and cooperation between consultants and clients during project design works have proven to have resulted in a very limited number of design changes in the construction stage of some of the projects.

Incomplete design and laxity in design management have had a greater bearing on the emergence of design changes during the construction stage. This implies that diligently designing and detailing works could help in curbing the magnitude of design changes in the course of project construction. Clients have also been found to establish design changes that target enhancement of the project value while the design team members act to reactively avert or correct possible obstacles related to project execution. The client could have been helped by early application of value studies such as Value Management (VM), Value Engineering (VE) and Value audit (VA) in the quest to enhance project value.

Design changes made in building construction project can be beneficial to the project through enhancement of the project value. However, the extent of benefits obtained usually depends on the timing of institution of the design changes because of the cost associated with their implementations. The Late institution has been proven to limit the benefits obtained while early introduction could result in higher benefits due to lower cost of making changes as well as a smaller number of drawings and personnel involved.

6.2 MAJOR FINDINGS AND RECOMMENDATIONS

6.3 Major Findings and Recommendation for Specific Objective One

The first objective sought to identify design changes and their causes in the building construction projects. It was found that the design changes instituted in case projects evaluated may be classified based on their initiators. Key findings and recommendations of the main causes of design changes are as follows.

Clients' involvements and understanding of the Design works

It was observed that clients in three projects were at fault for some of the main design changes instituted in the case projects. That was due to either less attention to design and detail works of their projects or limited capability to clearly interpreting the design works before project construction. In that case, it is recommended that;

i. Clients could ensure that they have skilled advisors capable of scrutinizing design works on their behalf as early as the inception stage of their projects. That will enable them to have a clear picture of what the final product of their project will be.
ii. Clients and design team's utilization of physical and CAD models might also be of great help in realizing the layouts and set up of interior works contrary to the

current practice in which only the exterior parts are shown on the CAD and physical models.

Design team's performance during design and construction works

The performance of the design team was very questionable in three out of four case projects that were evaluated. Designers were at fault for most of the changes in the PSPF commercial and MOI phase III projects. Their indeterminate performance in the design and detailing works led to excessive design changes. On the other hand, strict adherence to the practice and diligence detailing of works by design team members and the client resulted in a very limited number of design changes in the NMB building project. Therefore; it is recommended that;

i. Architects as team leaders shall ensure that their co-consultants perform accordingly in the design and detailing of works. Less detailed works should not be accepted for tendering and if need be, detailing firms or individual shall be sought at the expense of the fee to be paid to the consultant at fault.
ii. Architects and other design team members shall forge professional relationship among them that would allow intra-firm collaboration to enable, among other things, project scrutiny and knowledge sharing contrary to the current situations in which firms engages in negative criticism that is rooted greed competition.
iii. Design team members shall demand the diligent involvement of the client and their representatives in the design works, demand signing of works at the end of every design stage and where possible, have a contract clause that permits request of extra payments for design changes and additional works done beyond the scheme design stage.

iv. Client shall require higher PII premiums to be set by design team members and demand reimbursements for additional costs incurred due to inadequately detailed works are done by architects as team leaders and their co-consultants.

Design management

Design management seems to be a prevailing issue in the building construction works in Tanzania especially to design team members. That might be due to the late introduction of management skills in the architectural and engineering programs in the prominent universities in the country. Therefore, it is recommended that;

i. Professional bodies such as Engineers Registration Board(ERB) and Architects and Quantity Surveyors Registration Board (AQRB) should increase training and seminar such as Continuing Professional Development (CPD) for their affiliated professionals regarding design management.
ii. Professional bodies such as AQRB and ERB should liaise with the Universities to ensure that at least essential skills on design management are being included and properly taught in the courses and programs such as architecture, engineering, survey; thereby making them as eventually qualify as professionals. Accreditation such as ones done by Royal Institute of British Architects (RIBA) should be set for courses and programs to ensure adherence.

Coordination of design and construction works

i. There is a need of having a project manager other than project architects who can ensure there is a correlation of the works done by different consulting team members, especially in mega and specialty projects.

ii. Project managers should be enabled by clients to ensure that all design works are thoroughly done and that only inevitable design changes that hardly be foreseen during design works and are likely to increase the value of the project are allowed.

iii. It is imperative that architects, as team leaders see to it that design works done by other consultants, are incorporated and simulated in the architectural design to ensure that conflicts between separate design works are prevented. The application of CAD for simulation, incorporation, and coordination of architectural, structural and MEP works is in this case highly recommended.

Inevitability of design changes

i. Changes should be minimized as much as possible through diligent design works and proper exhaustion of possible areas that are at high risk of being changed and eventually set the risk mitigation procedures as early as the project inception stage.

ii. Architects as team leaders should ensure that there are strict procedures to be followed by other team members in executing their part of design works and make them aware of the possible consequences of negligence related to inadequate design and detailing works.

iii. Client should demand higher Professional Indemnity Insurance (PII) as precaution measure that will assure them of cost recovery in case the team members are found to be negligent of their duties contrary to the current situation in which design team members do not feel the pinch of more payment and therefore pay less attention to cost and time detail.

iv. There is a need to have in place a Real Estate Regulatory Authority (RERA) that would support the establishment of a reference indexes for estate development in Tanzania. That would help in proper asset allocation, performance measure,

transparency on investments, evaluation standards and act as a trusted source of real estate market insights.

6.4 Major Findings and Recommendation for Specific Objective Two

The second specific objective aimed to determine the targets of design changes made in the building construction projects. The findings indicated that enhancement of the functional performance of the project, acceleration of parts of works, enhancement of quality and aesthetic appealing of the project, cost savings as well as improvement of the clients and the end-user satisfaction, were the main targets of the design changes made in the case projects evaluated. All the mentioned targets can be summed up as value enhancers. However, the timing of design changes was a major constraint to the target set as it led to higher cost of the institution. Unreservedly, it is recommended that;

i. Clients shall compel their potential consultants to diligently consider all value-enhancing factors in the design works. Similarly, clients have to scrutinize design works to ensure that their requirements have been adequately met through the use of highly experienced professionals and expert advisors.
ii. Value studies such as Value Engineering, value audit, and value management shall be included as TOR for undertaking design and construction works of mega and specialty projects. It is undoubtedly cheaper to pay for value studies in mega and specialty projects than incurring higher variation costs due to design changes that originate from incomplete and inadequate detailed design works.
iii. Clients would benefit from the inclusion of the VECP clause on the contracts and tender documents to incentivize the contractor to come up with alternative design or detailing part of the project. The change proposal would be beneficial to the

project as it allows potential savings from materials and cost waste and enhancement of the project performance at lower costs.

6.5 Major Findings and Recommendation for Specific Objective Three

The third specific objective ascertained the benefits that are being obtained from design changes. Findings revealed that design changes made in the case projects yielded varied effects, some of which can be said to benefit the individual projects, enhanced clients and end-users satisfactions. However, the benefits obtained are so limited as most of them are attributed to a very high expense. In this regard, it is recommended that;

i. Design Changes, where required, should not be instituted with cost savings as the only target but with considerations placed on such other factors that will enhance project performance, the health and safety of the project end-users and reduce the whole life-cycle costs of the project. These must be changes that could not be foreseen during the exhaustive and well-detailed design works.

ii. Design changes, where required, shall be better instituted up to the scheme design in which the number of drawings to be amended is minimal, few consultants involved and the cost of making those changes are very limited as compared to making changes beyond the detailing stage.

iii. Design changes can be more beneficial if they are a result of proper Value Engineering, Value Audit or the Value Engineering Changes Proposal (VECP) instituted before the commencement of the construction process contrary to the current situation in which some of these studies are partially or incorrectly done.

6.6 Area for Future Studies

There is a need to broaden research-based knowledge on the following topical issues

i. Quantified impact of design changes due to inadequate detailing of design works;

ii. Viability Introducing Value Engineering change proposal (VECP) in the building construction works in Tanzania and

iii. The effectiveness of Value studies done in the building construction projects.

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APPENDIX -I

.Dissertation *for MSc Construction Economics and Management*
Title*: Exploration of Benefits of Design Changes in Building Construction Projects*
Name*: Romwald Raphael Byarugaba*
Reg*. HD/T.752/2014*

INTERVIEW GUIDES FOR DESIGNERS

CONCERNING CASE PROJECT …….

a) General information

i) What is your name and profession? …
ii) Are you a registered profession? If yes; when were you registered?
iii) How long have you been practicing in your profession?

Years	Less than five years	5 to 10 years	10 years and above
Mark			

iv) How many projects have you been involved in from design to construction? Please tick in the appropriate box

Number of Projects	Less than five	5 to 10	10 and above
Mark			

Please comment on the sizes and complexity of most of the projects you have been involved

v) Which phase of the building construction between design and construction are you more familiar with?

Years	Design stages(from inception to detailing & tendering)	Contract administration & Construction	Both the design stages and Construction
Mark			

vi) What is your comment on the design process of this project?

b) ***Concerning a Case Project*** *(Project Information)*

i) What makes this project special?
ii) What were the main goals and pre set milestone of this project?
iii) How long did it take for the design works of this project to be completed? Can you please comment on the amount of time allocated or taken for this works?
iv) How long did it take for construction works of this project to be completed? Can you please comment on the amount of time allocated or taken for this works?
v) What kind of difficulties did this project face?

c) Concerning design changes, sources and their causes

1) What kind of design changes do you remember making or being made in this project?
2) What were the main reasons and causes for these design changes in this project?

Please indicate by ticking in the appropriate box, the extent to which the following were the causes of design in the project under question

Cause /extent of consideration	**Too often**	**Often**	**moderately**	**Rare**	**Very rare**
Incompleteness of the design works					
Inadequate detailing and specification					
Misinterpretation of the clients' requirements					
Value engineering					
Lack understanding of the design by the client					
Need for acceleration of works					
Change in technology of materials					
Introduction of new statutory requirements					
Force majeure					

3) Who were the main initiators of these design changes?
4) There is a perception among the construction stakeholders the *design team members are the main perpetrator* when it comes to initiating design changes. To what extent was that statement true or false in this project? Please tick in the appropriate box in the table accordingly to show the extent to which the following construction stakeholders were the main source or initiators of design changes.

stakeholder /extent of involvement	Very much	much	moderately	Less	Least
The client					
Project Architect					
Structural Engineer					
Specialist subcontractor					

5) What time did these changes save or add to the project as extension of time? Please comment accordingly
6) What were other outcomes of the design changes made in the course of this project?
7) Please tick in the appropriate box in the following table to show the extent of design changes made in corresponding the period or phase of the project.

Project stage/extent of involvement	More	Much	Little	Less	Least
Before tendering process					
During the first quarter of the construction period					
During the second and third quarter of the construction period					
During the last quarter of the construction period					

8) What is your comment on the timing (*period of initiation and execution*) of the design changes? Do you think *timing* had any effect on the outcome of the design changes made in this project?
9) Do you think that these design changes were necessary? Please explain why and how they were/ weren't?
10) What should be learnt from the design changes made in the course of this project?

d) *Concerning targets of design changes*

i) In your advice, what should be the considerations for making design changes?
ii) Please fill the appropriate number that indicates the extent to which the following attributes were applied as targets in making design changes in this project. 1=Most,2=Much, 3=Little, 4=Less,5=Least

Client's satisfaction
End user satisfaction
Value engineering requirements
Functional performance
Aesthetic enhancement
Health and safety enhancement
Indoor air quality enhancement
Cost reduction
Work acceleration
Easing work performance
Life cycle cost reductions
Material Durability or Maintainability
Change in technology
Regulation requirements

Please comment on the extent of consideration of the mentioned targets and explain if there were other targets (apart from the ones mentioned above) set for this project

iii) To what extent were these pre set targets of design changes in this project achieved? What were factors of their failure or success?
iv) Why do you think these targets were not pre conceived during design phases?
v) What were the shortcomings in achieving the pre set targets of design changes?

e) Concerning Benefits of Design Changes

i) What can be said to be the benefits of design changes made in this project?
ii) Which among the design changes made to this project can be considered beneficial?
iii) What were the *factors of success* make design changes made in this project beneficial?
iv) What were the *factors of failure* of design changes which you consider to have had detrimental effects on project under question?

f) *Improvements of situation*

i) What can you comment on the benefits obtained from design changes made in this project?
ii) What do you think could have made design changes more beneficial?
iii) How can the *factors of failure* in design changes be avoided?
iv) In your opinion, what should be done to improve the current situations in which design changes in the building construction projects are made?
v) Please provide any other relevant information that can be useful in this study