A MODEL FOR UNDERTAKING BUSINESS PROCESS RE-ENGINEERING (BPR) TO IMPROVE CONSTRUCTION PROJECT PERFORMANCE IN TANZANIA

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By

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A Thesis Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy (Engineering) of the University of Dar es Salaam

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the University of Dar es Salaam a thesis titled: ***'A Model for Undertaking Business Process Re-engineering (BPR) to Improve Construction Project Performance in Tanzania***' in fulfilment for the Degree of Doctor of Philosophy of the University of Dar es Salaam

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DECLARATION

AND

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I, **Yazidi Hassan Bakari Mwishwa**, declare that this thesis is my original work and that it has not been presented and will not be presented to any other University for a similar or any other degree award.

Signature………………………………

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DEDICATION

I dedicate this thesis to my daughters, Amina, Aisha and Mwantum. I’m saying, you always have the power to learn by yourself.

LIST OF ABBREVIATIONS

BIM	Building Information Modelling
BoQ	Bills of Quantities
BOT	Build Operate Transfer
BPR	Business Process Reengineering
CET	College of Engineering and Technology
CPI	Cost Performance Index
CM	Construction Management
CMM	Capability Maturity Model
CRB	Contractors Registration Board
CSMSF	Construction Site Management Supervisory Firm
DB	Design Build
DBB	Design Bid Build
DVC-ARC	Deputy Vice Chancellor, Academic Research and Consultancy
ECP	External Control Process
ERB	Engineers Registration Board
GDP	Gross Domestic Product
IT	Information Technology
LAN	Local Area Network
MoF	Ministry of Finance
MoID	Ministry of Infrastructure Development
MoW	Ministry of Works
MUST	Mbeya University of Science and Technology
NCC	National Construction Council
NHC	National Housing Corporation
PPRA	Public Procurement Regulatory Authority
RAS	Regional Administrative Secretary
RBV	Resource Based View
SPI	Schedule Performance Index
TANESCO	Tanzania Electric Supply Company
TARURA	Tanzania Rural and Urban Roads Agency

TBA	Tanzania Building Agency
TQM	Total Quality Management
UDSM	University of Dar es Salaam
WHC	Watumishi Housing Company

ABSTRACT

The performance of construction projects in Tanzania is commonly plagued with time overrun, cost overrun and poor quality. These problems are deeply rooted in weaknesses of project processes. This thesis improves the project processes and project performance through BPR philosophy. The BPR model was developed based on the concepts of process performance measurement and BPR philosophy.

Data used to develop the model was obtained through interviews and questionnaire surveys from 33 selected organizations. Data from a case study of a road construction project together with the critical comparative analysis of a BPR model against other models were used to validate the model. The dimensions of the developed model include: BPR foundation; Understand Current Process; Weaknesses of Current Processes; Desired (**To-Be**) Processes and Continuous Improvement. The model considers design, procurement and construction management as core project processes. The Model also analyzed indicators for identifying weaknesses and for driving improvement. The thesis has established forty (40) indicators to identify process weaknesses and fourteen measures to identify desired project process. With regard to strategies to enable continuous improvement, the study proposes continuous learning, benchmarking, use of IT technology, plan resources and adopt Capability Maturity Model. Model was validated to identify weaknesses, identify desired (**To-Be**) process, enable improved project processes, identified weaknesses of traditional processes and compared with the other models.

The study concludes that forty established indicators are appropriate to identify process weaknesses; fourteen measures are useful to design **To-Be** process. They can be deployed through using of the proposed strategies for improvement. Suggestion is made for each contracting party in the country to use the model to undertake BPR to improve performance of core project processes.

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CHAPTER ONE

INTRODUCTION

1.1 Background

In any country, the construction industry is very important as it provides facilities for shelter, transportation systems, storage, telecommunication systems, to mention but a few. In Tanzania, the contribution of this industry to the economy in terms of Gross Domestic Product (GDP) in 2014 stood at 8.3% and the capital formation in the same year was 60.5% (MoF, 2014). Furthermore, statistical data show that the industry accounts for more than 9% of the employment creation in the nation (Mwankusye and Fundi, 2005; UNESCO, 2010).

Despite these contributions, the construction projects have, over the years, fallen short of expected performance as measured in terms of duration, budget, quality and safety (MoW, 1977; MoW, 2003; PPRA, 2008). They suffer from both time and cost overruns, they are also executed at an unsatisfactory quality and safety (Baradyana, 2000; Samson, 2003; Mamiro and Kasuwi, 2005; Digaga, 2010; Mawenya, 2011; Ngowi, 2014; Amasi, 2014; Mhando *et al.*, 2017).

In Tanzania, public projects are major investments accounting for over 90% of all development projects (Addo-Abedi, 2006). The duration and the corresponding number of registered projects (in bracket for recent four years) are: 2014 (691), 2015 (806), 2016 (847) and 2017 (445 data picked up to 10/8/2017), making a total of 2789 public registered projects (ERB, 2018). The projects performance trend shows that in the post colonial period (1961 – 1980), projects were mainly implemented by public institutions, notably, MECCO and NEDCO. During this period, the industry was characterized by uncertainty with regard to the availability of required resources and low productivity levels (Bjorklof *et al.*, 1992; MoW, 1997). In the 1980s, the industry was still hampered by inadequate project performance. In duration between 1976 – 1985 a study of thirty one [31] projects showed that the projects were completed at an average time overrun of 2.88 times the original planned duration and at a cost overrun of 1.79 times the original planned budget (Lema and Mutabazi, 1988). In addition, in the twenty years period i.e. from 1978 - 1998, one hundred thirty two [132] construction projects were completed at an average time overrun of 2.42 times the original planned duration and at a cost overrun of 1.55 times the original project budget (Baradyana, 2000). Further, in the duration between 1995 – 2001 a study of thirty [30] projects showed that the projects were completed at an average time overrun of 1.60 times the original planned duration and at a cost overrun of 1.39 times the original planned budget (Samson, 2003). In addition, in 2006 and 2007 respectively, contracts in Local Government Authorities were assessed, where out of 93 audited councils, 41 (44%) did not qualify properly. Furthermore, in 2010, out of 79 audited councils 56 (71%) did not manage contracts properly (Digaga, 2010). In a period from 2005 – 2013, Ngowi (2014) evaluated TANROAD's reports and indicated that out of 96 road projects executed, 65 (68%) were not completed within the original completion period and budget. In the same year (2014), factors for measuring time management were established and used to study two road projects operations, where, one project (50%) was found to be completed on time against the other project (Amasi, 2014).

In Tanzania, public projects are usually delivered using traditional method where clients, consultants and contractors are involved at different stages of project with definite roles. It has been established that project problems is a result of inadequate performance of each and all of these parties (MoW, 2003; Muhegi, 2011; MoF, 2011).

At the early project's stage, clients fail to adequately define needs of the intended facilities thus resulting into poor scope definition. During construction stage, clients fail to honour their primary obligation of prompt payments to contractors. This is supported by results of a survey of public projects, which established that several projects were affected by delayed payments to contractors (Joseph and Haule, 2008).

This was partly due to the tendency of some clients to award contracts before ensuring the availability of funds contrary to the requirements of the public procurement legislation (Mamiro and Kasuwi, 2005).

In most public projects, designs are undertaken by consulting firms (architects, engineers and quantity surveyors). As for these, there are many complaints regarding failure to prepare adequate drawings on time thus resulting in delayed projects and sometimes disputes (Baradyana, 2000; Ntyakunze, 2011; Mhando *et al.*, 2017). This is critical when engineering details are missing to guide proper construction. During procurement stage, clients and consultants fail to properly evaluate tenders, hence leading to selection of incompetent contractors (Mawenya, 2011). Moreover, consultants perform poorly in inspecting project tasks, mainly due to occasional visits to the site; thus, leaving contractors to make major decisions on their own (Lema *et al*., 1992; Msita, 2001; Joseph and Haule, 2008). Consultants' occasional visits to the sites were attributed to, by the huge and unbalanced numbers of project workloads they usually engage with.

Contractors, whose major obligation is to execute construction work according to the terms and conditions of contract, have been found to have many weaknesses. Most contractors are faced with inadequate resources, particularly, skilled personnel, finance and equipment. In many of these firms, it is rare to find a construction programme outlining schedules for resources, (materials, equipment and labour). One can generally summarize these problems as contractors' failure to mobilize necessary resources (Msita, 2001; Muhegi, 2011; Ntyakunze, 2011).

Generally, performance trends of all main project participants (clients, consultants and contractors) display the following characteristics: inadequate planning, a*d hoc* process, weak adoption of IT in their processes, inadequate procurement and project delivery processes, weak capital and cash flow management skills, lack of innovation and entrepreneurship skills, lack of formal organization structures and lack of work commitment culture (Msita, 2001; Mamiro and Ksuwi, 2005; Mushi, 2007; Bambanza, 2011; Otoki *et al.*, 2018).

When critically reviewing the Tanzanian project performance problems, the concepts from Marchand and Stanford (1997) and Childe *et al.* (1995) are considered useful. They divide processes within any firm into two categories: administrative and support/control processes and the core processes (in this study, core process is the project process). The administrative and support process offers administrative and control role, effected by people competencies, finances, IT technology, organizational structures, visionary ideas, strategy and cultural attributes (Childe *et al.,* 1994). Core processes involve daily operatives of the firm.

Based on these concepts, the problem of project performance is referred here, as the 'poor processes management'. It is divided in two categories of performance weaknesses:

i) Weaknesses category one, based on 'administrative/control processes', this relates to the weaknesses in the management of the firm's: strategies deployment, organizational structures, technologies and information systems amongst others (Marchand and Stanford, 1997). These weaknesses are generally identified as the incapability of the firms (Dosi *et al.*, 2000; Sommerville and Craig, 2006).

ii) Weaknesses category two relates to critical inputs, critical activities and critical interfaces of each of three core project processes (Rever, 2002): design, procurement and construction management. Each weakness category is defined as, weaknesses: (i) within the critical inputs of each core project process - relating to lacking of, or using incompetent manpower, an expertise assigned unbalanced workloads that detriment his/her efficiencies amongst others (ii) within the critical activities of each core project process - relating to, poor: scope management, selection and use of construction methods, resources acquisition and management and forecasting of the outputs (Msita, 2001; Ntyakunze, 2011; Amasi, 2014) and (iii) within the critical interfaces of each core process - relating to poor interconnection between the output(s) of the preceding activity with the inputs of the succeeding activities and the fault approval processes (Joseph and Haule, 2008; Amasi, 2014).

Before seeking solution to ‘process management problem’ documentations indicate several efforts made to improve the performance of the Tanzanian construction industry (Mukama, 2005; Mlinga, 2005; Muhegi, 2007). Efforts made and the reasons of adoption are described next.

Ministry of Works under the Act of Parliament, No 17 of 1997 established three key construction industry regulatory bodies (CRB, ERB and AQRB). The reason was to regulate construction industry activities by ensuring that competent firms and professionals are key operators in the construction industry. Such entities (NCC, ERB, CRB and AQRB) were also aimed to provide training through workshops and seminars on selected themes e.g. tendering procedures, financial management, partnering amongst others to speed up development of the industry.

In addition, in the same year (1997), Civil Engineering Contractors Association (TACECA) was established by Civil Engineering Contractors to enable civil works contractors share experience and pool resources for capacity development. In 1998, Ministry of Works established TANROADS with aims to supervise the maintenance and development of roads in Tanzania.

In 2002, CRB established Contractors’ Assistant Fund (CAF) to assist small and medium contractors to obtain bid bonds and Bank guarantees for advancing project payments.

In 2003, the Ministry of Works also prepared construction industry policy with the aim of guiding performance of construction activities in the country. In the same year, ERB established Structured Engineer Apprenticeship Program (SEAP) to help graduates in engineering to acquire professional experience and competencies.

In addition, Public Procurement Regularity Authority in 2005 amended the law such that projects are divided into small lots and sizes for national businesses. This effort was aimed to allow many local firms obtain projects.

A critical review of these efforts revealed that no one of them was directly focused specifically on improvement of critical: inputs of the processes, activities of the processes and interfaces of the processes of a project as well as the administrative processes of the firm. Therefore, new approaches that focus on process performance management improvement are important to be established.

In order to solve process management problems, literature suggests two types of process management philosophies. The radical change improvement implemented through ‘Business Process Reengineering (BPR) philosophy’, and ‘incremental change’ achieved through philosophies such as Total Quality Management (TQM), Kaizen, Lean amongst others (Robinson and Ullah, 1996; Sobek and Jimmerson, 2003; Oakland, 2003; Hirano, 2009). Three notable differences between these two categories of management techniques are outlined to help understand their underlying concepts, thereby, aiding the decision of selecting one of use in the current study.

Whereas incremental changes focus on altering the existing processes, implements minimal variation to existing processes and provide low pace of resulting improvement changes, BPR allow adoption in either of two options: start from clean slate (start afresh) or redesign the existing process. It implements radical redesign and drastic improvement and has high pace of resulting improvement changes (Manganelli and Klein, 1994; Pearman, 1999; Sobek and Jimmerson, 2003; McAdam, 2003; Hirano, 2009).

Based on the aforementioned, information suggests that BPR philosophy may be adopted in this study over the incremental management techniques. The reason is that BPR would help local firms to create radical changes on their core processes. Three more reasons of its selection are outlined: (i) provides concepts that help create huge amount of improvement, a significant improvement amount quoted was 3000% or more (Manganelli and Klein, 1994, pp.7), (ii) advocates the adoption of concepts of innovativeness, i.e. how to think creatively, learn from best practices and struggle to work excellently in the business (Perman, 1999; Ulsric *et al.*, 2005), and (iii) advocates the use of IT to exploit the technology that greatly support process improvement (Davenport and Short, 1990). In order to discuss further the potentials of BPR philosophy, the benefits derived from its experience of use is categorized in construction and manufacturing industry context as follows:

(i) In the construction industry, it increased work efficiencies, reduced project costs, process cycle time, project duration to mention but a few (Ireland, 1994; Sidwell *et al.*, 2002). BPR philosophy also helped to shape cultural attributes of the employees on committing to the jobs due to their participation in the project process mapping (Riley and Brown, 2001).

(ii) In manufacturing firm within the United States of America, BPR reduced cost by 100% instead of 30% targeted; raised quality to 75% instead of 50% targeted, reduced cycle time by 100% instead of 50% targeted amongst others (Caron *et al.*, 1994; Manganeli and Klein, 1994; Muthu *et al*., 1999).

Besides the benefits of BPR, it also fits to both firms' categories, those that are doing well today and would want to do much more better in future, or, those that are doing inappropriate today and would need improvement (Robinson and Ullah, 1996;

Pearman, 1999). The BPR process improvement is done in steps that include (Mangalline and Klein, 1994; Muthu *et al*., 1999; Stoica *et al.,* 2004): understand process, identify process weaknesses, redesign process and improve redesigned processes in a continuous way.

In order to justify the selection of BPR and its use in the current study, its specific potentials are established and may be linked with the weaknesses of project processes that prevail in the local construction industry (MoW, 1977; Bjorklof *et al*., 1992; MoW, 2003; Mamiro and Kasuwi, 2005; Ngowi, 2014; Otoki *et al.,* 2018), they are outlined in Table 1.1. From this Table, the current tenets of BPR philosophy are outlined, showing potentials to solve weaknesses that exist in the local project process performance.

Table 1.1: Project Process Weaknesses against the BPR Potentials

Project processes	**Project process weaknesses**	**BPR potentials drawn from creativity and from best practices**
Design process	-*Inadequate functional brief* that create reworks during actual work executions -Provision of a single sketch during design stage -Provision of design documents with errors, omission or mistakes	-Deployment of experienced design team -Perform constructability review -Map out design process performance and deploy option sketches -Allow adoption of IT and BIM technology that deploy changes of processes in automation way
Procurement process	-Inappropriate project delivery method leading in creation poor project results. -Poor procurement methods -Inadequate use of contract types -no innovative processes, e.g. conducting tendering on line	-Map out procurement process to help deploy effective project delivery option, contract type and procurement options. Allow also deployment of IT and BIM that support process performance.
Construction	Poor resources mobilization, site planning, productivity and overall	-deploy competent contractor obtained through appropriate project

Project processes	Project process weaknesses	BPR potentials drawn from creativity and from best practices
manageme nt process	site management. The problem is due to failure to manage site activities by a contractor.	delivery option and adoption of appropriate contract types. -adopt IT and BIM technology to help support process performance

Thus, the BPR philosophy may be designed to improve processes, as it: identifies process weaknesses, redesigns new improved processes; and have elements of continuous improvement of redesigned processes amongst others.

Although BPR philosophy is proposed for use in this study, its (BPR) existing models have weaknesses (Robinson and Ullah, 1996; Pearman, 1999; Muthu *et al*., 1999; Ursic *et al*., 2005). Three criteria are used to discuss the existing BPR models so that the gaps can be identified and filled in the developed model of this study. The criteria of discussing the existing BPR model relate to: construction industry, manufacturing industry and generic BPR implementation steps.

(i) BPR models in Construction Industry, they include: model that redesigns procurement process of a project (Allweyer *et al*., 1996); redesign initial project planning phases to meet clients' project objectives (Tookey, 1998) on which it redesigned only one process of the project that was effected by only two European firms; redesign schematic design process to incorporate views of a contractor during design process (Brown and Riley, 2000); and reengineering of communication system between head office and construction sites (Charoenngam *et al.*, 2004).

(ii) Guimarae (1998) investigated factors for successful BPR implementation in manufacturing firms. Concluding that those who fail, the reasons are due to their tendency of not placing attention on important BPR activities such as matching customers' needs with their business processes on which values are drawn-in and do not apply right innovative technologies. Amrita and Sheriff (2016) studied perceptions of manufacturing firms in India (who implement BPR and those who do not implement it) with a view to radically change the business processes in that industry. In the results, both firm categories are motivated with BPR benefits, therefore, they proposed plans and strategies to help BPR implementation and improvement initiatives as lessons to those who wish to implement it. Bitok (2013) studied large manufacturing firms in Kenya which conduct BPR. He concluded that majority of these firms benefited by having efficient production processes, obtain quality products and elimination of non-value adding process, inspection time, moving time and waiting/queuing time amongst others.

(iii) Three Generic BPR implementation steps models are outlined. They include: (a) Davenport and Short (1990) who provided five BPR implementation steps: identify and document the existing process, understand and measure the existing process, develop business vision and strategy, identify the IT levers, design and build a prototype of new process. (b) Manganelli and Klein (1994) who provided five steps: prepare to conduct BPR, develop **To-Be** process, develop business vision and strategy, identify team and separate technical from social issues and (c) Zigiaris (2000) who provided eight steps: identify the team, employees trained, understand and measure the existing process, develop **To-Be** process, adopt IT strategy, allow envision by top management, implement, plan and monitor continuous improvement.

Drawn from the existing BPR models, the following four points can be outlined:

One: There is no single model that encompasses all critical processes in the construction project;

Two: Many BPR models are inclined towards manufacturing processes. There are significant differences between manufacturing and construction and therefore it needs re-work for such models to be adapted;

Three: Most models only identify steps to be followed without the specifics of how to go about. These models also have repetitive steps (Vakola and Rezgui, 2000); and

Four: There are no comprehensive indicators to enable businesses to identify weaknesses.

Based on the background to the problem, a hypothetical model of the current study is proposed that redesigns three core project processes: design, procurement and construction management. Such model is mapped out and assessed by evaluating its critical inputs, critical activities and critical interfaces of design, procurement and construction management processes. The proposed model therefore, creates improvement in three phases:

(i) conceptually, it addresses BPR model dimensions and their relationships;
(ii) identify process weaknesses; and
(iii) improve weak identified processes and improve redesigned processes in a continuous way.

1.2 Problem Statement

In Tanzania, construction projects suffer from unsatisfactory performance in duration, cost, quality and safety (MoW, 1977; Bjorklof *et al*., 1992; Baradyana, 2000; MoW, 2003; Samson, 2003; Mamiro and Kasuwi, 2005; Mawenya, 2011; Ngowi, 2014). The performance problems are caused mainly by weak project processes (Muhegi, 2007; Ntyakunze 2011). Design documents are incomplete, not accurate, and inconsistent with other tender and contract documents. Likewise, procurement processes and construction management are weak and lack innovation (MoW, 2003; Mlinga, 2005; Kasuwi and Mamiro, 2005; Kato, 2014). Procurement lack appropriate planning and the methods are rigid and create chance of selecting an incompetent contractor. Construction management processes may have weaknesses in resources acquisition and management and poor quality delivery of the work (Msita, 2001; Joseph and Haule, 2008). Therefore, design, procurement and construction management processes may have weaknesses that lie in their: 'critical inputs', (e.g. incompetent manpower, unbalanced workloads to the employees etc.); 'critical activities' (e.g. scope management problem, weak methods adopted amongst others), 'critical interfaces' (e.g. unrelated task's deliveries i.e. work task delivery and approval problems) and weaknesses in ‘administrative/control processes’. Administrative processes may be weak in terms of selecting and adopting process innovation such as project delivery option, flexible contract type, constructability, work progress management, amongst others).

Efforts have been made to solve these problems, they include: coaching and training local firms, dividing large projects into small lots to allow small and medium local firms participate in the project shares amongst others (Muhegi, 2007; Mukama, 2005; Mlinga, 2005; Mawenya, 2011). While these efforts concentrated to prepare and organize resources on the activities of the construction industry at predetermined levels, they have not brought satisfactory results partly because they may not specifically address the project processes weaknesses.

Process improvement has been achieved elsewhere (in manufacturing and in construction industries, in the United Kingdom, in the United States of America amongst others) by embracing BPR philosophy. BPR philosophy helped to: identify weak processes, redesign them into improved processes. Beyond this radical change, BPR also advocates for continuous improvement of the redesigned processes in UK and USA amongst others (Caron *et al.*, 1994; Robison and Ullah, 1996; Pearman, 1999; Riley and Brown, 2001).

The existing BPR models in the literature have several weaknesses. They are not exhaustive of all core and critical construction processes (Allweyer *et al.*, 1996; Riley and Brown, 2001). Many existing models are inclined to manufacturing and services businesses that need re-working on their adaption (Guimarae, 1998; Amrita and Sheriff, 2016). Indeed, the existing BPR models only identify steps to be followed without the specifics of how to go about, and also the steps are repetitive (Davenport and Short, 1990; Zigiaris, 2000; Vakola and Rezgui, 2000).

This research is therefore set to improve project performance through BPR philosophy. It would thus consider all ‘core project processes’, and provide specific details on how to go about (redesign the processes). Moreover, it will develop indicators for identifying weaknesses in project processes.

1.3 Objectives

The objectives of this research are categorized as main and specific objectives as follows:

1.3.1 Main Objective

The main objective of this study is ‘to develop a model that undertakes a BPR to improve construction project performance in Tanzania’.

1.3.2 Specific Objectives

The main objective was accomplished through the following specific objectives:

i) To formulate a BPR conceptual model for improving ‘project processes performance’;

ii) To analyze indicators that identify weaknesses of project processes and their performance;

iii) To formulate strategies for achieving improved ‘project processes’; and

iv) To analyze components of a model for undertaking BPR.

1.3.3 Scopes of the Study

This study deals with public project processes performance in Tanzania. It focuses attention onto improvement of three core project processes: design, procurement and construction management through assessing their critical inputs, critical activities and critical interfaces processes deployed by public clients, consultants and contractors.

1.4 Significance of the Study

In Tanzania, public construction project processes are performed poorly. They are poorly planned, executed, checked and controlled (MoW, 1977; Mamiro and Kasuwi, 2005; Ngowi, 2014). This research aims at contributing knowledge by developing a BPR model to be used to improve 'project processes' performance. The BPR model is expected to provide the structure for enhancing and improving 'project processes' management, and providing strategies for 'continuous process improvement'.

A developed model constitutes 'indicators' that are used to 'assess design', 'procurement' and 'construction management' processes through examination of their 'critical inputs', 'critical activities', and 'critical interfaces'. These 'indicators' would be used by each contracting parties (client, consultant and contractor) to assess and improve design, procurement and construction management processes.

When a 'BPR model' is implemented, individual contracting parties (clients, consultants and contractors) would be able to evaluate design, procurement and construction management on identifying 'process weaknesses' and improve overall 'project process performance'.

In addition, based on the concepts addressed in the parameters of the BPR model, policy makers in construction industry, for example, Ministry of Infrastructure Development (MoID), National Construction Council (NCC), Engineers Registration Board (ERB), Contractors Registration Board (CRB) amongst others together with construction project implementers such as clients, consultants and contractors may benefit by extracting information for making up their policies and the implementation actions towards 'project process' performance improvement.

With the aforementioned concepts, result is a BPR model developed, indicators developed, a BPR model implemented, and new knowledge is created.

1.5 Thesis Structure

This thesis is organized into seven chapters, on which, the contents are outlined in Figure 1.1. From this Figure, a respective Chapter and the headings that form the thesis theme are outlined. Summary descriptions of the contents follow:

Chapter One comprises of background information, research problem and objectives. Significance of the study and the thesis structure are also provided in this Chapter.

Chapter Two reviews relevant literature that is organized into two parts. It reviewed construction industry performance in Tanzania and in process performance measurement. Process performance measurement is also divided into four parts: (i) project performance in general (ii) BPR philosophy (iii) process measurement and (iv) organizational processes.

Chapter Three formulates a BPR conceptual model based on the critical review and evaluation of the relevant literature. Five reviewed areas that guided the development of the BPR conceptual model come from: local construction industry performance, process performance measurement - project process performance, BPR philosophy, process measurement and organizational processes.

Chapter Four presents the methodology adopted in this thesis. Data collection tools, sampling, methods and data analysis are discussed. Research approaches (i.e.

combination of qualitative and quantitative methods) that linked with the research objectives of the study have been covered in detail.

In Chapter Five, data presentation, analysis and findings along all specific objectives are discussed.

Chapter Six presents BPR model development and validation. A developed BPR model is compared to the conceptual model and a traditional project performance.

Chapter Seven presents conclusions and recommendations.

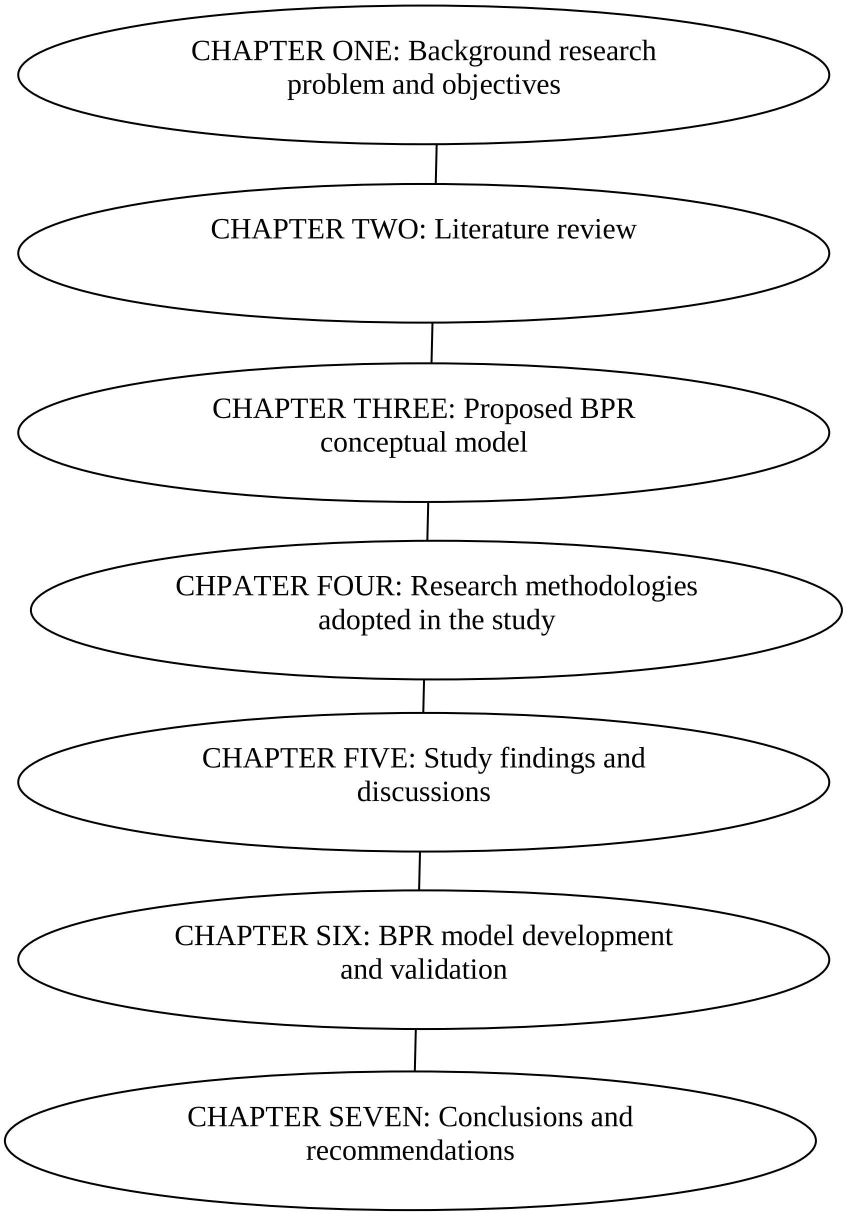


Figure 1.1: Thesis Structure

1.6 Chapter Summary

Chapter One outlined the background to this research including the problem statement, objectives, scopes and structure of the research. Next Chapter reviews and discusses the literature pertaining to the study.

CHAPTER TWO

TANZANIAN CONSTRUCTION INDUSTRY AND BPR PERFORMANCE

2.1 Introduction

Chapter One has presented the background to this research. This Chapter reviews and evaluates relevant literatures that are used in the current study. The reviewed work is organized in two parts. Firstly, performance trends of Tanzania construction industry that is organized in four sub themes: (i) the importance of construction projects (ii) projects processes performance trends (iii) performance trends of three main contracting parties and (iv) efforts tried by the construction industry's regulators to improve performance. Secondly, process performance measurement, divided also in four sub-themes: (i) project process performance in-general (ii) BPR philosophy (ii) process measurement and (iii) organizational processes.

2.2 Performance of Tanzania Construction Industry

The performance of the Tanzania construction industry is examined in the sections that follow:

2.2.1 Performance Significance of Construction Projects

In Tanzania, construction activities take a large proportion of the Government budget from the ministries responsible for social economic development. In the year 2011/2012 for example, the financial budget set by the Government for the Ministry of Infrastructure Development responsible for construction was 20.6% (MoF, 2013). This amount was higher than that for all other ministries. Notwithstanding, even the development budgets given to other ministries such as: education; agriculture; water; health; science, communication and technology; transportation; defence; energy and mineral amongst others, have large proportions that go to infrastructure construction projects. These ministries engage in different construction projects: schools, hospitals, dams, irrigation schemes, water supply systems, railways, airports, harbours, godowns, amongst others. This information is indicative that the huge amount of Government money is used yearly for public project accomplishments, therefore, project performance improvement study is crucial.

2.2.2 Projects Performance Trends in Tanzania

As it is the case worldwide, the construction projects' accomplishments in Tanzania are measured using three key indicators of time, cost and quality. Time is referred to as 'the time incurred to execute a task/activity, or duration to accomplish overall project'. Cost is 'the fund incurred to execute a task/activity, or, a project as a whole'. Consequently, quality concerns 'conformance to requirements'. Such indicators were, and are still used to assess construction projects performance in the country from the time the country got independence (i.e. 1961) up to now. Projects performances measured by these indicators are described as follows:

In the 1960s, and the period thereafter, studies report shortage of documentations that describe project performance in the country (MoW, 1977; NCC, 1984; Bjorklof *et al.,* 1992). The Little available and accessible information maintains that the construction industry was characterized by uncertainty in the availability of resources (materials, equipment and manpower) thus resulting in very poor quality of work and low productivity (Bjorklof *et al.,* 1992).

During this time, projects execution was shifted from the hands of British colonialists to the indigenous firms that were dominated mainly by the public institutions (MoW, 1977; Bjorklof *et al*., 1992). As was the case, these institutions received subsidies from the government, and they failed to support themselves in terms of building and sustaining their own capability. As a result, poor project performances prevailed, in terms of time, cost as well as quality (NCC, 1984; Bjorklof *et al.,* 1992; Lema *et al.*, 1992; NCC, 1997).

Further, projects' performance studies conducted from 1976 to 2001 by researchers indicate the same trend of poor performance as indicated by both the Schedule Performance Index (SPI) and the Cost Performance Indexes (CPI) (see Table 2.1). In the Table, SPI represent the 'ratio of actual project performance duration against the planned project performance duration', and CPI represents the 'ratio of final project cost sum against the award project contract sum'.

Table 2.1: Mean Schedule and Cost Performance Indexes of Projects Executed From 1976 to 2003

s/n	Authors	Study period	Number of projects studied	Mean Schedule Performance Index (SPI)	Mean Cost Performance Index (CPI)
01	Lema and Mutabazi (1988)	1976 – 1985	31	2.88	1.79
02	Baradyana (2000)	1978 – 1998	132	2.42	1.55
03	Samson (2003)	1995 – 2001	30	1.60	1.39

From Table 2.1, it can be learnt that, in all three study periods, both SPIs and CPIs improved as the values decreased from (mean SPI of 2.88, in 1976 to the mean SPI of 1.60, in 2001 and mean CPI of 1.79 in 1976, to the mean CPI of 1.39 in 2001). However, these values did not reach the optimal level of improvement needed for the mean SPI and the mean CPI of 1.0 or below. Moreover, the mean SPI and the mean CPI reported here represent only 194 projects for a period of 25 years out of many projects accomplished during that time. Undocumented projects might have larger values of mean SPIs and mean CPIs. As for quality, there is no documentation about how quality was compared.

In addition to information presented in Table 2.1, the period after 2001, different studies indicated poor project performance in terms of the same indicators as follows:

i. Nine [9] public funded projects were studied in a period between 2001 to 2005 and recorded the time overrun, cost overrun and dissatisfactory quality standards (Mamiro and Kasuwi, 2005);

ii. In 2006, out of 93 audited councils, 41 (44%) failed to manage contracts properly, and in 2007, out of 79 audited councils, 56 (71%) failed to manage contracts properly resulting in unsatisfactory use of the government budget, time delay and poor quality standard (KAPSEL, 2007 and ITECO, 2006 in Digaga, 2010);

iii. In 2008, some public projects were studied (number not established), where, 35% did not achieve the time, budget and quality standard targets (Kangwaya, 2008);

iv. For a period of eight years (i.e. from the year 2005 up to the year 2013), TANROADs reported that 65 (68%) projects out of 93 performed poorly in terms of agreed duration, budget as well as quality standard (Ngowi, 2014).

v. In 2014, factors for assessing project management practices (including schedule, budget and quality) were used to assess only two road projects, where, one project was completed within time, budget and quality against the other project (Amasi, 2014).

Generally, projects performance trend in the country indicate unsatisfactory performance mainly related with time overrun, cost overrun as well as unsatisfactory quality work. The review of these problems suggests that they are caused by all three main project parties.

2.2.3 Performance Trend of Public Clients

In Tanzania, public clients in type (and number) are Ministries; (26), Regions (21), Agencies (35), Parastatal Organizations (102), Local Government Authorities – District towns, amongst others. Available reports indicate that most of these institutions, when implementing projects, they fail to adequately define needs of the intended facilities, thus, resulting into poor scope definition (NCC, 1984; Msita, 2001), delay payments (in time) to contractors and consultants (Mamiro and Kasuwi, 2005; Joseph and Haule, 2008), fail to manage projects contracts appropriately (Ngowi, 2014) amongst others.

In the year 2008, Public Procurement Regulatory Authority (PPRA), the institution responsible for regulating the performance of the Procuring Entities (PEs) carried out procurement audits in twenty (20) PEs. The audits were carried out by the consultant, Kilimanjaro International Corporation limited (KIC) of Tanzania. Thirteen indicators were established and used on the assessment on whether they were complaint. They include: establishment and composition of tender boards, functionality of tender boards, advertisement of bid opportunities, publications of awards, method of procurement, time for preparation of bids amongst others. The PEs studied include: two Ministries, nine local Government Authorities, and nine Parastatals/Agencies/Independent departments. In results, out of thirteen studied indicators, nine (69%) performed below the target level (PPRA, 2008). The report further indicates that only four of the PEs (31%) performed as per requirements of the PPRA.

2.2.4 Performance trend of Contractors

The CRB is an institution responsible for regulating contractors' performance. It therefore established means of evaluating annual return forms (usually assessed by both the clients and the contractors) to establish contractors' performance gap. The data sought helps CRB and any stakeholders understand the problems facing contractors in the country, and therefore, work out development strategies and plans (Muhegi, 2003). The data studied by the board include: work opportunities of the contractors, manpower, equipment and plant, financial position, value of work a contractor has executed during a respective year (turn over), corruption, amongst others. Using this CRB source of information for the year 2011, problems facing contractors are expressed in percentages (Muhegi, 2011): difficulty in accessing loans/credit facilities (57.2%), high price for construction materials (56.1%), stiff competition for work opportunities (55.4%), retention of skilled employees (53.6%), small capital base (53.6%), high taxes for imported materials, delay in payment from clients (48.4%), equipment being not readily available/high hire rates (46.9%) and corruption, favouritisms, bureaucracy in procurement (40.6%). Three of these problems: finance, equipment and manpower are further discussed as follows:

- Financial problem: inability of the contractor to advance project, hence fail to raise first certificate. When contractors wish to solve this problem by borrowing in the banks or other institutions, they lack sufficient collateral to qualify for the loans (Laswai, 1998). As a result, they lack work opportunities. In addition, when contractors secure small and medium projects, they face difficulties to manage cash flows, thus, creating project delays (Byabato and Addo-Abedi, 2004).
- Equipment problems: Laswai (1998) quoted a survey conducted in 1995 by PEHCOL (a government owned plant and equipment hire company) determining that more than 40% of equipments stand at poor to scrap. Persistence of equipment problems to contractors still prevail (Muhegi, 2003; Byabato and Addo-Abedi, 2004).
- Manpower problem: the problem of manpower in contractor organization is viewed in three perspectives. Firstly, unavailability of technical personnel, and those who are available are overcome with large amount of work roles (Hallway, 2001). Secondly, lacking business skills to help firms create vision of their businesses (Addo-Abedi, 2006). Thirdly, few contractors take construction business as full time occupation; many of them undertake construction work as an extracurricular activity (Laswai, 1998, pp. 106). As a result, full control of operations is missing.

In addition, CRB has also been visiting contractors' sites routinely to study the extent to which contractors adhere to safety, provision of hoarding and the general accountability. Site visits to the contractors (cited here) were conducted for nine years from the year 2002 to 2010 (Table 2.2). This Table provides substantial values of shortfall performance of the studied contractors, ranging from 22% to 55%. As the Table 2.2 indicates, these values raised from 21.6% in 2007 to 38% in 2010 indicating an increase in inadequate performance. It can be summarized that the shortfalls are caused by the incapability of performance of the contractors.

Table 2.2: Contractors' Conformance to Site Works for a Period from the Year 2002 to 2010

Years	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Number of sites visited	308	675	759	785	1096	1251	1588	1760	2111
Compliant sites	140 (45%)	346 (51%)	540 (70%)	478 (61%)	764 (61.5%)	980 (78.4%)	1122 (70.5%)	1235 (70%)	1307 (62%
Sites with shortfalls	168 (55%)	329 (49%)	219 (30%0	307 (39%)	422 (38.5%)	271 (21.6%)	468 (29.5%)	530 (30%)	805 (38%)

Source: (Muhegi, 2011)

2.2.5 Performance Trend of Consultants

Consulting firms are responsible for designing and inspecting the works. Their performance problems are divided into three parts as follows:

i. Technical manpower problem: the firms created and continue creating inappropriate designs, thus, causing: mistakes, errors and omissions of the construction documentations (NCC, 1984; Msita, 2001; Mamiro and Kasuwi, 2005; CRB, 2008). The problem is attributed with the lacking of competent and experienced designers (Msita, 2001), they also lack partnering skill (Hallway, 2001);

ii. Managerial skills: a problem relating to their tendency of paying occasional visits to the sites (Hallway, 2001), individual employee assigned work above own control (overloads), poor work control and coordination (Mwamila and Mkamba, 2001; Mamiro and Kasuwi, 2005; ERB, 2018). Firms also lack appropriate organizational structures (Mushi, 2007);

iii. Business skills: problems of defining their in-house operations that can be caused by lacking of leaderships, partnering skills and contracting skills (Hallway, 2001; Addo-Abedi, 2006; Joseph and Haule, 2008; Seng'enge, 2011; ERB, 2018).

2.2.6 Causes of Time Overrun, Cost Overrun and Poor Quality

Critical review of the performance trends of these contracting parties reveals that their performance problems create time overrun, cost overrun and poor quality of projects.

Time overrun in the project performance caused by the actors involved. Contractor delaying in supplying respective resources in the work site, thus, a work will be delayed. A party, mainly, either a consultant or a contractor deploys incompetent personnel; as a result, he/she produces fault jobs. **Cost overrun** is caused by inadequate planning, deficiencies in the initial estimates which occur both in the part of client and contractor. Other extra costs are caused by fluctuations in materials, labour and equipment costs. **Poor quality** of the work is caused by shortage of qualified and experienced staff. For example, for consultants, incompetent manpower provides unclear and sometimes verbal instructions that worsen work quality. Poor quality may also be caused by adopting outdated technology.

The poor performance of three main contracting parties is summarized in Table 2.3. The attributes given in this Table outlines specific weaknesses within the respective contracting party. As such, they can be directly linked with the facets of improvement.

Table 2.3: Performance Problems of Tanzanian Contracting Parties from 1977 - 2014

Clients	Consultants	Contractors
Lack of proper guide to select competent consultants	Inappropriate designs, thus, creating: mistakes, errors, omission of some detail works	Low payments to the employees, also sometimes such payments are delayed
Give poor briefing of the works	Delay to approve work without proper reasons	Lack of working capital
Delay payments to contractor	Lack of transparency	Have cash flow problems
Call tenders before ensuring availability of funds	Provide verbal instructions, that cannot be referred in future	Difficult to retain skilled personnel for a long time
Excessive bureaucracy in procurement	Sometimes, do not pay visits to site works as required	Equipment breakdown, new or used equipment not available
Inadequate supervision of works	Do not study early project issues in sufficient detail	Not adhering to occupation and safety, health administrative
Create unnecessary variation of the works	Create unnecessary variation of the works	Few works opportunities
Short term goals	Lack of business skills	Lack of business skills
Lack of organization structure	Inadequate management skills	Little attention to study critically the contract condition
Poor recording systems	Lack of access to finance	Lack of access to finance
Lack of planning and control on the finance	Predominate short term goals	Predominant short term goals
	Lack of appropriate documentation systems	Lack of appropriate documentation systems
	Favouritism	adopt old technology
	Based on old technology	Lack of experience

Generally, performance trends of all main project participants (clients, consultants and contractors) display the following characteristics: inadequate planning, a*d hoc* process, weak adoption of IT in their processes, inadequate procurement delivery processes, weak capital and cash flow skills, lack of innovation and entrepreneurship skills, lack formal organization structures, and lack of work commitment culture. Therefore, people competencies, finances, IT technology, structures, visionary ideas, strategy amongst others are problem areas the contracting parties have been failing to overcome.

Despite the performance problems that prevail in the construction industry, some efforts were made, and are discussed in brief in the section that follows:

2.2.7 Efforts Made by the Tanzanian Construction Industry's Regulators

Some efforts were made to improve performance, and the notable results are outlined as follows:

i. Large projects were, or, are split into small lots, to allow many local firms to obtain project shares (Mlinga, 2005). A small lot might help local firms to secure a job, and also, deliver quality jobs by such parties. This effort helped to provide experience and capability to promote growth of the local small firms;

ii. Building capabilities of many fresh graduate engineers through development and adoption of Structured Engineers Apprenticeship Programme (SEAP) established by ERB. The effort reduces problem of lack of skills, shortage of qualified engineers, amongst others;

iii. Provision of short courses, seminars and workshops to the practitioners of the construction industry and other stakeholders, made by ERB, CRB, NCC amongst others. This effort helps to provide skills development in various aspects – entrepreneurial, management, finance, amongst others;

iv. MoW had one of its objectives stipulated in the construction industry policy (of the year 2003) to enable local consultants and contractors to undertake most of the entire construction project shares by the year 2012. Although the target was not met at a hundred percent, the effort helped to raise the share of securing projects by local firms from 10% in 1998 to a range of 30% to 40% in a six years period 2005 - 2011 (Muhegi, 2007; Mawenya, 2011).

v. CRB established the Contractors' Assistance Fund (CAF) in 2002 and has already issued a total of Tanzanian shilling eight (8.0) billion to serve a total of 653 members (Muhegi, 2011). These efforts, despite some challenges of delay to return the funds by some contractors, other colleagues were benefited.

These efforts are seen to have created some specified benefits. However, the problems of poor performance still persist, and projects continued to be executed, so something is missing. The Process needs to be improved: critically evaluated and drastically changed/improved for better performance.

In summary, project performance in the country record poor performance in time overrun, cost overrun as well as poor quality standard. Three main contracting parties involved in the accomplishment of these projects also perform below expectation. Moreover, despite several efforts made by the construction industry to improve performance, problems still persist. This study has the view that, the problem in this research is the 'process management' – project process management viewed in two parts, firstly, on 'a process perspective' and secondly, on the side of 'the contractor', 'the client' and 'the consultant'. Therefore, concepts of process performance measurement can be a useful guide of improvement.

2.3 Process Performance Measurement

Process performance measurement concepts are widely discussed in literature (Mari, 2005; IS Consulting, 2008; Harvey, 2008; APQC, 2010). It represents means in which a firm or business establishes its performance measures to assess results, production and operative efficiency to meet objectives intended (Griffith and Watson, 2004; Mari, 2005; Tupa, 2010). In this study, concepts of process performance measurement are put in four perspectives: project process performance in-general, BPR philosophy, process measurement and organization processes. Discussions follow.

2.4 Project Process Performance

2.4.1 Project Defined and Decomposed to Foster Process Understanding

According to a Project Management Institute, Project Management Body of Knowledge (PMBOK) (2000) project is defined as a temporary endeavour undertaken to create a unique product or service (i.e. it has defined start and end), uniqueness, consume resources and must have a goal to be realized. Every construction project is executed through processes, including feasibility studies, design, procurement, construction, maintenance and operation (Bennett, 2003; Halpin, 2006). In order to establish means of managing project performance - researchers use different terminologies interchangeably - processes, stages, activities or phases (Atkin, 1998; Wu *et al*., 2000; Torbett *et al*., 2001). The terminologies have been used to represent perspectives in which project performance can be realized (see Table 2.4). In this Table, the author(s) identify specific project activity or tasks to execute a project. Consistent terminologies to be adopted here come from Harrington (1997) who regards project process at the macro level, decomposed down to processes, sub-processes, activities and tasks (detailed level).

Table 2.4: Projects Processes and the Contained Activities/Stages from Previous Studies

Researchers	Projects processes' activities/stages
Torbett *et al*. (2001)	Project design process: has two activities/stages – firstly, schematic designs and secondly, detailed design and component specification
Fabricio *et al.* (1999)	Project design process: cover five activities/stages - firstly, project planning, secondly, conception of the product, thirdly, development of the product (scheme design, permit design, pre-executive design, executive design and production design), fourthly, the design 'as built', and fifth, a final client's satisfaction assessment.
Atkin (1998)	Full project cycle: - have the activities/stages: inception, briefing, feasibility, concept design, scheme design, detail design, tender documentation, estimating and tendering, evaluation of tenders and construction.
Halpin (2006)	Full project cycle: constitutes of the activities/stages - establishing the need, conceptual design, approval of the conceptual design, preliminary and final design, prepare to completion the bid package and the construction works.
Kagioglou *et al*. (1999) and Wu *et al*. (2000)	Full project cycle: have the activities/stages - pre-project [demonstrate the need, conception of need, outline feasibility, substantive feasibility study and outlining financial authority], pre-construction [outline conceptual design, full conceptual design, coordinated design, procurement and financial authority], construction [production information, construction] and post construction [operation and maintenance].
Lema (1995) and Bennett (2003)	Full project cycle: have the activities/stages - pre-project, planning and design, contractor selection, contractor mobilization, fieldwork (construction) and project closeout and termination.
Ducan (1996)	Full project cycle: have the activities/stages - feasibility study, planning and design, production (construction) and turnover and maintenances.

Information in Table 2.4 provides two important results that help to design project process performance. Firstly, it provides knowledge of project decomposition. A project is firstly viewed as a project process (macro level), decomposed to the middle levels (processes, sub-processes) and detailed level (activities or tasks). At each of these levels, one understands the work scopes in terms of the work contents and their interfaces (Harrington, 1997; Wu *et al.*, 2000). Therefore work become more understood and managed while it is on detailed levels than it is on middle or in a macro level. Secondly, the core project processes represent design, tendering/procurement and construction management. They are regarded as the core processes due to two reasons (i) their scopes may be drawn to cover overall project cycle. For example, decisions to incorporate feasibility study activity during design stage, and decisions to incorporate maintenance activity in the construction management may be made or not depending on the preferences, and (ii) the three processes are widely accepted by many researchers (see Table 2.4 and Figure 2.1, work of Kwakye, 1997, amended).

Although a sub-process is considered at a higher level than the activity in terms of hierarchical listing, what matters is the understanding of the scopes (Harrington, 1997). In this study the ‘activity’ would be preferably used. Thus, the activities constituted in two core processes, design and construction management are outlined. Design process has three activities – preliminary design, schematic design and detail design. Construction management has seven activities – site lay out, resource planning, resource mobilization, work implementation, quality control, budget control, duration control and safety control. Procurement adopts different divisions, it has three elements: – project delivery option, contract type and procurement option and has three activities: advertisement, evaluation and negotiation.

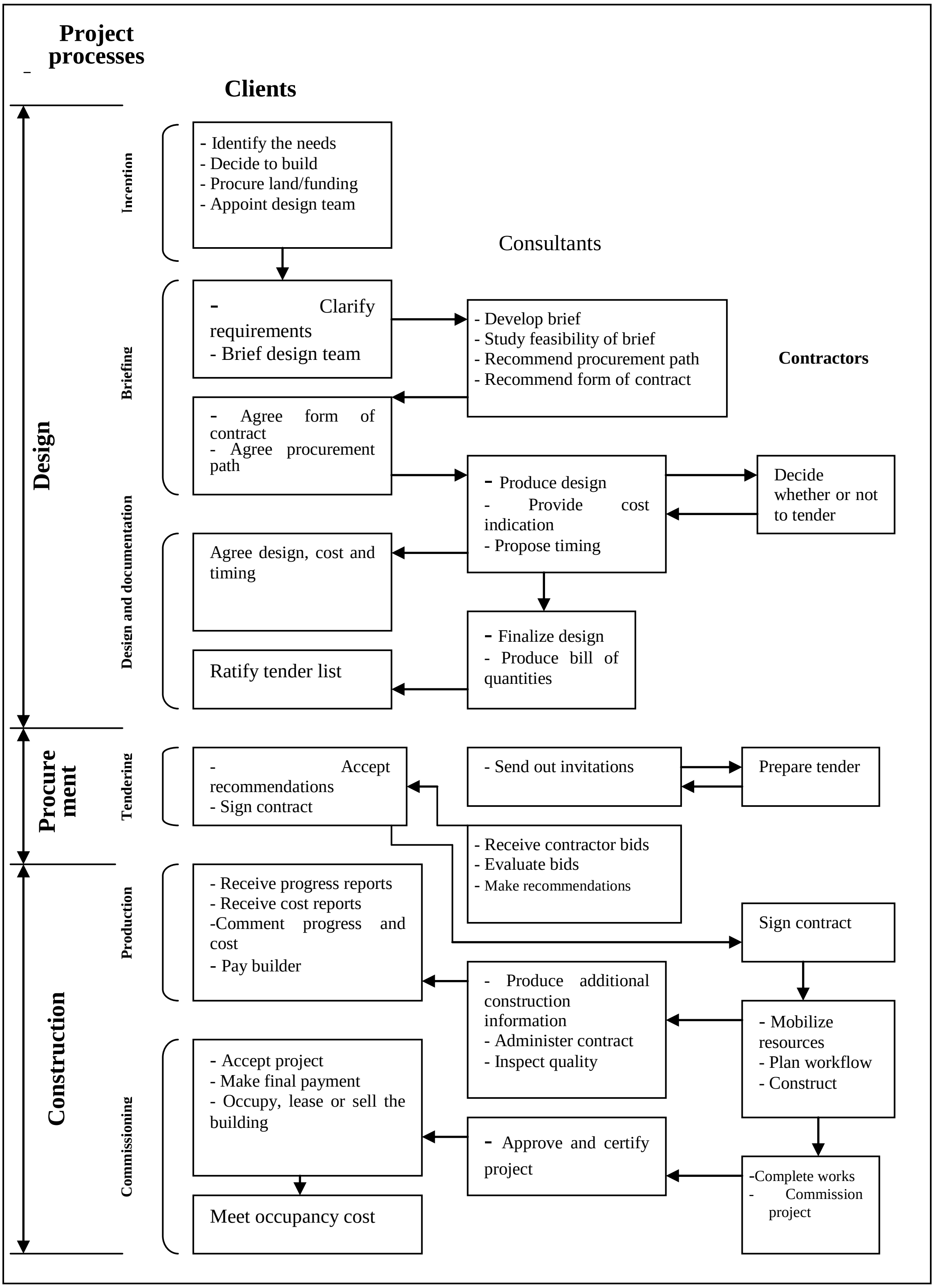
The knowledge of project process decomposition helps identify core project processes and the activities contained in. When the activities are understood, evaluation of their methods for their execution would be possible (Jackson, 2010). This is followed by the decision of resources planning, acquisition, deployment/assignments and management (Fabricio *et al.*, 1999; Halpin, 2006) initiated by the contracting parties (Bennett, 2003). Three main contracting parties and their roles are described.

2.4.2 Main Contracting Parties and the Project Roles

The roles of three main contracting parties (clients, consultants and contractors) are well explained in Austen and Neale (1984), Lema (1995), Kwakye (1997), and Halpin (2006) and are well summarized in Figure 2.1. From this Figure, a project process and the actions to be effected by the main contracting parties are interlinked to ease in project procedures and operations. Main roles of contracting parties are outlined:

- Client procures a consultant to design and supervise the construction works;
- Consultant is contracted by the client to design and supervise the construction work while also advising client accordingly; and
- Contractor contracted by the client to execute project works under supervision of consultant.

Each contracting party may engage with own roles and improve all three core project processes under the contained activities: design processes, procurement process and construction management processes.



Source: (Kwakye, 1997, pp. 5)

Figure 2.1: Construction Project Activities and the Parties Involved

2.5 Business Process Re-engineering (BPR) Philosophy

2.5.1 General Concepts and Motivations

The basic concepts of the BPR philosophy are introduced here to enable new users of this philosophy (i.e. the local practitioners) to familiarize themselves with it, appreciate its potential, learn how to use it and possibly benefit from it. Therefore, in the subsequent sections, BPR concepts are organized as follows: definition and motivation are given, radical and incremental changes are explained in detailed, BPR implementation steps and the BPR models in construction industry context are also explained.

2.5.2 BPR Definitions

The BPR is well defined in Davenport and Short (1990), Manganelli and Klein (1994), Caron *et al*. (1994), Grover and Kettinger (1997), Amoroso (1998), Zigiaris (2000), Sidwell *et al*. (2002), Patel (2005) and Ursic *et al*. (2005). A BPR definition made at the perspective of the current study is adapted from Ireland (1994) with the four key terminologies:

- Fundamental rethinking: understanding of the construction business, questioning the characteristics of the three contracting firms and their survival in the business, their current nature of operatives, what is their true future if they change the ways they conduct businesses;
- Radical redesign: - should the companies forget the old/usual way of working and think deep on the business processes;
- Dramatic: - striving to achieve quantum leaps in performance than small incremental changes;
- Looking on critical aspects to pursue a process's perspective, i.e. defining process – sub-processes, activities, tasks and their relationships that are focused under the inputs, methods and outputs model (Harrington, 1997; Susan, 2010).

Therefore, in this work, BPR is defined as ‘a process of fundamentally rethinking the ways projects are accomplished by the three contracting parties to radically change their processes, thereby, and dramatically, improving performance in terms of time, cost, quality and flexibility’.

2.5.3 Industrial Empirical Re-engineering Experience

Generally, there are high frequencies of adoption of BPR in the manufacturing sector (Childe *et al*., 1994; Strandhagen and Skarlo, 1995). Other sectors where reengineering has been practiced include: banks (Shin and Jemella, 2002) and education (Balaji, 2004; Kontio, 2007). Discussing one example of the use of BPR in manufacturing firm where it had been widely adopted, Joshi and Dangwal (2012) studied reengineering project in Multinational Corporation (MNC) that manufacture more than 200 products and distribute them to several continents with the intention to change and improve processes operations. By investigating the established success factors, that include: interaction between operations, managing scopes, re-examination and management of human resources, communication, times requirement, operational costs and quality standard needs, the corporation managed to improve operative efficiencies at an average level of 50% instead of 25% targeted and managed to produce products and transport them to the end points in two months’ time compared to six months’ time before re-engineering.

BPR philosophy was also adopted in the construction industry, although, not at a satisfactory level. BPR themes in construction exist in literature rather than in practices (Betts *et al*., 1997). These authors question existence of the re-engineering concept ‘discontinuous thinking’ necessary for traditional managers to question ‘why certain task need to be done in the first place’ is not satisfactorily deployed in construction practices. The BPR themes that benefited construction practitioners but have low rates of adoption include: focusing on a process view to drive-in the tasks and functions, work of managers became coaches, adoption of IT technology, and deployment of process mapping amongst others (Betts *et al*., 1997; Riley and Brown, 2001; Sommerville and Craig, 2006). The two reasons for this low rate of adoption are cited here, (i) number of re-engineering initiatives in construction have been established in previous investigations but the majority of them have not been implemented – indicating that the industry might be inherently resisting to changes (Sikazwe, 1999; Kagioglou *et al.*, 2000) (ii) the industry lacks systematic processes with collaborative processes that allow interaction of diverse process participants, and its improvement efforts are either not, or, are partly adopted (Sikazwe, 1999). Other researchers claim that the uniqueness of the industry is the cause of the slow rate of adopting re-engineering and other change initiatives (Sidwell *et al*., 2002). Despite these views, and, due to the importance of BPR results gained from manufacturing processes, Childe *et al*. (1994) and Magutu *et al.* (2010) suggest that BPR needs to be adopted with great care while linking the uniqueness of the processes within construction industry context (Amoroso, 1998).

2.5.4 Radical and Incremental Changes

(i) Radical Changes

Robinson and Ullah (1996) state that radical changes means to exercise revolutionary changes, targets major improvement through initiating rethinking of new ideas; thereby, discouraging discontinuous thinking. In order to explain stories of the radical change, well experienced firms who created radical changes are used as examples: In manufacturing firm within the United States of America, BPR reduced cost by 100% instead of 30% targeted; raised quality to 75% instead of 50% targeted, reduced cycle time by 100% instead of 50% targeted (Caron *et al.*, 1994; Manganeli and Klein, 1994; Muthu *et al*., 1999; Patel, 2005). A multination corporation in Europe managed to improve operative efficiencies at an average level of 50% instead of 25% targeted and managed to produce products and transport them to the end points in two months time compared to six months time before re-engineering (Joshi and Dangwal, 2012). In the construction industry remarkable radical change was found in documentation. BPR increased work efficiencies, reduced project costs, project duration amongst others (Ireland, 1994; Grover and Kettinger, 1997; Brown and Riley 2000; Sidwell *et al.,* 2002).

Some researchers further urge that radical change improvement may even go up to 3000 percent (Mangalline and Klain, 1994 pp.7). These results attract attention of the firms that need to improve their processes.

In order to achieve radical changes, the three approaches/techniques are important. These include: benchmarking, IT and creativity.

(a) Benchmarking

The firm learns the strengths and weaknesses of processes of the firms against the best practice. Five steps can then be adopted (Flower, 1993; Costa *et. al*., 2005; Zairi, 2005): (i) assess strengths and weaknesses of the internal operation (ii) assess strengths and weaknesses of the competitors (iii) analyze to isolate best practices (iv) incorporate best practices by making modification and (v) gain superiority.

(b) Creativity and Innovativeness

Creativity is all about synthesizing new ideas and concepts by radical restructuring and re-association of the existing one (Heap, 1989). It can be achieved through:

i) visioning, role-playing, storytelling and assumption listing (McFadzean, 1999);

ii) team working, imagery, brainstorming and mind mapping (Roffe, 1999); and

iii) 5W/H (who, what, when, why, where and how) techniques (McAdam, 2003).

(c) Information Technology (IT)

IT has technology referred to as the ‘IT technology’ (Rivard, 2003). It uses various perspectives to improve project performance, including: using several machines and programmes for processing, storing, transferring and presenting information. It is also used as database to sort and speed searching for information amongst others.

(ii) Incremental Management Techniques

The incremental management techniques are widely discussed in literature, they include: TQM, Kaizen, JIT and Lean amongst others. They are characterized by the evolutionary changes which are low risk, easy to manage and less disruptive in the short term (Childe *et al.,* 1994). The improvement changes are below 10% (Grover and Kettinger, 1997; Muthu *et al*., 1999; Al-Mashari and Zairi, 1999; McAdam, 2003).

With regard to radical or incremental change, each occurs subjectively or quantitatively. Subjective change involves for example, changes in quality or in safety standards. Quantitative change is based on reduction of statistical values, e.g. time or cost in numbers or percentages (Caron *et al*., 1994).

2.5.5 The BPR Implementation Steps

The BPR implementation steps were reviewed and evaluated with the view that they can be used to improve problems of construction projects in Tanzania. Therefore, in this work, the work of five authors are summarized in Table 2.5. The authors include: 1- Davenport and Short (1990), 2 - Manganelli and Klein (1994), 3 - Muthu *et al.* (1999); 4 – The US Department (2006), and 5 - Tsalgatidou (2008).

Table 2.5: Synthesizes of BPR Implementation Steps Models

s/n	1	2	3	4	5	Adapted step	Reason for adaption
i	Develop vision and strategy	Preparation	Prepare for BPR	BPR planing	Understand and measure the current process	Understand and identify process	Two reasons: i.steps are generic, thus, they need to be streamlined for specific use ii. steps are repititive, they thus selected to bring one direction to be focused on
ii	Understand and measure the existing processes	Identification of processes	Map and analyze '**As-Is**' process	Create '**As-Is'**	Develop '**To-Be**'	Measure/ assess process to identify weaknesses	
ii	Identify processes to be reengineered	Vision/ desired process	Designe '**To-Be**' process	Research and benchmarking	Develop business vision		
iv	Identify the IT levers	Solution: technical and social design	Implement reengineered process	Develop future '**To-Be**' process	Conduct training	Identify '**To-Be**'	
v	Design and build a prototype	Transformation	Continuous improvement		Continuous improvement	Identify strategies for improvement	

From Table 2.5, it is agreed that initial step is preparation for undertaking the reengineering, therefore, it will require understanding of the process in its details including the work flows and resources. There is also agreement that in order to reengineer your processes you need to understand its current weaknesses. Given that you know the process weaknesses, what is required next is to establish the new process (**To-Be**) that match your vision/desired process. After the new process is known and established, next is establishing strategies of improvement adopted continuously.

In implemetation of these steps, Authors describe the flexibility available in two of the re-engineering implementation steps, identification of process weaknesses and the '**To-Be'** processes; you may decide either to identify current weaknesses and use them as a basis to establish the '**To-Be'** processes, or you establish the '**To-Be'** processes first and use them as a target to identify weaknesses (Manganelli and Klein, 1994; Pearman, 1999). Four steps are adapted in the current study as follows :

Step one: Understand and Identify Core Project Processes

The main business in construction industry is excecution of construction projects, as such, core business processes of these entities are linked to what they do when excecuting projects (Atkin, 1998). In a way core business process of individual firms are processes of any construction project; indeed, this research has identified design, procurement, and construction as core project processes. Any project process is understood by marking its interfaces - start, midle and the end points, together with the critical inputs, activities and their administrative/control process.

Step two: Identification of Weaknesses

When project process boundaries are identified, outlining the core processes, design, procurement and construction management; their critical inputs, critical activities and critical interfaces may be viewed where they perform negatively (Harvey, 2008; Jackson, 2010). They can also be checked on their perspectives of not delivering what a customer requires (Muthu *et al.,* 1999).

Step three: Identify Desirable (**'To-Be'**) Process Performance Level

This step is created based on the already identified process weaknesses (Manganeli and Klein, 1994), and, or creation of the new **To-Be** processes. '**To-Be'** processes are also termed as the desired processes, processes/events that seeks to meet the standard of performance or objectives of the firm (Pearman, 1999; McAdam, 2003; Ursic *et al.,* 2005). They can be identified through: creativity, brainstorming, IT technology, learning from best practices, amongst others (Mangalline and Klein, 1994; Al-Mashaari *et al.,* 1999; Pearman, 1999; Rivard, 2003; Ursic *et al.,* 2005; Suermann *et al.,* 2006).

Step four: Institute Re-engineering Strategies

Re-engineering strategies are efforts to meet the established desired (**To-Be**) processes (Robinson and Ullah, 1996; Muthu *et al.,* 1999). In order to meet desired (To-Be) process, the formulated re-engineering strategies ensure team is formulated, team is selected, best practice processes are studied through benchmarking studies, amongst others (Al-Mashaar *et al.,* 1999; McAdam, 2003; Zairi, 2005). The strategies also foster a changing culture of the employees (Zigiris, 2000) and afford continuous learning to help create radical changes of the processes in the firms (Oakland, 2003; Jackson, 2010).

2.5.6 BPR Models in the Construction Industry

Three models that have been used to reengineer construction project processes are selected and described as follows:

i) Allweyer *et al*. (1996) re-engineered the procurement of a construction project. The study investigated operations of the two European contractors during project planning and procurement process stages respectively. The model concentrated on assessing only selected important activities, and mapping out of the initial planning processes presented using the flowcharts. The map out process allowed involvement of all employees responsible for activity/process concerned, helping them to transfer the knowledge (Wyssusek *et al.,* 2001; Mayer and Dewitte, 1999). In addition, the mapped out processes became easy to be visualized in terms of the tasks that appear at the detailed levels, their boundaries, amongst others, which contributed to identify any irrelevant step, rigidity and flow of the work determined as the inefficiencies/weaknesses. Other weakness identified was persistent activities which are possible to be done in parallel fashion but were conducted serially consuming unnecessary efforts of time and other resources (Ireland, 1994).

ii) In mapping out the project process, the detailed task levels would be understood in terms of the scopes, resources (inputs) and procedure of the work. This helps core project processes to be understood that is part of improvement (Fryman, 2002). A model that incorporates views of constructability (by bringing-in a contractor) during design stage (Brown and Riley, 2000). In this model, the authors studied the Millennium bridge project in the United Kingdom procured after re-engineering the tradition procurement system. A brought-in contractor worked hand in hand with the design team where they shared views about the design issues (practicality of the method on which a design is to be implemented, cost estimated, duration estimated, material chosen etc.) that are ensured practicality of the work. The collaborative efforts of the brought-in contractor and design team provided significant savings in cost reduction and created quality of the work.

Incorporating constructability ideas prior to actual construction helps to share practicality ideas obtained from an experienced party (e.g. a contractor), thus avoids reworking that occur during actual construction (Stamatiadis *et al.*, 2012).

iii) A model that studied procurement process in the P Trant Limited, a medium-sized civil engineering contractor based in the United Kingdom (Riley and Brown, 2001). The aim was to explore reengineering techniques in a firm, by using two modelling tools (i) process oriented system design (POSD) and (ii) activity networks. POSD helped in understanding of the procurement process [at its high level) and its sub-processes: marketing, purchasing, contract management, construction and plant transportation and their relationships. Activity networks helped understanding of the sequences of activities, input-activity-output–input amongst others. Results encouraged changing culture, for example, in management positions on reorganization and agreed to implement IT as support process. Employees also were motivated by their involvement in the mapping process that helped them understand widely their processes.

This model described project procurement aspects of the contractor, it could not highlight information relating to other processes of the whole project, for example, design amongst others. However, ideas relating to mapping out of the construction related activity – procurement on its two levels of detail and macro level are useful lessons of the current study.

These models provide some notable results. They focus re-engineering activity on construction context. They provide tools such as flow charts and map out concepts that help employees to understand process critically, thereby, seeking improvement measure (Mayer and Dewitte, 1999; Zairi, 2005).

The models are gauged on their potentials to provide knowledge on how to re-engineer processes. Critical look at these three studied models, the first model reengineered the planning process of the project, the second model incorporated constructability ideas during design and lastly, the third model mapped out procurement process in the contractor organization. All of these models do not cover all core processes of the construction project (design, procurement and construction process) participated by all three main contracting parties (client, consultant and contractor). As such, the whole project performance cannot be improved. Reengineering study focusing to improve all core project processes is dealt with in this study.

2.6 Process Measurement and Improvement

Some authors establish that in order to improve a process performance, this must be measured by its three elements (Harrington, 1997; Oakland, 2003): (i) inputs that include people in terms of skills, knowledge, experience, just to mention a few; materials and equipment (ii) process that include organized activities, conversions of the inputs and critical focus into outputs (IS Consulting, 2008), and (iii) outputs that include: products, services just to mention a few. Outputs also include: productivity, budget served and operative time served (Griffith and Watson, 2004). In order to create more value into a process, process flow concepts is also introduced (Koskela and Sharpe, 1994; CURT, 2005; Hirano, 2008) which allow studying processes/activities on their boundaries also termed as interfaces. The four process elements: inputs, process/activities, interfaces and outputs are useful in process performance measurement of this study (Figure, 2.2).

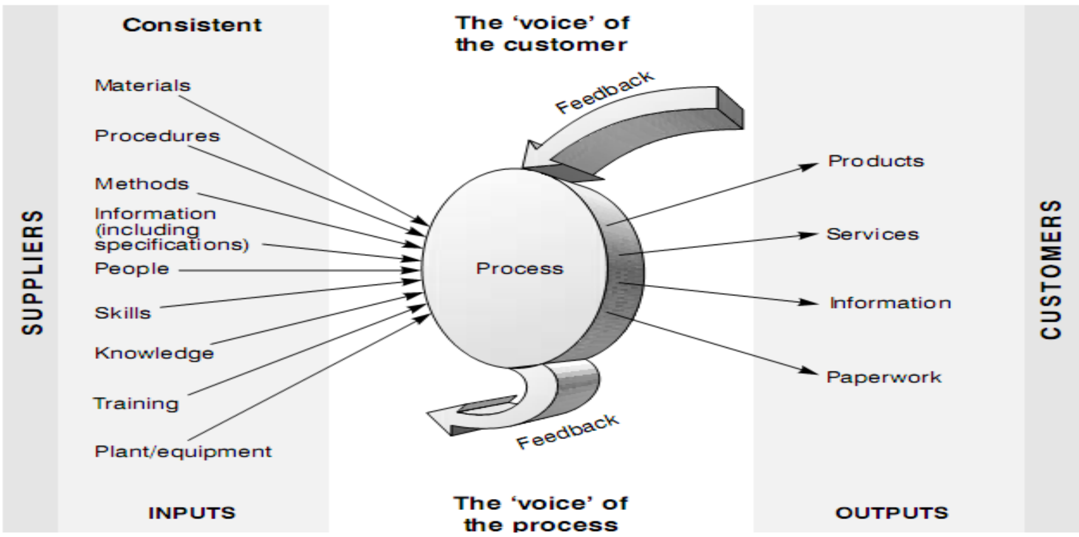


Figure 2.2: A Process (adopted from Oakland, 2003)

2.7 Organizational Processes

2.7.1 Overview

Organizational processes are processes that provide control of firm operative performance, e.g. resources, work environment against the guidelines/standards and the rules established (Mazda, 2000). They provide dimensions of the firm for ensuring realization of its overall goals (Marchand and Stanford, 1997). They can be put into two categories (i) administrative processes – such as organizational structure, strategy and people, and (ii) support/control processes – such as technology, communication, culture just to mention a few (Childe *et al.,* 1994; Childe *et al.,* 1995; Kettinger and Grover, 1997; Marosszeky and Oakland, 2006). Five organizational processes are selected due to their functionality of guiding BPR initiatives of this study. They are described as follows:

2.7.2 Organization Structure (OS)

OS is a means in which an organization assigns and control work roles and responsibilities for accomplishment of a task. It has two potentials, it: (i) provides foundations for standard operation procedures in the company and (ii) determines which individuals participate in decision-making; thus, shaping an organization's actions (Galos and Schein, 2006; Fiss, 2008). OS has the following functions:

i) It vests authorities to the firms decision makers (Mazda, 2000);
ii) In conjunction with a 'strategy', all activities in the organization are identified, named and described. Relationships of activities are identified according to their functionality;
iii) Workloads to employees are assigned and balanced, amongst others.

2.7.3 Strategy Deployment

Out of many definitions of strategy that exist in literature, one quoted here is 'the art of devising plans towards a goal' (Ulrwik, 1999; Formisano, 2004). It is adopted in the firm for different purposes, including, to: achieve desired competitive position, lower production cost, increase customer satisfaction, increase market share, deliver much more value to the processes, and improve quality amongst others (Mazda, 2000).

Strategy deployment is adopted through (Ulrwik, 1999):

i) Vision: defines an overall agreed goal of a firm, say, ten years (Mazda, 2000).
ii) Key strategies: is breaking a vision into achievable plan at around four or five strategies (Dosi *et al.*, 2000; Fiss, 2008);
iii) Strategic goals: specific, quantifiable and measurable goals (Dosi *et al.*, 2000; Fiss, 2008);
iv) Value: defining uniqueness, e.g. specific company culture (Ulrwik, 1999);
v) Policies: guides in managerial actions; and
vi) Deploy a goal: strategic goals set initially are converted into operational plans and projects/sub-goals, it has short term goal between 1 to 2 years, (Ulrwick, 1999; Dosi *et al.,* 2000).

2.7.4 Technology Adoption

Technology refers to the materials and processes used in transforming inputs into outputs (Dawson, 2002). This author adds other components as the skills, knowledge and labour that an organization possesses. Thus, technology has the soft and hard components, machinery and people or materials and operations and knowledge on the other hand. Gray and Hughes (2001) adds that technology has combination of accumulated scientific knowledge, technical skills, implements, logical habits and material products of people, information, logic, amongst others. Thus, every piece of work touched has aspects of technology.

2.7.5 Information

Information concerns the way message is conveyed between individuals or the overall firm. This is conducted in order to convey or receive new information or a feedback (Rivard, 2003). There are varieties of ways information can be conveyed or exchanged, including: face to face communication, phones, mails, letters, faxes, meetings, memorandums and reading from books, articles amongst others; this is enhanced by a IT tools (Sommerville and Craig, 2006).

IT has many technologies such as computers, software, networks, telephones and fax machines. Computers are the hardware that are manufactured and supplied by the manufacturers. Software are programs that operate in hardware to process information. It supports processes performance in a variety of ways: recording, storing, processing, emailing, Internet surfing amongst others.

2.7.6 People and Culture

Different categories of people are involved in organizational performance. They include groups of employees; unskilled, semi skilled and full skilled and knowledgeable. Under this context, people are recognized as suppliers – one producing a service or a product. People can also be categorized as the customers, one who receives/buys a service or product. People can also occur partly as a supplier, influencing a service/production of a work and partly a customer, by giving finance for a service to be carried out, among others, each group has diverse needs derived by culture (Robison and Ullah, 1996; Mazda, 2000; Galos and Schein, 2006)

Therefore, in order to improve organizational processes for each of three contracting parties, five organizational processes are crucial: organization structure, strategy, people and culture, technology and information (Figure 2.3). They need to be considered as iterate as well as a balanced way (Marchand and Stanford, 1997) to improve project process performance (see Figure 2.3).

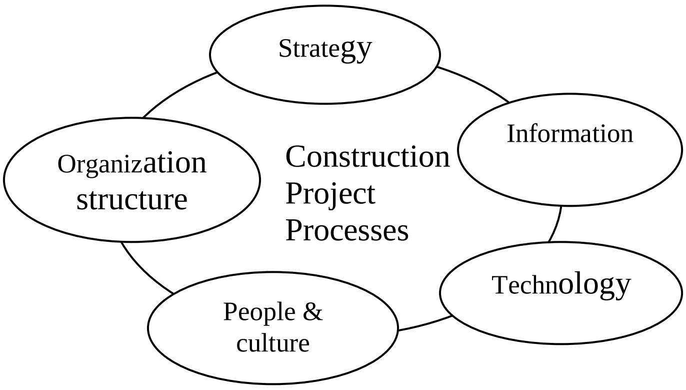


Figure 2.3: Organization Processes

2.8 Findings from the Literature Review

Literature review pertaining to this study covered the following areas: construction industry performance, generic project process performance, process measurement, BPR philosophy and organizational processes. The findings from these reviewed works are summarized in Table 2.6. From the Table, the usefulness of each specified reviewed work is summarized, giving the views that guide in establishing the constructs of the BPR conceptual model.

Table 2.6: Findings from the Literature Review

S/N	Reviewed work sub themes	Results of the review work and their usefulness
1	Construction industry performance – projects and contracting parties performance trends	Project incurs huge amounts of money when implemented (MoF, 2013), therefore, its' intensive studies may create serving to the industry and the nation
		Project performance trends in the country result into: cost overrun, time overrun and poor quality standards (MoW, 1977; NCC, 1984; Bjorklof *et al.*, 1992; Baradiyana, 2000; Samson, 2003).
		Contracting parties had weaknesses in: people competencies, finances, IT technology, structures, visionary ideas, strategy amongst (Addo-Abeidi, 2006; Hallway, 2001; Byabato and Addo Abedi, 2004)
		Efforts tried involved coaching and training local firms, dividing large projects lots to fit small and medium local firms, but they have not improved specific project processes (MoW, 2003; Mlinga, 2005; Muhegi, 2007; Mawenya, 2011)

S/N	Reviewed work sub themes	Results of the review work and their usefulness
2	Generic project processes and parties involvements	Three core project processes: design, procurement and construction management, each of them can be improved through the identified (contained) activities. Improvement can better be effected by a respective contracting party (Atkin, 1998; Lema, 1995; Ducan, 1996; Kagioglou *et al*., 1999; Wu *et al*., 2000; Bennet, 2003; Halpin, 2006)
3	Process measurement	Any process has four elements to target improvement: inputs, activities, interfaces and outputs, they deserve crucial examinations (Koskela and Sharpe, 1994; Harrington, 1997; Oakland, 2003; IS Consulting 2008; Griffith and Watson, 2004; CURT, 2005; Hirano, 2008).
4	BPR tenets and potentials	Knowledge of BPR adoption, benefits, tools, techniques and procedures exist from the 1990's, it is still useful to improve processes (Robison and Ullah, 1996; Muthu *et al*., 1999; Pearman, 1999; Manganeli and Klein, 1994; Al-Mashaal *et al*., 1999)
5	Existing BPR models	Generic BPR steps are repetitive. BPR in construction industry deals with specific process of a project. Knowledge on how to conduct BPR (e.g. how to map out process and identifies weaknesses, redesign process just to mention a few) are identified (Zigiaris, 2000; McAdan, 2003; Caron *et al.*, 1994; Tsalgatdou, 2008)
6	Organization al processes	Addresses five organizational processes: organizational structure, strategy, technology, people and culture and information communication. They provide organizational administrative roles (Mazda, 2000; Rivard, 2003; Sommerville and Craig, 2006; Galos and Schein, 2006; Fiss, 2008)

2.9 Chapter Summary

This Chapter discussed the performance of the construction industry in Tanzania and BPR performance. Significance of project's performance, contracting parties' performance trends and the efforts made by the construction industry regulators have also been discussed. In addition, description on project process performance, BPR philosophy, process measurement and organizational processes was conducted.

CHAPTER THREE

A BPR CONCEPTUAL MODEL

3.1 Introduction

The main objective of this research is to develop a model that undertakes BPR to improve performance of construction project processes. In Chapter Two literature review relating to Tanzania construction industry performance and BPR performance were presented. In this Chapter the BPR conceptual model is presented. The chapter discusses the theories upon which the conceptual model is based and provides the step by step conceptualization of the model and the graphical presentation of the final model.

In developing this conceptual model, BPR philosophy is used to identify five phases required to bring about construction project process performance improvement. These are: build BPR foundation, understand your processes, conduct measurement to identify process weaknesses, conduct radical improvement changes, implement strategies for improvement.

3.2 Build BPR Foundation

In order to implement any organizational changes, there should be a team, resources and policies dedicated for that change. Likewise, for any organization that is to use and adapt BPR to drive its performance improvement, there should be a team (referred to here as a 'BPR team') properly selected and charged with the responsibility to prepare all necessary tools to enable the successful implementation of the conceived changes (Kaschek, 2011; Zahoor *et al*., 2015).

BPR team is critical factor of BPR implementation (Muthu *et al.*, 1999; Zigiaris, 2000). A team should be adequately composed (Zairi and Sinclair, 1995; Ursic *et al*., 2005) and contain members who are experienced in variety of techniques (Kettinger and Grover 1997; Manganelli and Klein, 1994). The determinants of an effective

BPR team are: competency of the team members (Pearman, 1999; Mazda, 2000), their credibility and creativity within the firm (Manganeli and Klein, 1994; Robinson and Ullah, 1996), team empowerment (Robinson and Ullah, 1996; Zahoor *et al.*, 2015), motivated (Pearman, 1999), effective leadership (Mazda, 2000), has members who are capable of mapping out a process (Oakland, 2003; McAdam, 2003), who are well organized (Mazda, 2000; Ulriscic *et al.*, 2005), adequate in size (Mazda, 2000; Zahoor *et al.*, 2015), accountable and results oriented (Kettinger and Grover, 1997). Committed leadership is also considered most important element of build BPR foundation to contribute to its successful (Towers, 1994; Caron *et al.*, 1994). It provides creative thinking and understanding (Mazda, 2000) which also foster a clear vision of future (Pearman, 1999; Muthu *et al.*, 1999) that is communicated to all employees who are process participants (Mazda, 2000) amongst others.

Provision of adequate resources is also crucial to make any BPR implementation initiative a success (Guimaraes, 1998; Ulrisc *et al.*, 2005; Bryson *et al*., 2007). The resources are well evaluated and determined in terms of categories or type and numbers (Shem, 2010; Caliskan, 2010; Lo, 2012; Habib and Shah, 2013; Zaied *et al*., 2015). Their determination help to identify the gaps [available against un-available] (Zigiaris, 2000). As such, unavailable resources would be easily sought out, acquired and utilized to meet the intended purpose (Al-Mashari *et al*., 1999; Pearman, 1999; Muthu *et al.,* 1999). Budgets must be allocated to resources without fear of huge sums in the initial stages as the meaningful return is expected in future (Mazda, 2000; Zigiaris, 2000). Furthermore, resource scheduling (plans for resources availability, acquisition, and management is also of great importance (Muthu *et al.*, 1999) amongst others.

Strategies, vision and policies: building imaginative thinking and a clear compelling vision of the firm for future processes is critical to BPR successful implementation (Davenport and Short, 1990; Tsalgatidou, 2008). Process vision directs both long and short term actions (Pearman, 1999; Brown and Riley, 2001). Development of process vision involves evaluating and deploying BPR policy (Stoica *et al.,* 2004; Lo, 2012), and other wide range of policies such as: quality policy (Bennert, 2003; Oakland, 2003), environmental policy (Mazida, 2000), health and safety policy (Mazda, 2000) amongst others. Also conducting customer based assessment of performance targets (Zigiaris, 2000), benchmarking similar BPR efforts and developing process measures, amongst others (Marchland and Stanford, 1994; Muthu *et al.,* 1999).

Generally, in order to guide BPR initiative, a ‘build BPR foundation’ phase of the model provides three aspects, namely: a team, resources and policies. Formulate a team that constitutes relevant individuals with BPR knowledge and skills and they would be managed by senior firm management personnel. A BPR team leader is responsible to guide BPR initiatives including roles and resources requirements, enhanced by deployment of strategies and policies. The next stage after this foundation is built will be for the team to comprehensively map out the process with the view of knowing them.

3.3 Understand Your Process

It is well agreed that you cannot improve what you do not know. Therefore, after the team, resources and formulating policies, the next important stage is to ensure that all organizational processes are well understood and the core processes identified for improvement.

A well equipped firm has its organizational processes divided into two parts, firstly, administrative processes which include organizational structure and strategy that provide overall directives of the firm (Childe *et al.,* 1994). Secondly, the control process that include: technology management, communication and information management and financial management that support administrative processes of the firm (Childe *et al.*, 1995; Grover and Kettinger, 1997). The administrative process and control process (i.e. the organizational processes) exist because of the functional role of ‘core process’ (Oakland and Marosszeky, 2006). Core process is also termed as primary process (Childe *et al.*, 1995) which represents the daily operation of the firm (Kettinger and Grover, 1997). In this study, core processes come from a project process; they are here-in further discussed for improvement purposes.

In any construction project, three processes: design, procurement and construction management are the core processes due to some reasons. Design process represents a phase in which the owner/client's requirements are interpreted in documentations and the final product agreed conceptually (Gray and Hughes, 2001). Procurement process involves project ideas critically evaluated in a way to obtain best contractor, consultant and a fair contract that ensures construction work is executed to meet client's needs (Halpin, 2006; Jackson, 2010). Therefore, design establishes exactly what to build (needs of the client) and a control mechanism, procurement gives out who may build it in an appropriate way and construction management offers ideas, and builds it to meet the end goals of meeting schedule, budget and the expected quality and safety performance standards (Halpin, 2006; Jackson, 2010).

In order to improve these three core project processes, concepts of process measurement are necessary to be employed (Harrington, 1997; Susan, 2010). Any process is made up of flow(s), stages or activities and interfaces, resources (controllable inputs) and outputs which are summarized in this study as critical controllable inputs, critical process flows and critical outputs (Harrington, 1997; IS Consulting, 2008). Therefore, improving project process performance means improving inputs, process flows and outputs for each of three core project processes: design, procurement and construction management. Pyzdek (2003) states that, in order to improve a process, one should improve results, and the best approach to improving results is simply to improve the inputs and a process flow(s) as they are the ones that give the results (Rever, 2002).

As such, improving design process involves improving critical design process outputs. Critical design process outputs are the complete and accurate sets of construction documents produced. Critical design process inputs involve stakeholders' requirements. They include: user requirements, owners requirements, financier requirements and regulators requirements; these provide the boundaries of the design. In addition, competent and experienced design is critical input in design process. Critical design flows (activities and interfaces) involve: preliminary design, schematic design, and detail design together with their interfaces.

Improving procurement process involves improving critical procurement process outputs. Critical procurement process outputs are best consultant and best contractor obtained as well as a fair contract established and deployed (Davis, 2008; Jackson, 2010). Critical procurement process inputs involve project objectives, project characteristics, risks allocation and project design. Critical procurement process flows (activities and interfaces) involves assessing and evaluating procurement activities: project delivery options, contract types/forms and procurement methods/options; and evaluating: advertisement, tender evaluation and negotiation and their interfaces.

Improving construction management process involves improving critical construction management process outputs. Critical construction management process outputs are: the site works conducted efficiently, end product obtained in cost effective, on timed schedule, on low/no site accidents and highest level of client satisfaction amongst others (Halpin, 2006; Jackson, 2010). Critical construction management process inputs involve: design documents, the contract, competent and experienced personnel, other resources – materials, equipments, technology used, just to mention a few. Critical construction management process flows (activities and interfaces) involve: site layout, resources planning, resource mobilization, work implementation, cost control, quality control and safety control and the interfaces.

Therefore, knowing project process performance improvement involves knowing and improving three facets: critical design process outputs improved through improving critical design inputs and critical design activities and interfaces. Improving procurement process involves improving critical procurement outputs achieved through improving critical procurement inputs and critical procurement activities and interfaces. Improving construction management process involves improving critical construction management process outputs achieved through improving critical construction management inputs and critical construction management activities and their interfaces.

3.4 Measurement of Current Processes

When each of three core project processes: design, procurement and construction management are well mapped out to foster process understanding, next is to use the detailed process understanding concepts to identify: redundant or unnecessary activities, methods or approaches (Fryman, 2002) also termed as process disconnects (Mayer and DeWitte, 1999), which in this study are regarded as weaknesses. The study establishes four perspectives of a process weakness within: inputs, activity, interfaces and overall process performance to be used to identify process weaknesses (Harrington, 1997; Koskela and Sharpe, 1994), they are described as follows:

- Weaknesses in the inputs/resources, measured by their: unavailability, insufficient, defective (if material), incompetent or lack experience (if manpower (Robson and Ullah, 1996; Mazda, 2000), amongst others;
- Weaknesses in the activities or tasks, measured on, if they are: poorly identified, lacking clarity to the process participants, not addressed in a view to create value (Koskela and Sharpe, 1994; CURT, 2005; Hirano, 2008), amongst others;
- Weaknesses in the interfaces, measured by, or, when they are: non logically arranged, linkages between activities not clearly drawn, inadequate delivery results are approved, thus, creating hurdles in the following activities (Levy, 2010) amongst others; and

- Overall process production: lacking re-consideration of any operation that emerges during process performance and impact results, negatively (Koskela and Sharpe, 1994).

The study further uses concepts of process performance measurement that provide two steps to be followed in this phase of ‘measuring process to identify weaknesses’ (Pyzdek, 2003; Oakland and Marosszeky, 2006; Susan, 2010; Marwah *et al.*, 2012). They include: step one, map out process to detail process flows, and step two, establish metrics/indicators to be used to check the progresses – i.e. to compare before and after adoption of the model (Takim and Akintoye 2002; Jirasukprasert *et al.*, 2012). Each of these steps was employed in each design, procurement and construction management process as follows:

3.4.1 Mapping out Design Process and Establish Indicators to Identify Weaknesses

In any design, users’ requirements, owners’ requirements, financer’s requirements and regulators requirements are critical inputs. Likewise, the design team is also critical input, therefore, their competencies, experience and presence into the job is crucial. If either of these design inputs’ indicators is missing, or is partially deployed, a design process suffers from inputs’ weaknesses. The design team is involved with soliciting information from client(s) or, and, users and proceed with developing drawing sketches, and then produce sets of construction documentations achieved through three design activities: preliminary design, schematic design and detail design. If design activities are not well identified, defined, methods not evaluated in a creative and innovative way, amongst others, a design process suffers from design activity’s weaknesses. In addition, on each end of design activity (also termed as interfaces), delivery decisions occur (Gray and Hughes, 2001). Therefore, if results are not reviewed and evaluated for accuracies, outputs of preceding activities not properly linked with the succeeding activities, a design process suffers from design interface weaknesses. The causes of inadequate design as a cited example are depicted in Figure 3.1. From this Figure, practitioners may learn that inadequate design attributes (in combination/totality) contribute to overall design inadequacies. These concepts were used as a basis for outlining indicators to assess design inputs, design activities and their interfaces (Figure 3.2). These indicators are used to assess design process performance, thereby, help in identifying performance weaknesses.

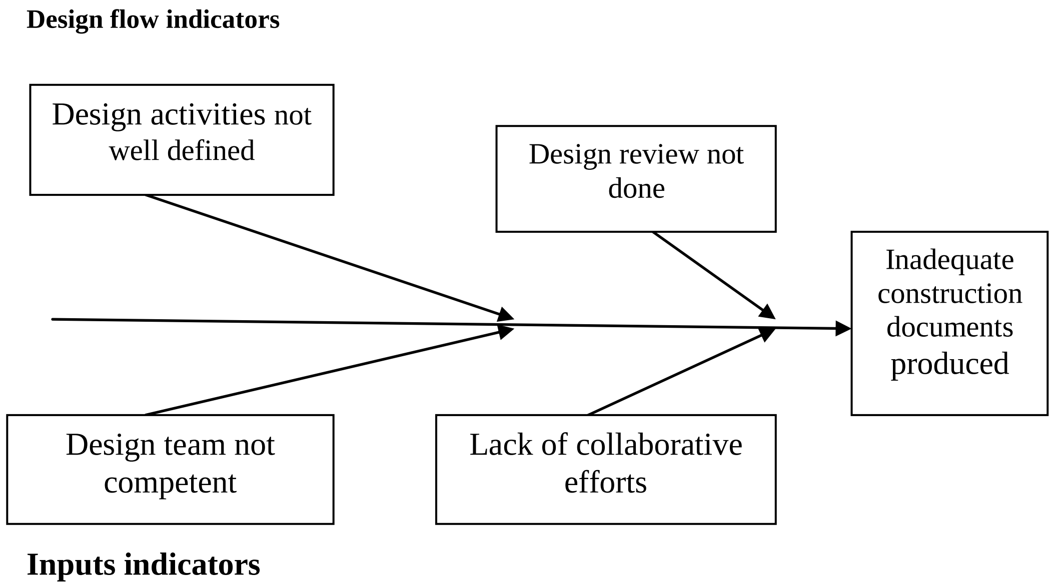


Figure 3.1: Cause and Effect Diagram Outlining Inadequate Construction Documents

3.4.2 Mapping out Procurement Process and Establish Indicators to Identify Weaknesses

In any procurement, project performance objectives, project characteristics, project risk allocation and the level of client’s involvement are the critical inputs, therefore, the extent to which they are evaluated is crucial. If either of these indicators is missing/not evaluated, or is partially deployed, a procurement process suffers from procurement inputs’ weaknesses. The client team is involved with the role of assessing and evaluating activities of procurement that involve: project delivery methods, procurement option, contract types, advertisement, evaluation and negotiation. If procurement activities are not well identified, defined and evaluated in a creative and innovative way, amongst others, a procurement process suffers from procurement activity's weaknesses. In addition, on each of procurement activity's interfaces, delivery decisions occur. On these interfaces, if results are not reviewed and evaluated to meet the intended needs, a procurement process suffers from procurement interface weaknesses. Figure 3.3 outlines indicators to assess procurement inputs, procurement activities and their interfaces. These indicators are used to assess procurement process performance, thereby, helping in identifying performance weaknesses.

3.4.3 Mapping out Construction Management Process and Establish Indicators to Identify Weaknesses

In any construction management, design documents, the contracts, (resources – material, equipments, amongst others), competent contractor and technologies used are the critical inputs, therefore, their evaluation, identification and definitions are crucial. If either of these construction management indicators is missing/not well evaluated, or is partially deployed, a construction management process suffers from inputs' weaknesses. The construction management team/personnel is involved with site layout, resource planning, resources mobilization, work implementation, cost control, schedule control, quality control and safety control, amongst others. If construction management activities are not well evaluated; identified, defined and managed in a creative and innovative way, amongst others, a construction management process suffers from construction management activity's weaknesses. In addition, on each construction management activity's interfaces, delivery decisions occur. On these interfaces, if specified job is not reviewed, evaluated, implemented and controlled to meeting the intended needs, a construction management process suffers from construction management interface weaknesses. Figure 3.4 outlines indicators to assess construction management inputs, construction management activities and their interfaces. These indicators are used to assess construction management process performance, thereby, helping in identifying performance weaknesses.

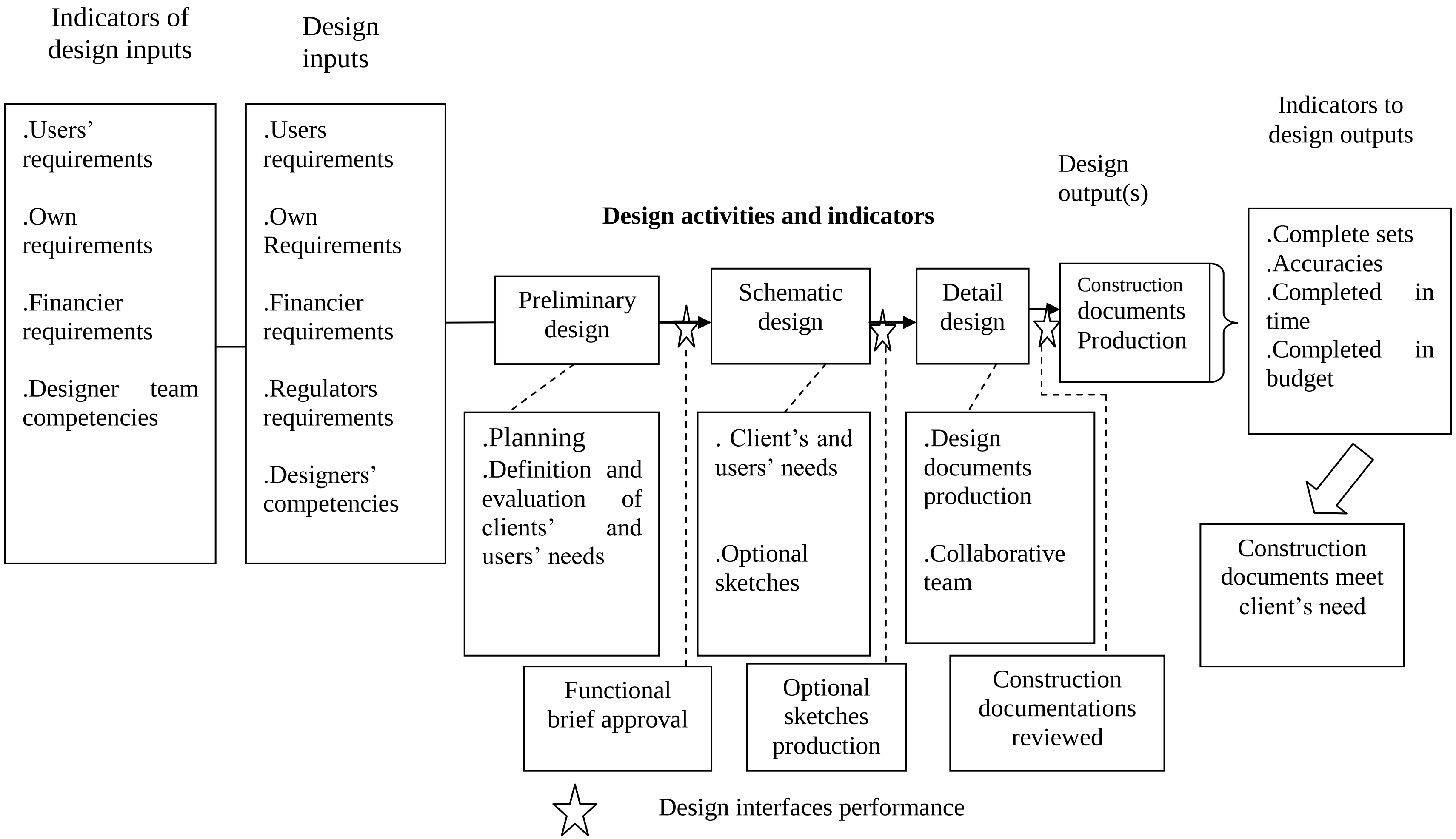


Figure 3.2: Mapping out of Design Process Performance

Sources: (Fabricio *et al.*, 1999**;** Gray and Hughes, 2001; Halpin, 2006; Susan, 2010)

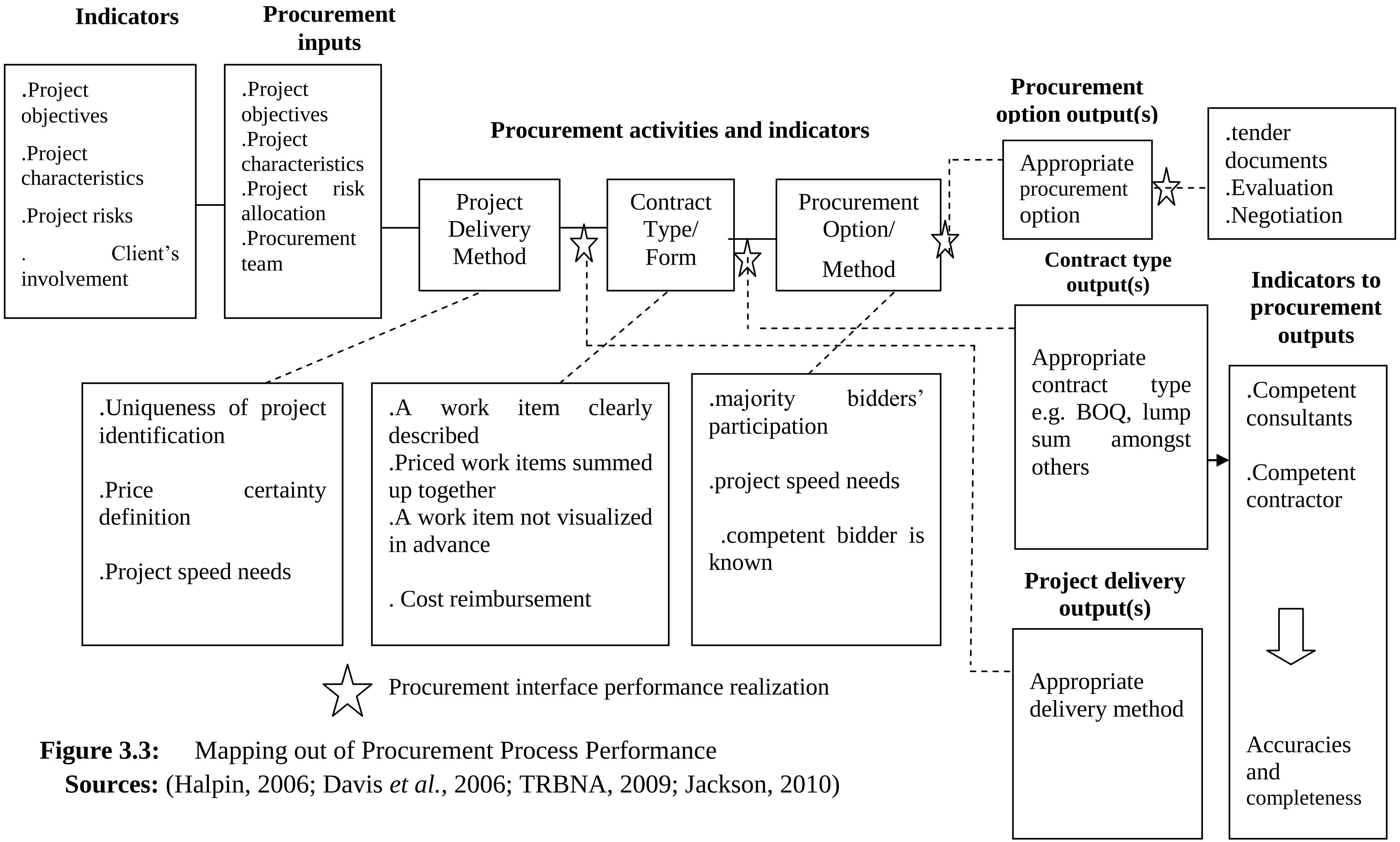


Figure 3.3: Mapping out of Procurement Process Performance
Sources: (Halpin, 2006; Davis *et al.*, 2006; TRBNA, 2009; Jackson, 2010)

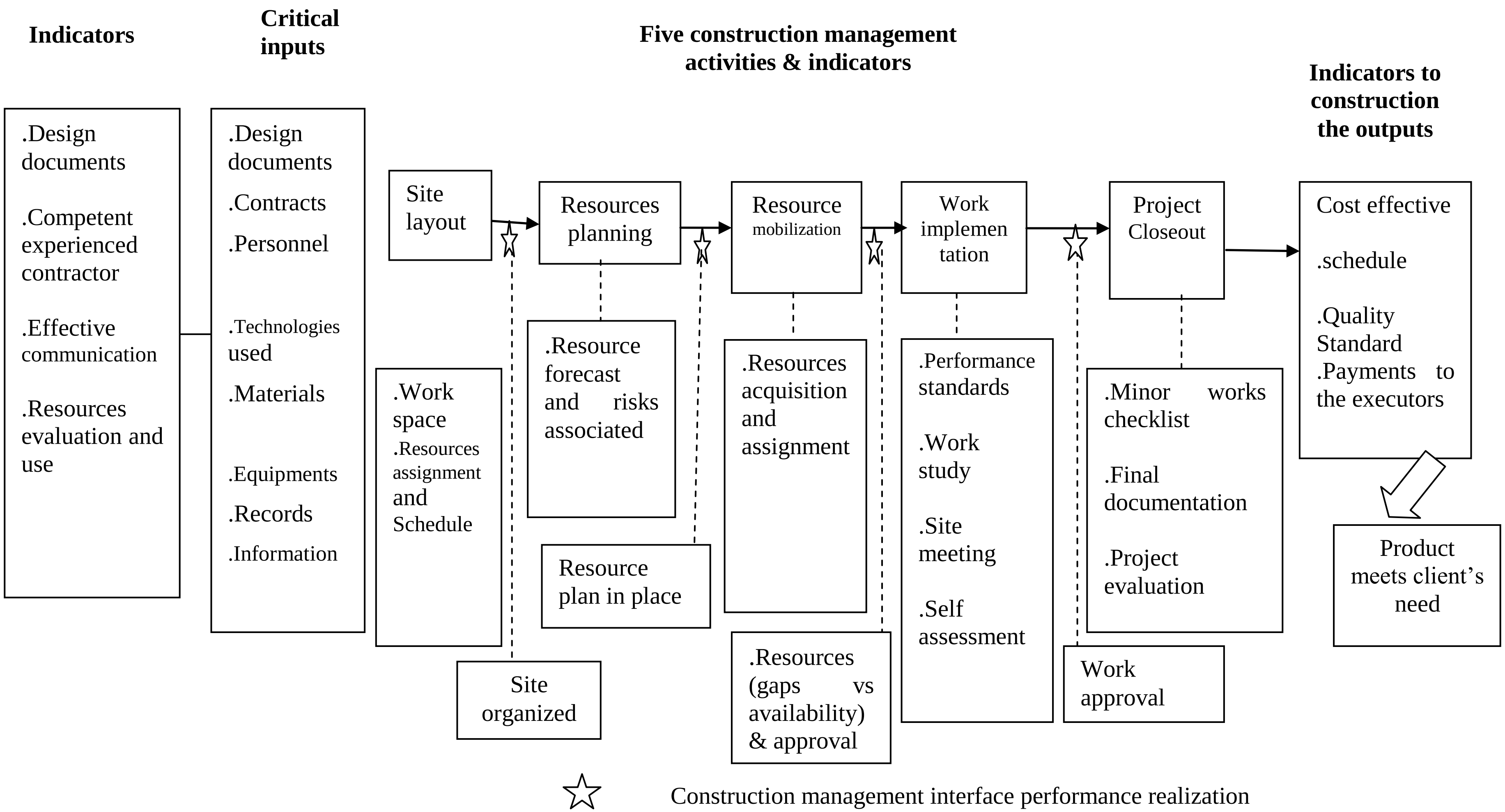


Figure 3.4: Mapping out of Construction Management Process Performance

Sources: (Austen and Neale, 1984; Halpin, 2006; Jackson, 2010; Levy, 2010)

3.5 Holist lists of Indicators to identify Process Weaknesses

From Figures 3.2, 3.3 and 3.4 sets of indicators organized under critical inputs, critical activities and critical interfaces to assess design, procurement and construction management are established. These indicators were evaluated from the literature and are considered of commonly use in the local construction industry operative performance. Additional indicators (provided with a star mark, Table 3.1, column one) were sought from best practices (i.e. those that are well practiced elsewhere). Best practices indicators are added on the list of a commonly (locally) practiced indicators in order to obtain a robust and holist set of indicators to be used in this study to identify weaknesses and create desirable (‘**To-Be**’) processes (see Table 3.1) to improve design, procurement and construction management.

In summary, indicators considered to be commonly practiced in the local construction industry operative performance were mapped out to improve core project processes and are presented in Figures 3.2, 3.3 and 3.4. Indicators sought from best practice were evaluated, and added into this list (they are specifically marked with a star). Combination of these categories of indicators form a holist list to help practitioners identify core project processes weaknesses and desired (‘**To-Be’)** processes (Table 3.1). The desirable (‘**To-Be**’) processes and indicators used are described in the sections that follow:

Table 3.1: Indicators to identify Weaknesses and Desired (**To-Be**) for Design, Procurement and Construction Management Processes

Indicators	**Weaknesses Identification**	**Desirable (To-Be) Process**
	DESIGN PROCESS	
Critical inputs		
Client/user's requirements	All users categories not identified, their needs not identified, not met, or needs identified and met partially	Users categories and their needs well identified and met, at satisfactory level
Financier's requirements	Financier's capability of client not known, and not linked with the project needs	Financier's capability of client known and linked with the project needs
Regulator's requirements	Needs of the industry regulators not sought, or deployed partially	Needs of the industry regulators are sought and fully deployed
A qualified and experienced designer	Unqualified or, and inexperienced designer	Qualified or, and experienced designer
*Qualified and experienced design team	Insufficient design team (an expertise is missing)	Sufficient design team (all expertise play a needful roles)
Design flows (design activities and interfaces)		
Definition and evaluation of clients and users needs	Client and users needs partially or not evaluated	Clients and users needs well evaluated
Functional brief approval	Poor functional brief	Functional brief approval by a client
Client's and users' needs further solicited	Client's and users' needs not sufficiently solicited	Client's and users' sufficiently solicited
Optional sketches	Single sketch option	Option sketches deployed
Design documents production	No, partial efforts deployed to design documents production	Design documentation production checked
Collaborative efforts	Designers not working as a collaborative team	Deploy collaborative designers' efforts
*Constructability	No critical review of design documents by other specialists	Critical review of design documents deployed by

Indicators	Weaknesses Identification	Desirable (To-Be) Process
		other specialists
	No buildability study done by bring-in a contractor or his concepts	Buildability study deployed by bringing-in a contractor
*Value creation	Standardized methods, error proofing amongst others not effected in design tasks	Standardized methods, error proofing amongst others deployed in design tasks
*IT technology	Unsatisfactory level of using of IT in design – storing and processing information, Internet and data base	Deploy satisfactory level of using IT in design
*IT and BIM	Unsatisfactory level of using of IT and BIM in design, e.g. on changing design elements in automated model	Deploy satisfactory level of using IT and BIM in design
*Design management	Unsatisfactory use of design management – dynamic leaderships, detail design task management amongst others	Deploy satisfactory level of using design management
PROCUREMENT PROCESS		
Inputs		
Project objectives	Project objectives: time needs, prices, uniqueness, amongst others, not sufficiently evaluated	Project objectives: time needs, prices, uniqueness, amongst others, evaluated
Project characteristics	Project characteristics: uniqueness, technology, social needs, amongst others not well evaluated	Project characteristics are well evaluated
Project risk	Holist risk management not deployed	Holist risk management deployed
Client's involvement	Client is rarely, or partially involved to contributes onto own project issues	Client is well involved to make project decision
Procurement Flows: (procurement activities and interfaces)		

Indicators		Weaknesses Identification	Desirable (To-Be) Process
Elements	Project's Type/and Size	Project not, or partially defined on its type and scope/size	Project well defined on its type and scope/size
Project delivery option	Uniqueness	Specifics of the project not established, not known, e.g. location, technological complexities, to mention a few	Specifics of the project established and known
	Project changes flexibility	Extents/tolerant of the client to allow changes after work commencement not known	Extents/tolerant of the client to allow changes after work commencement is well known
	-External factor(s), e.g. market needs, political will	External factors of the project not evaluated and identified	External factors of the project are evaluated and identified
Contract type	BOQ	Individual work item not defined and not priced	Individual work item is priced and a total sum is quoted
	Schedule of rate	Non visualized work quantities not understood	Non visualized work items are familiarized
	Lump sum	Single cost sum based on knowledge of detailed work is not known	Single cost sum of a work item is known and used
	Cost reimbursable	Cost reimbursable not evaluated, not identified and not deployed	Cost reimbursable evaluated, identified and deployed
Procurement option	Competitive	Criteria on engaging majority bids is not deployed	Criteria on engaging majority bids is deployed
	Direct	Reluctant to deploy a direct (selected) bidder	Deploying a direct (selected) bidder
Activities	Advertisement	Fault project advertisement procedures	Deploy project advertisement procedures
	Evaluation	Poor criteria for evaluating the bids	Fairness in evaluating the bids
	Negotiation	Inadequate bid negotiations	Adopt win-win negotiation

<table>
<tr><th colspan="2">Indicators</th><th>Weaknesses Identification</th><th>Desirable (To-Be) Process</th></tr>
<tr><td colspan="2">Interfaces between project delivery option and contract types and procurement option</td><td>Incompleteness exist on project delivery method, contract type and procurement</td><td>Completeness on project delivery method, contract type and procurement</td></tr>
<tr><td colspan="2">*Value creation</td><td>Standardized methods, error proofing not effected in procurement tasks</td><td>Standardized methods, error proofing amongst others deployed in procurement tasks</td></tr>
<tr><td colspan="2">*IT technology</td><td>Unsatisfactory level of using IT – storing and processing information, Internet and data base</td><td>Deploy satisfactory level of using IT in design</td></tr>
<tr><td colspan="2">*IT and BIM</td><td>Unsatisfactory level of using IT and BIM in procurement</td><td>Deploy satisfactory level of using IT and BIM in procurement</td></tr>
<tr><td colspan="4">CONSTRUCTION MANAGEMENT PROCESS</td></tr>
<tr><td colspan="4">Critical inputs</td></tr>
<tr><td colspan="2">Design documents</td><td>Design documents, either worn out, not for use</td><td>Readable design documents and are available</td></tr>
<tr><td colspan="2">Contract</td><td>Parts of the contract are vague (or not self explanatory</td><td>Parts of contract are clear and fair</td></tr>
<tr><td colspan="2">Project objectives</td><td>Project objectives (quality, schedule, time and safety) are not well focused on</td><td>Project objectives are focused on</td></tr>
<tr><td colspan="2">Technologies used</td><td>Update technologies, either partially or not deployed</td><td>Updated technologies deployed</td></tr>
<tr><td colspan="2">Competencies of the builder</td><td>Incompetent contractor</td><td>Competent contractor deployed</td></tr>
<tr><td colspan="2">Resources (materials, equipment) deployment</td><td>No schedule of resources (e.g. materials, equipments amongst others)</td><td>Appropriate schedule of materials deployed</td></tr>
<tr><td colspan="4">Construction management flows (activities and interfaces)</td></tr>
<tr><td>Site lay out</td><td>Site space requirement</td><td>Site space evaluation and use not well done</td><td>Site space use well evaluated</td></tr>
</table>

Indicators		Weaknesses Identification	Desirable (To-Be) Process
Resources planning	Resources schedule	Resource schedule not well identified and used	Deployment of resource schedule
Resources mobilization	Resource acquisition evaluation	Resources acquisition problems	Evaluations on resources acquired deployed
Work implementation	Work study and control	No critical work studies	critical work studies deployed
Project close out	Record and filling of documents	No appropriate work records and filling of the documents	Appropriate work records and filling of the documents deployed
*Value creation		Standardized methods, error proofing not effected in construction management tasks	Standardized methods, error proofing amongst others deployed in construction management tasks
*IT technology		Unsatisfactory level of using IT – storing and processing information, Internet and data base	Deploy satisfactory level of using IT in design
*IT and BIM		Unsatisfactory level of using IT and BIM in construction management	Deploy satisfactory level of using IT and BIM in construction management

3.6 Desirable (To-Be) Project Process

Radical change of processes have the following features: one that is altered in huge amounts from a weakness process performance level (Manganeli and Klein, 1994), have great impacts (positive) in the organization depending on the changing needs (Robinson and Ullah, 1996), and changes are continuous (McAdam, 2003). Radical changes are achieved quantitatively or subjectively through altering organizational processes: organizational structure, strategy, technology, people amongst others (Marchand and Stanford, 1997; Stoica *et al.*, 2004). The changes are achieved through questioning: (who, why, when, what, where and how, brainstorming, creativity and benchmarking from best practices amongst others (Zigiaris, 2000;

McAdam, 2003). Such ideas can be used in two steps (i) work from sources of weaknesses (Robinson and Ullah, 1996; Bose, 2012) and (ii) establish a desired (**To-Be**) process. In this study, the desired (**To-Be**) process changes are established based on the three sources of information: (i) weakness identified (see Table 3.1, column two), (ii) best practices benchmarked elsewhere (see Tables 3.2, 3.3 and 3.4) and (iii) researcher's knowledge (McAdam, 2003). In the Tables 3.2, 3.3 and 3.4, indicators/measures to create desired (**To-Be**) process changes for design, procurement and construction management respectively are put in italic and bolded. The desired (**To-Be**) process) are aimed to improve design, procurement and construction management.

Table 3.2: Desirable (**To-Be**) Design Process

Project process	**Measures**	**Attributes (Items of measures) for desirable (To-Be) process**
Design	-	Deploy ***competent and experienced*** design team Use ***constructability skills***
	(i)Activity definition for value creation	Borrow concepts from **lean thinking** on value creation (University of Kentucky, 1997; Hirano, 2008) to guide design team, on letting them ***deal with only activities and manage their interfaces***. Therefore, three activities: preliminary design, schematic design and detail design and their interfaces are adopted by: (i) ***doing only task required and avoid errors*** (ii) ***ensure no unnecessary movement of resources*** (iii) ***designer conduct error proofing and self inspection*** (iv) and ***allow the use of standardized methods***

Project process	Measures	Attributes (Items of measures) for desirable (To-Be) process
	Adoption of IT and BIM	In order to perform design tasks, IT and BIM support tools are proposed to help (Mendez, 2006; Sommerville and Craig, 2006; Suermann *et al*., 2007; Azhar *et al*., 2008); Ashcraft, 2009): (i) ***record information*** (ii) ***store information*** (iii) ***process information*** (iv) ***update - add/delete information*** (v) ***database use*** (vi) ***Internet surfing*** which gives access to share views between designers (vii) [a ***BIM*** for example] provides a platform/interface where rough graphic ideas and sketches may be easily viewed by the parties e.g. a client, this reduces chances of rework (vii) allow ***changes of the project elements on an automation format***, thus, reducing chances for errors or mistakes and accelerate work speeds (Azhar, *et al*., 2008).
	Constructability and Phase review	Incorporates constructible ideas in the design stage on: ***usability of the materials***, ***work method, realist budget estimate***, amongst others that can be done by, (i) ***experienced designers' oversight*** (i) ***designers seek this ideas outside the firm*** or (iii) ***allow bringing-in a contractor during design stage to share views*** with the designers (iv) ***use designers expertise*** [other than those involved in the original work] to re-review design documents (Gray and Hughes, 2001; Brown and Riley, 2001; Pulaski and Horman, 2005; Pruett, 2004; Jackson, 2010).
		Create review and re-reviewing in the interfaces of design activities: (preliminary design, schematic design and detail design), re***strict any progression until a correct and complete work is achieved and approved*** (Pruett, 2004; Emmitt, 2007; Pettee, 2009). It allows that no possible errors or mistakes or omissions are passed on (Gray and Hughes, 2001).
	Design management	Adopt a design management (Gray and Hughes, 2001; Emmitt, 2007; Levy, 2010): • All ***design participants are identified*** subject to their engagements; • ***Designer manager appoints other designers*** since he is expertise in the field; • ***Deploy a design team leader*** who deals with planning, coordinating and controlling the

Project process	**Measures**	**Attributes (Items of measures) for desirable (To-Be) process**
		overall design work; • ***Define project design at both high and low levels*** and give detailed scopes; • ***Detailed definitions of the design process*** - detailed map out information flow between all parties; and • ***Adopt process control*** that focuses on overseeing the completeness of activities

Table 3.3: Desirable (**To-Be**) of Procurement Process

Project process	Measures	Attributes (items of measures) for desirable (**To-Be**) processes
Procurement	Activity definition for value creation	Borrow concepts from **lean thinking** on value creation (University of Kentucty, 1997; Davis *et al*., 2006; Hirano, 2009) on ***deploying only procurement activities*** required and ***manage interfaces***. Therefore, three procurement activities: project delivery methods, contract type and procurement option and their interfaces are adopted
	Interfaces	Based on the three interfaces proposed, ***each procurement activity should be examined on its completeness and the approval*** when conducted (Emmitt, 2007)
	Adoption of IT and BIM	In order to perform procurement process successful, IT and BIM tools are also employed to help (Rivard, 2003; Mendez, 2006; Sommerville and Craig, 2006; Suermann *et al.*, 2007): (i) ***record information*** (ii) ***store information*** (iii) ***process and manipulate information*** (iv) ***update - add/delete information*** (v) ***database use*** (vi) ***Internet surfing which helps conducting tendering online*** (vii) ***Perform tendering on line*** (viii) [use a ***BIM*** for example] provides a platform/interface of collaboration between participants (Azhar, 2008).

Table 3.4: Desirable (**To-Be**) of Construction Management Process

Project process	Measures	Attributes (items of measures) for desirable (**To-Be**) processes
Construction management	(i) Activity deployed and their interfaces	Borrow concepts from **lean thinking** on value creation (University of Kentucty, 1997; Hirano, 2009) to guide construction management team to ***decompose work and deal with only activities required***. Therefore, five activities are: site lay out, resources mobilization, work implementation, cost control, quality control etc and their interfaces are adopted by: (i)***doing only task required and avoid errors*** (ii) ***ensure no unnecessary movement of resources*** (iii) ***conducting error proofing and self inspection*** (iv) ***allowing standardized methods and*** (vi) ***track progresses***
	Risk management	Holist ***definition*** of, and ***adoption of risk management***: understanding the context, risk identification, quantification and mitigation (Halpin, 2006; Department of Transportation, USA, 2014)
	Adoption of IT and BIM	In order to performing all five construction management activities, IT and BIM support tools are employed to help (Rivard, 2003; Mendez, 2006; Sommerville and Craig, 2006; Suermann *et al.*, 2007; Azhar *et al.*, 2008): (i) ***record information*** (ii) ***storage information*** (iii) ***process and manipulate information*** (iv) ***update - add/delete information*** (v) ***database use*** (vi) ***Internet surfing which gives access to share views between designers*** (vii) [a BIM for example] provides a platform/interface that allow collaboration potentials (Azhar, 2008).

3.7 Strategies for Improvement

Indicators to identify weaknesses in design, procurement and construction management are outlined in Figures 3.2, 3.3 and 3.4. Measures to create desirable (**To-Be**) processes are outlined in Tables 3.2, 3.3 and 3.4. Summary of indicators to identify weaknesses and desirable (**To-Be**) processes are given in Table 3.1. In order for the practitioners to be able to conduct changes from a weak process level to a desired (**To-Be**) process level, strategies need to be established and deployed. As Ulrwik (1999) defines ‘strategy’ as the art of devising plans towards a goal. From Oxford dictionary, ‘improvement means achieving or producing something better than’. Therefore, some strategies were outlined in Table 3.5 to help practitioner to change from a weak process to a desired (**To-Be**) process – a level that is better than.

Based on information from this Table, attributes of strategies for improvement are given linking with the specified functionality.

Table 3.5: Attributes of Strategies for Improvement

Strategies of Improvement	Role/functionality
Continuous learning and benchmarking	Projects are unique, but their attributes can be learned and adapted, therefore, firms should learn from best practices and benefit with new lessons
Train - job training, formal training and participatory in seminars	Gives both short and long-term training to their employees to equip them with a meaningful knowledge and skills to deploy process improvement
Plan and set funds to manage changes	Ensures planning acquisition and management of cash flows for implementing the changes as they incur cost (Zigiaris, 2000)
Plans to invest, or expand IT and BIM application	Both IT and BIM tools add support to project performance improvement (Suermann *et al.,* 2007). Therefore, investing or expanding IT and BIM tools adds to improving project processes performance
Recruits, retains and recognizes manpower competencies	Fruitful of BPR initiatives take long (Ulrisc *et al.*, 2005), therefore, firm should prepare both short and long term plans that recruit, motivate, value and retain employee who implement BPR initiatives
Adopts Capability maturity model (CMM)	Firms differs in capability, therefore, they need to adopt CMM that enable them to learn and adopt changes in stages and grow (Paulk *et al.,* 1993)
Maintains records	Firms also should systematically record and store information in an updated way (Rivard, 2003) providing an easier way of tracking progresses

Sources: (Paulk *et al.,* 1993; Robson and Ullah, 1996; Suermann *et al.*, 2007)

3.8 BPR Conceptual Model Formulation

Figure 3.5 outlines a framework to improve project process performance with five steps: consider three core processes, know the current process, measure current process, establish weaknesses, establish desired (**To-Be**) and performance continuous improvement. BPR conceptual model is presented in Figure 3.6. Parameters of the conceptual model form basis for preparing a BPR model. Whereas, BPR conceptual model is presented in Figure 3.6, BPR steps and theories for its formulation are summarised in Table 3.6 to help showing the sources of related existing works.

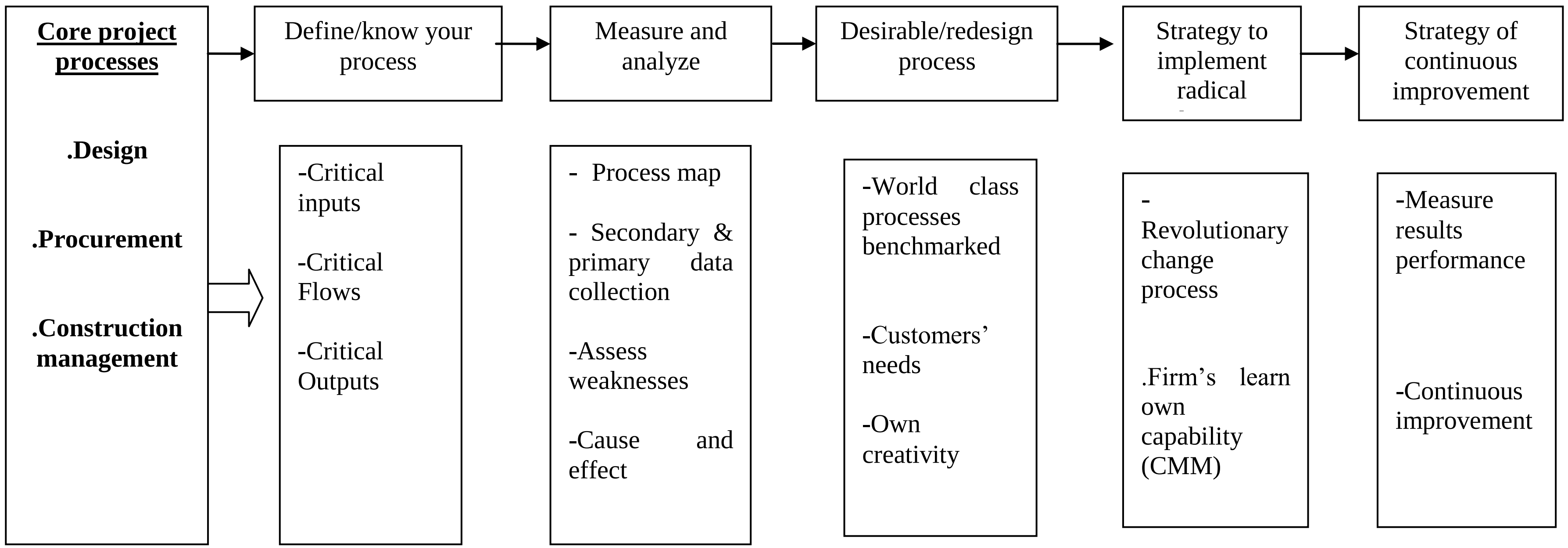


Figure 3.5: Framework of Project Process Performance Improvement

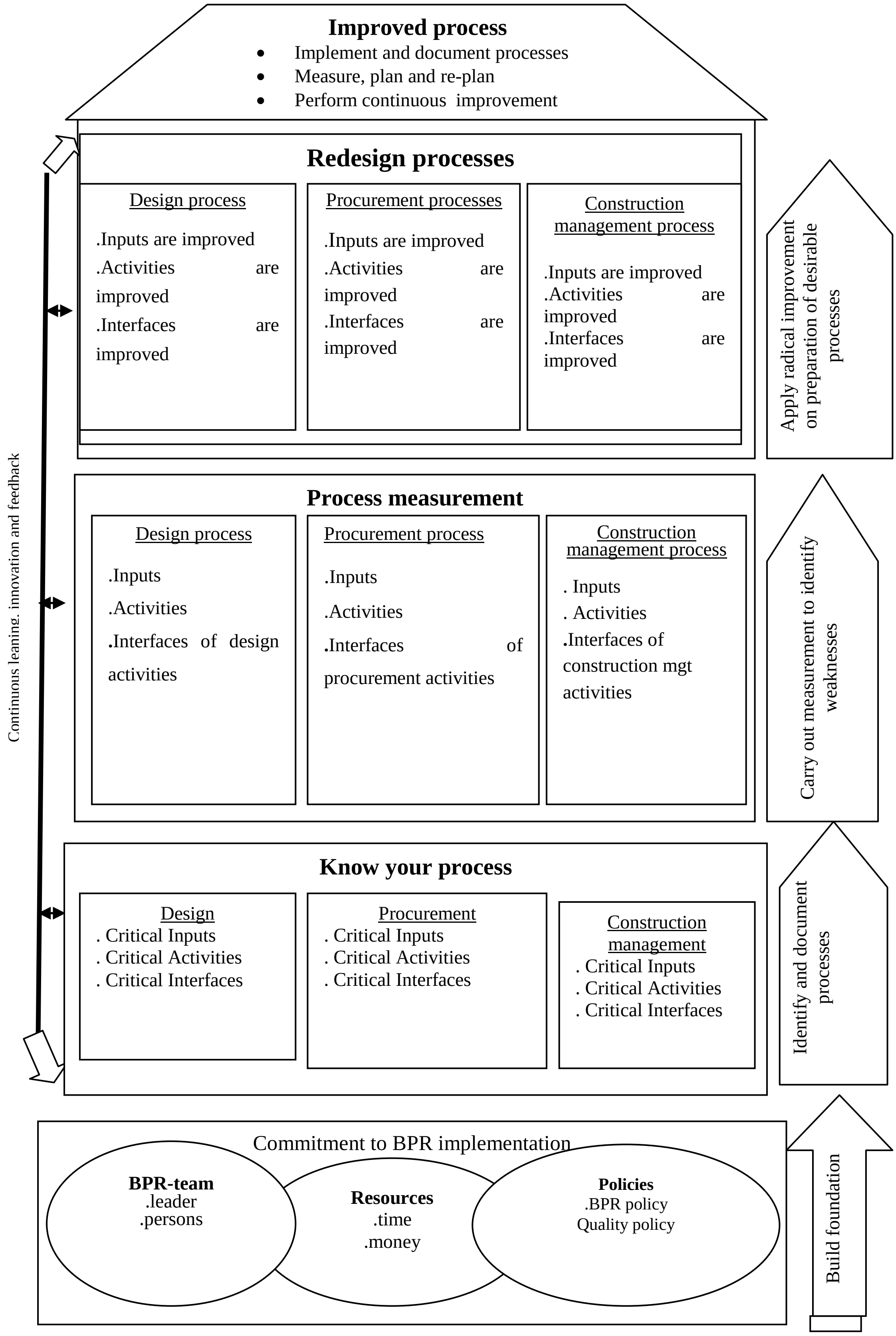


Figure 3.6: Conceptual BPR Model to Improve Project Performance

Table 3.6: Summary of BPR Steps, Theories and Dimensions of BPR Conceptual Model

Five BPR phase/steps	Theories used to formulate a BPR conceptual model	Parameters that make-up a BPR Conceptual Model
1:BPR foundation (three parameters)	BPR philosophy and organizational processes	Leadership commitment, personal responsibilities and teams
		Resources – finance, time, assets and other resources
		Policies – BPR policy, quality, Health and safety etc.
2: Understand your processes	BPR and organizational theories	Organizational processes from step 1 – for administrative roles –prepare, implement and avoid short falls
	Project process	Three core processes of a project: design, procurement and construction management and their activities
	Process measurement	Critical inputs, critical activities, critical interfaces and critical outputs
3:Conduct measurement to identify process weaknesses	BPR philosophy	How to conduct mapping out, what is weak, how indicators are developed and used
	Project process	Specific items measured, e.g. design inputs – users' needs, owner's needs, financier's needs etc.
	Process measurement	Process elements details weaknesses, e.g. – design inputs' indicator - user's needs not critically identified, etc
4:Conduct radical improvement changes	BPR philosophy	Radical changes, e.g. from weak process to best practices, e.g. constructability, IT and BIM etc.
	Project process	Specific project process, activities and interfaces
	Process measurement	Element of radical change to be used at a respective project process and its impact
5:Implement strategies for improvement	BPR philosophy	Prepare resources for changes, change culture of employees, continuous learning, allow changes in stages, amongst others.
	Project and process measurement	Project: scopes of activities, interfaces, milestones

3.9 Chapter Summary

This Chapter presented a BPR conceptual model. Descriptions on how a BPR conceptual model is formulated are well discussed. This model improves overall project processes through deploying five BPR implementation phases (Figure 3.6). The next Chapter presents research methodology adopted in this research.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

The previous Chapter presented the BPR conceptual model. This Chapter presents the research methodology adopted in the study. It introduces brief theories on research strategies and outlines the types of research methods and justifies their rationale for use in this thesis. The Chapter also discusses features of research population, sampling techniques used, sample size and the methods used in the sample selection. The Chapter further discusses the data collection methods and tools used in quantitative approach (i.e. questionnaire and interview), and in a case study. The Chapter also presents the validity and reliability of the data collected.

4.2 Research Strategies

Research methodology is a systematic approach that sets out and justifies the methods and techniques adopted for collecting, analyzing and interpreting data (Fellow and Liu, 2008). There are two approaches through which researches can be carried out, they are described as follows.

Quantitative research that seeks to answer questions like: how much? how many? how often? to what extent? and how satisfied? (Hancock, 2002; Bernard, 2006). The approach allows the use of standardized instruments so that the varying perspectives and experiences of people can fit into a predetermined response category (Kumar, 1996). It measures views of many people to a given set of questions. This facilitates comparisons and establishes diverse information. Further, the approach generalises results of many respondents.

Qualitative research on the other hand seeks to answer questions such as: why? how? and in what way? It also relates to the words like discover, motivation, experience, think, perceive and behave (Dawson, 2002). This approach involves subjective assessment of attitudes, opinions and behaviour.

Thus, the concepts from the aforementioned approaches can be adopted by using either of the methods: exploratory, survey, archival, analytical, narrative, empirical/observation, group discussions and interviews, descriptive and case study (Buckley *et al.,* 1976; Yin, 1993; Kothari, 2004; Bernard, 2006). Selecting and using either of the method(s) in the current study depends on the type of data required, sources of data and potentials of the method to meet research objectives.

4.3 Types of Methods Adopted

This research is aimed at developing a model for undertaking BPR to improve performance of construction project in Tanzania. The specific objectives are: to formulate a BPR conceptual model for improving 'project processes performance'; to analyze indicators that identify weaknesses of project processes; to formulate strategies for achieving improved 'project processes'; and to develop a model for undertaking BPR to 'improve performance of project process'. In order to achieve these specific objectives, the data types, sources and relevance of the methods required were evaluated and adopted in the study (Table 4.1 and Figure 4.1).

Table 4. 1: Research Objectives Driving the Data Types, Sources and Rationale of the Methods Used in the Research

s/n	Research objectives	Types of data required	Sources of data	A method and its rationale
1	Formulate a BPR Conceptual model	Literatures: .project performance .Process improvement .BPR philosophy .Organizational processes	**Literature review:** .Project performance: proceedings and reports from ERB, CRB, etc., from 1977 to 2015). .BPR: text books, conference proceeding, journal papers, published and unpublished Dissertations and Theses from the 1990 to 2016. . Organizational and process improvement – review works were sought from text books, conference proceedings and journal papers from 1976 to 2016	Literature review was adopted
2	Analyze indicators to identify weaknesses	Opinions from employees to identify indicators that identify weaknesses	.Clients, consultants, contractors, and developers. Data was collected from May – August, 2016 in Dar es salaam	Interviews seeking opinions on indicators that measure a process, and their usefulness to identify weaknesses
3	Formulate strategies of achieving improved processes	Opinions from employees to identify Desired (**To-Be**) process	Clients, consultants and developers who operate in Dar es Salaam. Data was collected from May – August, 2016 in Dar es salaam	Interviews seeking opinions on usefulness of the indicators to create desired (**To-Be**) process
		Opinions from employees on strategies for improvement.	Clients, contractors, consultants and developers who operate in Dar es salaam. Data was collected from May – August, 2016 in Dar es salaam	Interviews seeking opinions from respondents on usefulness of strategies for improving project process performance
4	Development of the model	Study indicators to create desired (**To-Be**) process	Selected indicators were used to study road construction project. This was done through case study in consulting firm in Mbeya city	Case study conducted on selected indicators: risk management, IT, amongst others to identify weaknesses and desired (**To-Be**) process
		Checking conformity of data from S/N 1 - 4	Cumulative information - conceptual model, model development and model validation	Information sought from above methods forms a BPR model

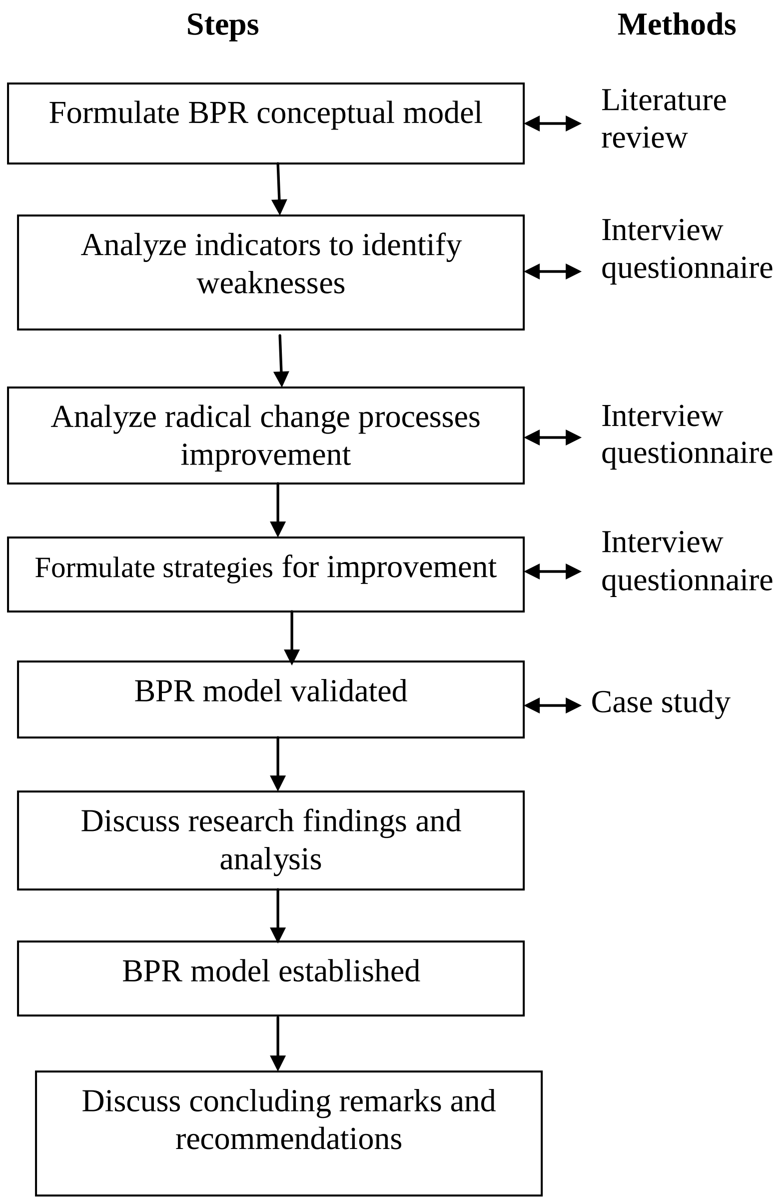


Figure 4.1: Schematic Research Methodology Adopted

4.4 Development of BPR Conceptual Model

The formulation of a BPR conceptual model is discussed in Chapter Three. The method used, i.e. the literature review and the approaches adopted are summarized in Table 4.1.

4.5 Conducting Survey to the Contracting Practitioners

4.5.1 General Overview

In order to achieve two specific objectives, specific objective two and specific objective three of this research, ‘to analyze indicators to identify weaknesses of a project process’ and, ‘to formulate strategies for achieving improved ‘project process’, survey method was used. This method was used mainly to test and verify whether the rational deductive thinking (BPR conceptual) model holds true (Kenley, 2003) under the environment of Tanzania, particularly, Dar es Salaam. That is, whether the model dimensions: BPR foundation guides in BPR implementation, the practitioners understand the process, the analyzed indicators identify project processes weaknesses, the measures analyzed identify desired (‘**To-Be**’) processes, and, strategies formulated evaluate process weaknesses and also guide in implementing ‘**To-Be**’ process in a continuous way.

Survey used interviews and questionnaires as the tools of data collection with intention of estimating the characteristics of a large population based on a smaller sample from that population (Kothari, 2004; Bernard, 2006). In deploying such survey tools, interviews allowed discussion forums that helped practitioners understand the model, therefore, easing the task of: identifying indicators that improve a project process, analyzing indicators that identify weaknesses, analyzing measures that create desired (**To-Be**) process improvement, and identify indicators that guide firms to change from a weak performance level to a ‘**To-Be**’ level (strategies for improvement). Such knowledge helped respondents understand the model, evaluate it, quantify the model dimensions and fill-in questionnaires appropriately (questionnaire survey).

4.5.2 Study Population, Characteristics and Sample Size

Population refers to as a totality of all the objects, subjects or members that conform to a specification on which the researcher wants to determine some characteristics (Bernard, 2006). Since this research is aimed at improving the performance of project process through BPR philosophy, the study population was formed from the five categories of organizations that highly participate in the project accomplishment. They include: clients, consultants, contractors, developers and regulators. Characteristics and composition of each organization is briefly described:

In Tanzania, out of three clients' categories that exist, i.e. public clients, private clients and individual clients, public clients was used in the study (see Chapter One). They comprises of: Ministries, (26), Regions (21), Agencies (35), Parastatal Organizations (102), Local Government Authorities – District towns, City Councils and Municipal Councils (135), Urban Water and Sewerage Authorities (21) and Independent Departments (27). These give a total of 367 public clients.

By considering contractor population groups in the country, they are divided into seven classes. Class 1 is the highest based on the criteria of financial capability and technical capacity amongst others and class seven is the lowest class. Class I contractors with 80 local contractors and 50 foreign contractors, with a total of 130 contractors (CRB, 2009) were considered in the study [see criteria of selection in Section 4.5.3].

Consulting firms had 106 local and 29 foreign firms operating in the country (ERB, 2008). These gave a total of 135 study population of consulting firms.

Recently, Watumishi Housing Company (WHC) which is a government (entity) property developer licensed as a fund manager for management of the WHC real estate was established in 2013, and is evidenced to engage with substantial projects annually (Msemwa, 2016). Thus, WHC stands as a one study population group.

Lastly, PPRA is an institution responsible for regulating public clients in the country, and it is involved largely in the project's accomplishments, particularly in procurement process. Thus, PPRA stands as the other study population group.

4.5.3 Criteria for selecting the Relevant Firms

Since the BPR philosophy is widely practiced elsewhere, and the BPR conceptual model developed in this study has dimensions that are not yet practiced in the local construction industry, therefore, the study selected and used firms with systematic processes to verify and test the model. The term ‘systematic process’ is defined to represent firms or entities with capability to: adopt process focus, benchmark their processes, improve efficiencies, conduct researches, pay for performance, set and use standard performance and improve outcomes (Hirano, 2009; Jackson, 2010). This study considered local firms exhibiting these characteristics as those who:

i) had two or more, huge, on-going construction projects. Huge project was estimated by a researcher as a project that worth five hundred million Tanzania Shillings or above;

ii) had two or more, huge and, recently (recently refers to as a period from three years back from time of this data collection), completed construction projects. Huge project was estimated by a researcher, as a project that worth five hundred million Tanzania Shillings or above;

iii) stayed in a construction business for more than five years, five years had only been perceived enough experience by a researcher;

iv) if a consultant, architect, quantity surveyor or contractor, should be registered with the respective boards, ERB for consulting firms, AQRB – for architects and quantity surveyors, and CRB – for contractors;

v) operate in the city of Dar es Salaam (to easy data collection exercise);

vi) for contractors, those who are in class one representing both local and foreign firms; and

vii) give relevant number of the firms which was important to permit adequate time to conduct interviews with respondents to understand the model.

4.5.4 Procedures Used to Determine Relevant Firms

In order to identify relevant respondents into the study (i.e. firms and the respective employees) five procedures were established and used as follows:

i) Reviewing magazines and revisiting websites to study firm's operative performance. Information sought related to the: types of project accomplished, their sizes, locations, number of projects executed and those under construction. The firms studied include: COWI Tanzania, Howard Humphreys (both of them are consultants), Estim, Skol (both are contractors), and Watumishi Housing Company [WHC] (a developer) amongst others;
ii) Discussing with the researcher's former class mates and friends, whom, some of them were employed by the respective firms and others employ themselves as contractors or consulting firms;
iii) Discussing with some representatives of regulatory bodies particularly ERB and CRB;
iv) Discussing with the academicians who have worked with the firms as consultants.

4.5.5 Sampling Procedure/Approach

According to the purpose of the study, i.e. improving project process performance through BPR, and the fact that a BPR philosophy is not yet practiced in the local construction industry, dimensions of the BPR conceptual model was verified by the firms with systematic processes (those who some-what follow a process focus). Indeed, reasonable time was required and used to discuss and understand dimensions of the model, amongst others. As such, a (purposive and judgement) non probability sampling was adopted. It allows using respondents who: qualify, are available, are accessible and are willing to participate (Bernard, 2006; Singh, 2006).

In order to establish the sample size, two issues emerged from the study needs. Firstly, reasonable time were needed and used in the interview forums to enable participants discuss and understand dimensions of the model. These are facets of qualitative study which suggest ignoring necessity of determining/using sample size (Kumar, 2008). In view of other researchers, such concepts also allow a sample size to be determined by the researcher alone (Ary *et al*., 2010). Secondly, the dimensions of the model were quantified and results presented in a statistical way, and also needed generalizing results. These are concepts of quantitative research that emphasize careful consideration of a sample size (Straub *et al.*, 2004; Kumar, 2008).

Based on the aforementioned concepts, this study used the criteria to select relevant firms presented in Section 4.5.3 and a qualitative approach concept suggested by Ary *et al*. (2010) and determined a population size of 40. Such concepts were combined with the quantitative research concepts deployed by Krejciea and Morgan (1970) to provide representative sample. The concepts allow the use of two methods, a Table and a graph. They provide numbers of population and numbers of sample sizes, with confidence level of 95% and degree of accuracy as 0.05. Such approach helped to determine study sample size of 35 (See Appendix I). This number was related to the population of the firms involved, then, broken down to reflect the extent to which a selected firm is involved with the project's accomplishment, see Table 4.2.

Table 4.2: Involvement of Respondents in a Project and the Study Sample Size

Firms	**Population identified**	**Extent of participating in a project accomplishment**	**Sample size**	
			Firms	**Individual employees**
Public Clients	367	A project financer who approves overall project performance	4	4
Consultants	135 (registered)	Involved fully with designing and inspecting construction work	7	14
Contractors	130 (registered class 1)	Involved fully, and, directly in the execution of the construction works	7	14
Developer	1	Involved with overall project performance and property development and management	1	2
Regulators (PPRA)	1	Involved in regulating public clients, more emphasise put on the procurement management	1	1
Total sample				35

Therefore, information in Table 4.2 helped to identify total sample of thirty five (35) respondents who were used in the study. The thirty five respondents represented key participants involved in the project's accomplishments. The number was sufficient to meet interview needs and questionnaire filling-in process. List of respondents involved is attached as Appendix A, an introduction letter for surveys is attached as Appendix B and the guide to conduct interview is attached as Appendix C.

4.5.6 Questionnaire Design

The questionnaire was designed with the intention to collect data that was required to achieve specific objectives two and three of this research: i.e. determination of acceptability of indicators that identify process weaknesses and acceptability of strategies for creating desired (**To-Be**) processes. Design of the questionnaire was organized to ensure that it covers all aspects of five dimensions of model, including: 'BPR foundation', 'understand the current process', 'identification of indicators to identify process weaknesses', 'identification of measures to create desired (**To-Be**) change process' and 'identification of usefulness of attributes of strategies for improvement'. The questionnaire was divided into two parts as follows.

Part one of the questionnaire was aimed to establish the profile of respondents. Such profiles of respondents present: name of the firm, its category in business, local or foreign (for consultants and contractors), individual ranking position in the firm, profession, and experiences of individuals in the firm as well as in the construction industry (see Appendix D). This information was useful to determine whether the data obtained was credible or not.

Part two of the questionnaire was divided into five sections: (i) section one sought the opinions from respondents about acceptability of the dimension 'BPR foundation' to enhance firms prepare to conduct BPR (ii) section two sought the opinions on usability of the developed indicators to identify process weaknesses (iii) section three sought the opinions about the usefulness of the measures to create desired (‘**To-Be’**) processes, (iv) section four sought the opinions about usability of the attributes of ‘strategies for improvement’ and (v) section five sought general opinions on the functionality of the holist BPR model. Whereas information in section five was open ended in nature, information in other sections (i, ii, iii and iv) were in closed nature (Appendix D).

4.6 Pilot Study

A questionnaire designed was pre-tested in the public client organization that has representation of three main parties to a project – a client, a consultant and a contractor. This firm operate in Dar es Salaam. The pilot study was conducted at a scheduled time and date between a researcher and the respective firm representatives. The main aim was to review the questions/statements in the questionnaire and provide views to a more elaborate or in a form they can be easily understood by respondents. It also informed any error observed. As a result, a refined tool had well worded sentences, unambiguous sentences, agreed attributes that improve a project, amongst others; this was used in the data collection.

4.7 Conducting Interview

After a questionnaire was designed and pre-tested, two tools (interview and questionnaire) were used in collecting data from respondents. Interviews were aimed to widen understanding of the dimensions of the model by the practitioners; this also made it easy to fill-in questionnaires. Procedure of data collection is briefly outlined as follows:

i) Firms studied were short listed (see criteria of selection in Section 4.5.3);

ii) Researcher visited the respective firm(s) with an introduction letter (Appendix B). He also had research instruments (four graphics of Figures 3.2 – map out of design, 3.3 – map out of procurement, 3.4 – map out of construction management and 3.6 – BPR conceptual model; and interview protocol, see Appendix D);

iii) After the researcher had introduced himself in the firms, the management agreed on his research concern, where, consequently, respondent teams were appointed and scheduled with the researcher, the appropriate meeting dates and time;

iv) In conducting interviews, a guiding tool to achieve consistency was used (see Appendix C);

v) After interview meetings were made, respondents filled-in questionnaires, giving their opinions on acceptability of: BPR foundation, indicators to identify project process weaknesses, measures to identify desired (**To-Be**) processes and strategies for improved processes.

4.8 Measurement of Research Opinions

In any research, the way data are analyzed depends on the way they were collected. In this research, opinions were collected from respondents on the dimensions of the model, acceptability of: BPR foundation, understand the current process, indicators to identify weaknesses, measures to identify desired (**To-Be**) process and attributes of strategies for improvement. Generally, there are four different scales of measurement (Bell, 1999; Kothari, 2004; Sekaran, 2003; Robinson, 2004) that include: nominal, ordinal, interval and ratio scale. Of these four scales, two measurement scales, ordinal and ratio scales were used; the reasons for their use are described in the following sections:

In the introductory part of a tool for data collection (section 4.5.6), the researcher sought the facts about respondents and firms' experience in the firm as well as in the construction industry. In addition the respondents were given questions to indicate firm's category (e.g. contractor, consultant, amongst others), year or experience in the business, amongst others, items of which were to be perceived and filled-in in the cells provided, (this has facets of ratio scale). This is so because ratio scale has a starting point and the interval that can be measured with interval data such as income, age, weight, height, experience, amongst others. It also has all properties of other measurements (nominal, ordinal and interval scales) (Kumar, 2008).

In the remaining part of a tool for data collection, the questions were aimed to test the five dimensions of the model: BPR foundation, understand the current process, identify process weaknesses, identify desired (**To-Be**) process and strategies for improvement of processes. The questions were designed such that respondents conceptualize whether the prescribed item of a specified dimension is agreed or not when permitting comparisons of high to low rates and ranks as of: 5 strongly agree, 4 agree, 3 average, 2 disagree, 1 strongly disagree of the phenomena. These represent features of the ordinal scale of measure. By using ordinal scale of measure, participants were able to give diverse views from 1 to 5 that generalized ideas for acceptability of the dimension of the model.

4.9 Validation and Reliability of the Questionnaire

4.9.1 Validity of Questionnaire

Validity of the research is the accuracy to which a test or an instrument measures what it was designed to measure. It concerns whether the instrument measures what it was supposed to measure (Kumar, 1996; Kumar, 2008). This study achieved aspects of validity by avoiding five types of errors that mostly occur in the quantitative study. They are: instrument design errors, respondents' groups' errors, sampling technique errors, Data collection measurements errors, and construct validity errors (Churchill, 1979; Perez *et al.,* 2001; Straub *et al.,* 2004; Kumar, 2008; Udo-Akang, 2012). Description on how each type of validity error was avoided is given as follows:

(i) Instrument design errors – these are errors that occur in improper designed questionnaire instrument. They also relate with an instrument that necessary constructs are not incorporated (Straub *et al.,* 2004). Such errors were avoided in the study by conducting a pilot study that: reworded the questions, identified and refined ambiguous questions, long questions were cut short, or rather, improved; generally, refined all questions and ensured that they are clear and their numbers were possible to be responded by the practitioners (see section 4.6).

(ii) Respondents group errors – the error caused by not using relevant respondents (Smith and Abaum, 2012). These errors were avoided in this research by considering respondent firms represented by main project participants (clients, consultants, contractors, developer and a regulator). Their number(s) were related to their extents of engagement with a project' accomplishments (see also Table 4.2). They were the firms also established to adopt process focus (necessary facets to test BPR phenomenon). Criteria of selecting respondent groups are described in section 4.5.3.

(iii) Sampling technique error - may be created due to using only those mostly available and accessible, ending up with misrepresentative information (Kumar, 2008). Non probability sampling technique was adopted that allows selecting those who qualify, accessible, and are willing to participate. According to the purpose of study, that made practitioners discuss the dimensions of the model and understand it, so as to later on implement the study phenomenon (Kumar, 2008), the firms with systematic processes (those who deploy process focus) were used.

(iv) Data collection measurement errors – they are also termed as surrogate information (Kumar, 2008; Smith and Abaum, 2012). They relate with the missing of the needed data. In this study, a questionnaire was well designed to represent the dimensions of the model (see reviewed work), and, a pilot study conducted to a selected firm that represents main project participants who refined the data collection tool. The refined tool was used in the data collection. Indeed, data were collected from expertise experienced in the firms as well as in the construction industry.

(v) Construct validity errors - relating with the measurements between constructs (Smith and Albaum, 2012) i.e. the constructs are considered lacking meaningfulness within their theoretical settings (Straub *et al.,* 2004). This error was avoided since all the constructs of the data collection instrument were based on the relevant literatures. For example, constructs of design process performance were formed from design inputs – users requirement, own requirements, financier needs, amongst others; design activities – preliminary design and detail design, amongst others (Gray and Hughes, 2001; Emmitt, 2007; Tzortzopoulos and Cooper, 2007; Jackson, 2010).

Generally, although no all errors can be removed perfectly at 100 percent (Kumar, 2008), however, they were greatly reduced using the aforementioned methods.

4.9.2 Reliability of the Questionnaire Survey

Reliability refers to whether you get the same answer by using an instrument to measure something more than once (Bernard, 2006). It is the consistency of the results from a test (Korb, 2014). Out of the methods available to measure reliability, three are of popularly use: (i) test-retest – on which the same set of respondents complete a survey at two different times (ii) alternate-form – different worded items measure the same attribute (iii) internal consistency - measure how well the different items measure the same concept. While the first two methods have limitations of deploying two administrative of the instrument on the same people, internal consistency method requires only one administrative method, and it was adopted in this study. In it, the split-half method allows the scale/items to be divided into two halves, usually odds and evens. Using the Spearman-Brown Prophecy formula, the scores for each halve of the items/scale are used to calculate reliability coefficient (Ary *et al.,* 2010; Korb, 2014). A correlation coefficient varies between 0 – 1; when the value is close to one, the more the items are internally reliable in the scale.

The spearman-Brown prophecy formula is:

$$r = \frac{2r_i}{1 + r_i} \quad \text{...Equation 4.1}$$

Where:

r_i = is correlation between the half tests, further calculated with Equation 4.2, and r = is the reliability projected for the test/scale,

$$r_i = \frac{\sum\left(x - \bar{x}\right)\left(y - \bar{y}\right)}{\sqrt{\sum\left(x - \bar{x}\right)^2\left(y - \bar{y}\right)^2}} \quad \text{...Equation 4.2}$$

$\overline{X}$ = mean for values of odd items; $\overline{Y}$ = mean for values of even items; X =sums for each odd values and Y = sums for each even values.

In this research, scores from twenty six respondents in surveys who assessed the items of the scale (that sought opinions on acceptability of sixteen indicators to identify design process weakness) are tested using Spearman-Brown Prophecy formula, Equations 4.1 and 4.2, see also Appendix E.

Therefore, using these equations, reliability correlation was equal to **0.81**, indicating that the items in the scale are internally reliable, Response score values of design performance do not differ significantly with that of procurement and construction management, therefore, the tools to assess these variables are also reliable.

4.10 Analysis of Data Collected Using Questionnaire Survey

Data analysis of a questionnaire survey was conducted in three stages presented in the subsections that follow:

4.10.1 Data Coding and Entry into Computer

Any data that are collected from survey instrument must be coded. Therefore, data coding is a plan for organizing research responses into a form that they can be properly analyzed. Data coding process involved three steps as follows:

- Preparation of data summary sheets;
- conduct 'record scheme' – transfer of data from questionnaire into data summary sheet; and
- Enter the data from data entry sheet into a computer and ensure cross checking so as to obtain accurate results.

4.10.2 Data Analysis

Data collected from surveys were checked for each and all of three credentials: completeness, readability and consistency. Then, they were arranged in a form that they could be analyzed. In the current research, data that relate with the dimensions of the model: BPR foundation, indicators to identify process weaknesses, measures that identify desired (**To-Be**) processes and strategies for improved processes were of quantitative nature (i.e. they were obtained from ordinal scale), they therefore analyzed using an Excel programme (a quantitative method).

In the use of Excel programme, statistic variables, mainly mean of the data was used amongst other variables. This is explained in brief, in Section 4.10.3. Based on the obtained results, statistical bar graphs, histograms and pie charts were used to produce pictorial interpretation of the results.

Other than the quantitative data, the other question in the survey sought opinions or suggestions from respondents about anything they think can further improve the model. Practitioners were therefore asked to add any attribute, or, suggest any redundant attribute or outline anything likely to obstruct the model implementation. This question was an open ended type with the facets of the qualitative nature. It was therefore described consistently following the arguments of the question.

4.10.3 Mean Score Values

The analysis of the opinions from practitioners that determine the extent to which practitioners agree or disagree about the proposed dimensions of the model were carried out by using ‘mean value scores’. Each of the dimensions of the model was broken down into statements/questions/indicators where, each of them was determined its mean value ranked to determine a significant attribute of category, on which a mean value above 3.0 was used.

The mean value on determination of acceptability of these dimensions were obtained by taking summation of multiplying the frequencies of occurrence and the rating (usually 1- 5). These were then divided by the total number of respondents concerning that factor. A formula for this computation is shown in Equation 4.3.

$$M_x = \sum \frac{F_i \, X \, S_i}{N} \quad \text{..Equation 4.3}$$

Where:

F_i = frequencies of respondents given to each factor by respondent category;

S_i = the rating ranging from 1 – 5;

N = number of respondents concerning the factor;

i = i^{th} relevancy and acceptability of the model dimension on identifying weaknesses or radical change improvement; and

M_x = the mean rating (giving feeling of involved respondents) about a variable.

Summary computation of the mean value is given in Table 4.3. Information from this Table helps to quantify mean score value needed to compare indicators studied.

Table 4.3: Summary Computation of Mean Value

Indicators	Attributes	Scores (Si) and Frequencies (Fi)					Total score	Mean score
		1	2	3	4	5	$\sum$Fi x Si	$M_x = \sum \frac{F_i \, x \, S_i}{N}$
		Fi x (Si=1)	Fi x (Si=2)	Fi x (Si=3)	Fi x (Si=4)	Fi x (Si=5)		
Inputs indicators	1							
	2							
Activities indicators	3							
	4							
Interfaces indicators								

Sources: (Kothari, 2004; Bernard, 2006)

In presentation of mean score values, note that Likert scale provides ordinal data that are rated and the order matters. Therefore, the mean score/average rating may represent numbers outside their translation category. They may produce a value of 1.3 for example, which translates ideas of respondents falling between strongly disagree to disagree or 4.3 which is between agree and strongly agree. This causes difficulty in translating results in the five point scale. To avoid this ambiguity, this study established continuous average ratings and proposed their respective ordinal values to help translate results in a true way (Table 4.4). The proposed ordinal values helped to translate results without ambiguity.

Table 4.4: Means Scores and Ordinal Values

Mean Scores/Average Ratings	Ordinal Values	Translation of the results of the studied issue
0.0 – 1.5	1	Strongly disagree that an issue studied identifies weaknesses, create radical changes etc
1.51 – 2.5	2	disagree that an issue studied identifies weaknesses, create radical changes etc -
2.51 – 3.5	3	Stand strongly disagree to strongly agree (average)
3.51 – 4.5	4	agreed that an issue studied identifies weaknesses, create radical changes etc -
4.51 - 5	5	Strongly agreed that an issue studied identifies weaknesses, create radical changes etc

4.11 Conducting Case Study to Validate the Model

4.11.1 Rationale of Case Study

Case study was conducted with the aim of validating the model. This was done because no model can be proposed for use before validation. The validation process therefore led to achievement of Specific Objective four of this research. This case study method was selected due to three main reasons that are described as follows:

4.11.2 The Individual Nature of Investigation

In this study, indicators were established and categorized under critical inputs, critical activities and critical interfaces, risk management and IT. It was intended that an indicator is investigated to provide evidence that it identifies process weaknesses and, or, create a desired (**To-Be**) process change. Therefore, the following questions were used: how does the indicator identifies a weakness? how does the indicator create a desired (**To-Be**) process? why such weakness occurs, and, why a desired (**To-Be**) process is not created?. These 'why' and 'how' questions demand case study research (Dawson, 2002; Creswell, 2007; Hurley *et al*., 2011).

4.11.3 Multiple Sources of Evidence

Multiple sources of evidence relate to investigations conducted encompassing more than two cases, using more data sources, amongst others; these help to replicate study findings as well as making it more robust (Brinberg and McGrath, 1987; Creswell, 2007). Sources of evidence in this research were four embedded groups (structure, survey, highway and management) within a consulting firm. In each of them, indicators to identify weaknesses and, or create desired (**To-Be**) process changes were investigated. Moreover, on each group studied, one or combination of the four methods: narrative, interview, observation and documentation were used. By using combination of the methods, it was possible to address drawbacks within them. For example, when a narration was unable to provide full information, this was capitalized by either observation or documentation studies (Yin, 1993; Creswell, 2007). Therefore, the case study strategy was used because it allowed the use of four embedded cases and methods that replicate information.

4.11.4 Previous Empirical Reengineering Studies in Construction

A number of reengineering studies in construction were conducted through case study approach; see for example (Allweyer *et al.*, 1996; Brown and Riley, 2000; Riley and Brown, 2001; Chanoenngan *et al.,* 2004; Albizu and Olazaran, 2006). Allweyer *et al*. (1996) conducted case studies to two (Spain and England based construction firms) and presented a framework for modelling and redesigning business processes and information systems. Their framework constitutes BPR facets that are learned from manufacturing industry. Brown and Riley (2000) conducted case study for procurement process of bridge project in the United Kingdom. The findings of the study resulted in a cut down of a number of procurement activities, leading also to 20% cost reduction and a significant compression of contract programme. Riley and Brown (2001) conducted case study to map out work operations of the UK based (P Trant Limited) an SME contractor. The results were confidence built among the employees involved on how to conduct process mapping and redesign processes.

The cited and discussed reengineering studies indicate that conducting case studies in the construction industry helped to collect appropriate data. They also informed this research on how to improve construction project performance from start to end. Generally, conducting case study to validate the model had one aim of checking that the proposed indicators identify weaknesses, and, or create desired (**To Be**) process change. Case study design to validate the model is described in the following section.

4.11.5 Case Study Design

According to Yin (1989), a case study design is the logical sequence that connects the empirical data to a study's initial research questions, and ultimately, to its conclusions. Five aspects are proposed for consideration in case study design (Yin, 2003; Hurley *et al.*, 2010). They are outlined and described with intention of their use in the current study: (i) preparing research questions (ii) selecting cases (iii) preparing protocols (iv) describing the methods, data collected and data analysis and (v) describing quality for judging quality of data.

4.11.6 Case Study Search Questions

As introduced in the previous section, five categories of indicators were identified: critical inputs, critical activities, critical interfaces, risk management and IT. They were used to assess operative performance within four groups (highway, survey, structure and management) on a road construction project. On each indicator, four questions were posed: (i) how does the indicator identifies weaknesses when operate in practice? (ii) how does the indicator create desired (**To-Be**) process change when operated in practice? (iii) why weaknesses occur (iv) why desired (**To-Be**) process was not created?. These questions helped to identify weaknesses, and, or, create desired (**To-Be**) process change.

4.11.7 Cases Selection

Case selection was divided in three sub-parts, (i) selection of case-study-area (ii) case(s) selection and (iii) functionality of groups studied. Descriptions follow:

- Case Study Area Selection (i.e. Mbeya City)

Mbeya city was selected as an appropriate region for conducting case study due to two main reasons. Firstly, it is one of the four major zones in the country; others are Dar es Salaam, Mwanza and Arusha. Therefore, Mbeya as a region and as a major zone, influences huge buildings and road construction projects to be executed annually. Secondly, this region is the place where the researcher is employed; therefore, it was easier for him to conduct case study.

- Selected case(s)

As stated in section 4.11.2, the indicators studied come from actual road construction project to identify weaknesses and desired (**To-Be**) processes. And the fact that a project is accomplished by three main contracting parties: a client, a consulting firm and a contractor. Client finances the project and approve the works, although this role was perceived important by the researcher, however, it was not prioritized on the case study. Contractor executes works directly, but, project control decisions are made by the consultant. Indeed, a contractor on which this project was studied was the Chinese firm who was unable to communicate efficiently in both English and Swahili. This firm also had its work offices placed away from Mbeya City; which was difficult to reach by the researcher; therefore, it was not selected. Consulting firm engaged with both re-design of the new emerged works and inspected work executions. Its work offices were located in Mbeya city, and had reliable supervision vehicles to transport employees to the work sites and office. The consulting firm also: had more than eight years experience in construction, (eight years was judged enough experience by a researcher); was willing to participate; is registered by the ERB; had ongoing project which is huge enough to provide sufficient information in this research. Therefore, a consulting firm was selected and studied.

The consulting firm was a foreign firm, but, huge amounts of tasks were being done by the local practitioners. This firm originates from Ireland and operates its business all over the world. The actual work study was a tarmac road project which covered a length of seventy six kilometres from Mbeya Municipality to Chunya town.

Conducting case study in a consulting firm engaging with one project had facets of a single case. Single case has disadvantages, as Hurley *et al*. (2011) and Susan (2015) note, one of the more controversial design issues in case study research is whether or not a single case is sufficient. Yin (1993) points out that, objection to single case research concern about representativeness of the chosen case, the extent to which generalizability is possible amongst others. Further, a single case brings difficult to carry out comparative analysis (Yin, 2003).

To avoid such shortfalls, a project was studied within four expertise groups (structure, highway, survey and management) in a consulting firm. This has concepts of embedded case study design type since it deals with a single case, but, gives attention to sub-units within it (Yin, 1993). Embedded case study design has similar advantages with multiple cases in that, its findings are considered more compelling and robust (Creswell, 2007). It also allows theories to be better grounded in more varied evidence, and they allow cross-comparison (Yin, 2003).

- Functionality of the Groups in a Consulting Firm

Functionalities of four groups studied are presented: (i) Management: had a resident engineer who engaged with planning, controlling, studying risks and their management, amongst others. (ii) Highway - was led by a highway engineer, responsible for: planning and controlling of laboratory works, borrow pit materials, earth working, amongst others. (iii) Structure was led by a structure engineer, responsible for: planning and controlling of gabions and culvert structures and (iv) Survey was led by a land surveyor, responsible for: planning and controlling survey tasks: providing marks on road positions, culvert and gabion structures' positions amongst others.

It was also generally considered that, any work that cross-cut the respective groups, decisions and approvals were shared by all such responsible groups.

4.11.8 Preparation of Case study Protocols and Approaches to Data Collection

- Data collection protocol

Data collection protocol was prepared to guide case study data collection exercise. It represented indicators for assessing road construction accomplished by four embedded groups (highway, survey, structure and management) in a consulting firm. The indicators are addressed by the four search questions (see Section 4.11.6). The indicators and the four groups studied are presented in Table 4.5. From this Table, it was easy to identify directly the respective group and a specified indicator(s) studied; thereby, providing more clarity and consistent data. Protocols of case study are attached as Appendix F.

Table 4.5: Indicators Studied on On-going Road Construction Project

s/n	**Aspects studied**	**Indicators**	**Groups to which operational indicator was studied**
1	Critical inputs	Competent designer	Structure, highway and survey
		Technology used	All four sections
	Critical activities	recording of the work	Structure, highway and survey
		on-time study delivery	Structure, highway and survey
		on-budget study delivery	Structure, highway and survey
	Critical interfaces	Approvals or relationships between activities	Structure, highway and survey
2	Risk management	Risk registrar template	Management section
		Risk management adoption	All four sections
3	IT technology	Record, store, process	All four sections
		Print, photocopying	All four sections
		Internet and emails	All four sections
		Database	All four sections
		LAN	All four sections

- Data collection approaches

Data collection started with the introduction letter presented to the respective firm (see Appendix F). This letter introduced a researcher to the firm management led by a resident engineer who also agreed the request of data collection needs. Resident engineer, thereafter, introduced the researcher to the respondents, whom, thereafter, scheduled on the appropriate dates, time of data collection.

With regard to data collection, a protocol was used as a basis. Data was collected as follows. In day-cycle one, study was conducted in the office, proximity sites, furthest sites and study and evaluate documents in the office. In day-cycle two, the study was conducted in the office, proximity sites and evaluates documents in the office. In day-cycle three, study was conducted in the office, proximity sites, in contractor's laboratory and study documentations in the office. In day-cycle four, study was conducted in the furthest sites, and study documentations in the office. A circle repeated all the time of the case study.

4.11.9 Description of the Methods, Data Collected and Data Analysis

Four methods, data collected and analysis is described as follows.

- **Narrative/Interview Study**

Narrative study was used in line with interview method. Narrative study involved an inquiry where a researcher examined the story the leader of the respective group gave about project practices (Ary *et al*., 2010). This method allowed respondents to tell the story continually following a protocol that addressed the search questions of the research (Kumar, 2008).

- **Observation**

Observation method was used because it gives opportunity to a researcher to access events and processes that not accessible through other methods (Yin, 1993). It also replicates other methods to maximize the evidences (Kumar, 2008). In this study, two types of observational studies were conducted (i) on work site operatives and (ii) on the offices. In the work sites, observations related to how: works were accomplished, directives were given to subordinates, amongst others. In the offices, observation sought how employees extract information from documentations, amongst others.

- **Documentations**

Documentation approach was adopted when information was found insufficient as studied on a narration or interview (Yin, 2003). In addition, in few occasions, documentations were used as a standalone method of study. For example, it was studied on whether a firm implemented works according to specifications or not.

Steps for conducting case study design are presented in Figure 4.2. They include stages where firstly, BPR conceptual model was developed, research questions prepared, case selected, case study protocol prepared, then data collected and analyzed for each and all studied groups.

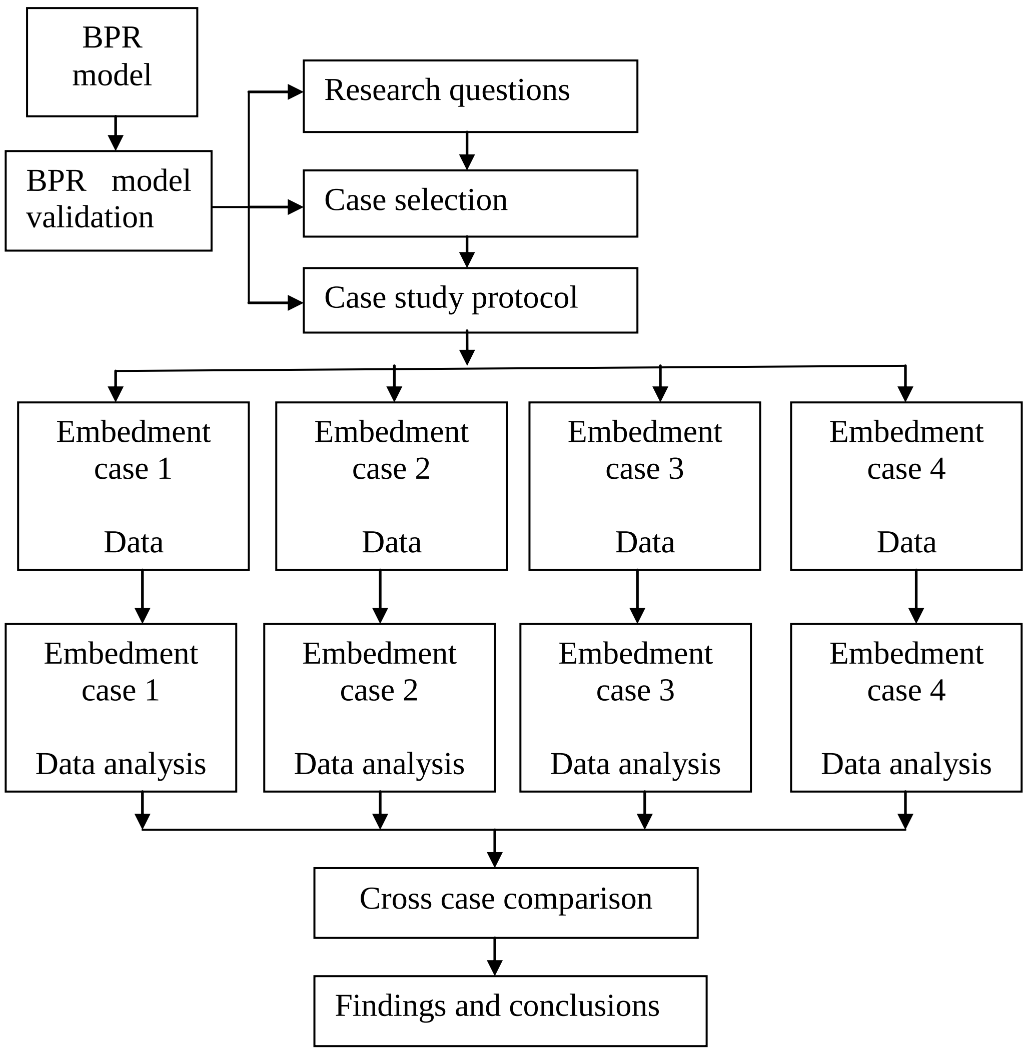


Figure 4.2: Steps in the Embedment Case Study Design of this Study
Source: (Adapted from Susan, 2015)

4.11.10 Criteria for Achieving the Quality of the Case Study

The final aspect of consideration in conducting case study was about achievement of the quality. Creswell (2007) and Takie (2005) state that equipping efforts to achieve the quality in case study design adds up the confidence in study findings. In agreement with this view, Yin (2003) identified four tests to be used to measure the quality of case study design that are also used in this study. Brief descriptions follow:

(i) Construct Validity

Construct validity measures the extent to which the items in a scale all measure the same construct (Flynn *et al*., 1994). In achieving construct validity in this study, multiple measures defined by the indicators, critical inputs, critical activities, critical interfaces amongst others were evaluated and measured for determination of weaknesses and creation of desired (**To Be**) processes. Indeed, four data collection methods were deployed: narration, interview, observation and documentation that maximize quality of the study (Creswell, 2007).

(ii) Internal Validity

Internal validity refers to as the causation of the effect (Bernard, 2006). A data collected to identify process weaknesses, for example, were used on justifying this. For example, an indicator (IT) studied, when no computer PC was available in the expertise's office; this caused work delays, amongst others, which is causation effect.

(iii) External Validity

This measure checks whether the study's findings are generalizable or not (Brinberg and McGrath, 1987). In this study, indicators to identify process weaknesses and create desired process were ensured to generalize results on four groups studied.

(iv) Reliability

Reliability focuses on the extent to which a measure gives the same results in repeated trials (Brinberg and McGrath, 1987). This can be achieved through the use of study protocol (Yin, 1993). 'Case study protocol' which is one component of this study's design, and also that accepts with the Yin (1993)'s view, was prepared prior to data collection, using it on the data collection, analysis and achieving conclusion.

4.12 BPR Model Parameters that Improves Traditional Process Performance

4.12.1 Conducting Interview and Documentation studies (Overview)

In order to identify that the BPR model improves traditional process performance, four BPR parameters were studied in the selected organizations and respondents. Descriptions follow.

4.12.2 Appropriate Project Brief Deployed by Conversant Client and Design Team

In the current study, a 'Project briefing' was studied where the conversant public client and design teams were studied on information they provide against the traditional process. The project studied was 'Construction of Theatre and Sterilization Unit at Mbeya Regional Hospital'. The client was/is Regional Administrative Secretary (Mbeya), designers and a contractor are Tanzania Building Agency (TBA), and users are Ministry of health and regional hospital employees. The project scope covers two storey building costing Tshs. 3,971,218,460.00; scheduled for two years from 22/7/2017 to 22/7/2019. The researcher approached both client and consultants' management with the introduction letter (Appendix J) to introduce him. Public client was represented by a civil engineer, whereas TBA (a designer and a contractor) were represented by architect, quantity surveyor, civil engineer and a technician. After introduction, both parties met together and interviews and documentation studies conducted. Project briefing files were evaluated and interviews were used in justification. Result is given in Chapter Five.

4.12.3 Deploy Optional Sketch Drawings

A 'building sketch' was studied in order to establish that the option sketches deployed in BPR model avoid reworks during actual project implementation. The project studied was ‘preparation of architectural drawings for a bungalow building of a private client. It was prepared by the E and G Archit. Firm. Optional sketch adopted was a serial fashion type. This is the one in which, first rough sketch option is prepared, then continued to be re-amended by incorporating inputs from the client(s) (Halpin, 2006). Several re-amendments were made by the architect as he continued incorporating inputs from the client (they were shown in plans and the 3D model). Results are presented in Chapter Five.

4.12.4 Perform Constructability Study

The ‘constructability’ as one parameter of BPR model was studied to help in identifying weaknesses in traditional design process performance. It was conducted by a researcher and an engineer representative from the client organization. The intention was that, if design documents are reviewed by other firm than those involved in the design, it would help in identifying and eliminating hurdles that might be overlooked during design stage (Pruett, 2004; AACE, 2009). The hurdles include errors, mistakes amongst others. Two indicators were studied, they include: (i) buildability and (ii) enforceability. Procedures follow. Three members, a quantity surveyor and a civil engineer represented client; they participated in the study. The indicator ‘buildability’ studied any event or anything likely to, or, create a problem, e.g. omissions - lack of specified detail, plan, section etc.; error or mistakes, amongst others. The indicator ‘enforceability’ investigated any ambiguous in the contract, e.g. poor descriptions and unclear statements in the contract etc. Results are presented in Chapter Five (see also Appendix J).

4.12.5 Adoption of Flexible Procurement Options

A parameter of the current BPR model ‘deploys the procurement options’ was studied to address rigidity that exist in the traditional process. Rigidity relates to deploying more on competitive procurement with little or no use of other options. To achieve this aim, for the financial year 2017/2018, TARURA Mbeya was studied by the researcher on the ways they utilized procurement options for road projects.

Interview was conducted that was capitalized by the documentation studies. Main issues were: for example, functionality of TARURA, number of projects implemented during a specified year, procurement method used, reasons for deployments of such methods, their benefits, amongst others. Results regarding deployment procurement options are presented in Chapter Five.

4.13 Chapter Summary

This Chapter presented methodology adopted in this research. Research approaches that comprise the methods and their rationale of use were presented. Data collection techniques and tools are also presented. Methods and tools to achieve each of three main components of a BPR model developed are discussed: (i) BPR conceptual model (ii) BPR model development and (iii) BPR model validation. The next Chapter presents the study findings, discussions and analysis.

CHAPTER FIVE

STUDY FINDINGS, ANALYSIS AND DISCUSSIONS

5.1 Introduction

Previous Chapter presented methodology adopted in this research. The Chapter continues with the presentation of research approaches that comprise the methods and their rationale of use. Data collection techniques and tools used are also presented. The objectives of the study are outlined in Chapter One and the methods, tools and techniques used for their achievement are discussed in Chapter Four and schematically represented in Table 4.1 and Figure 4.1. Therefore, in this Chapter, the study findings are presented chronologically, following the way each research objective was proposed and achieved.

5.2 BPR Conceptual Model Development

Objective one of this research aimed at ‘developing a BPR conceptual model for improving ‘project processes performance’. For this objective to be achieved, theories relating to local construction industry performance, and processes performance measurement: project process performance – general, BPR philosophy, process measurement and organizational processes were reviewed and evaluated where the constructs and their relationships were identified and used to formulate a BPR conceptual model. This model consists of five dimensions: BPR foundation, understand current process, weaknesses of current process, desired (**To-Be**) process and continuous improvement. The model’s dimensions may also stand as the steps to implement the model (See Figure 3.6, Chapter Three).

5.3 Results of a Survey that Investigates Indicators to Identify Weaknesses and Strategies to Improve Core Project Processes

Questionnaire and interview surveys were conducted in order to achieve the two aims. Firstly, to achieve specific objectives two and three of this research: - specific objective two, ‘to analyze indicators that identify weaknesses of project processes and their performance'. Data required for achievement of this objective was opinions from practitioners that investigated identification of process weaknesses through the use of the developed indicators. Specific objective three, 'to analyze strategies for achieving improved 'project processes', on which data required for its achievement was the opinions from practitioners that identified fitness/relevance of the proposed strategies to improve core processes in a continuous way. Secondly, to elicit overall survey data collected to help develop BPR model.

Data for achieving these two aims were organized in seven sub-themes: (i) descriptions of general respondents (ii) acceptability of the dimension 'BPR foundation' (iii) acceptability of the indicators that improve a project process (iv) acceptability of indicators that identify process weaknesses (v) acceptability of measures that create desired (**To-Be**) process (vi) acceptability of strategies for achieving improved process and (vii) acceptability of the holist BPR model. They are described in the sections that follow:

5.3.1 Respondents

Interview and questionnaire surveys were conducted to public clients, consulting firms, contractors, property developers and a public procurement regulator with a total of thirty five (35) respondents. Table 5.1 outlines the numbers and percentages of the respective respondents against the firms which they represent. Therefore, 4 public client firms were represented by 4 employees, 7 consulting firms represented by 14 employees, 7 contractors represented by 14 employees, 1 developer represented by 2 employees, and 1 regulator represented by 1 employee. These employees were working in the firms as the project's administrators. Project administrators deal with daily project implementation and control, therefore, combinations of their valuable ideas were considered as useful inputs towards project performance improvement.

Table 5.1: Firms and Individual Respondents Involved in the Interviews and Questionnaire Surveys

S/N	Category of the Firm	Numbers of Firms Involved	Numbers of Individuals Respondent
1	Clients	4 (20%)	4 (11.4%))
2	Consultants	7 (35%)	14 (40%)
3	Contractors	7 (35%)	14 (40%)
4	Property Developers	1 (5%)	2 (5.7%)
5	Public Procurement Regulator	1 (5%)	1(2.86%)
Total		**20 (100%)**	**35 (100%)**

With the fact that public clients, developers and regulators are not categorized, consulting firms and contractors are categorized. Among the 14 contractors involved in the study, there were 12 (83.3%) local and 2 (16.7%) foreign contractors; and, among 14 consulting firms involved, there were 10 (71.4%) local and 4 (28.6%) foreign consulting firms (see Figure 5.1). While the foreign firms were included in the study to provide experience from outside Tanzania, the local firms would retain the study phenomenon. Therefore, large numbers of the local firms and individual employees employed help in retaining study phenomena.

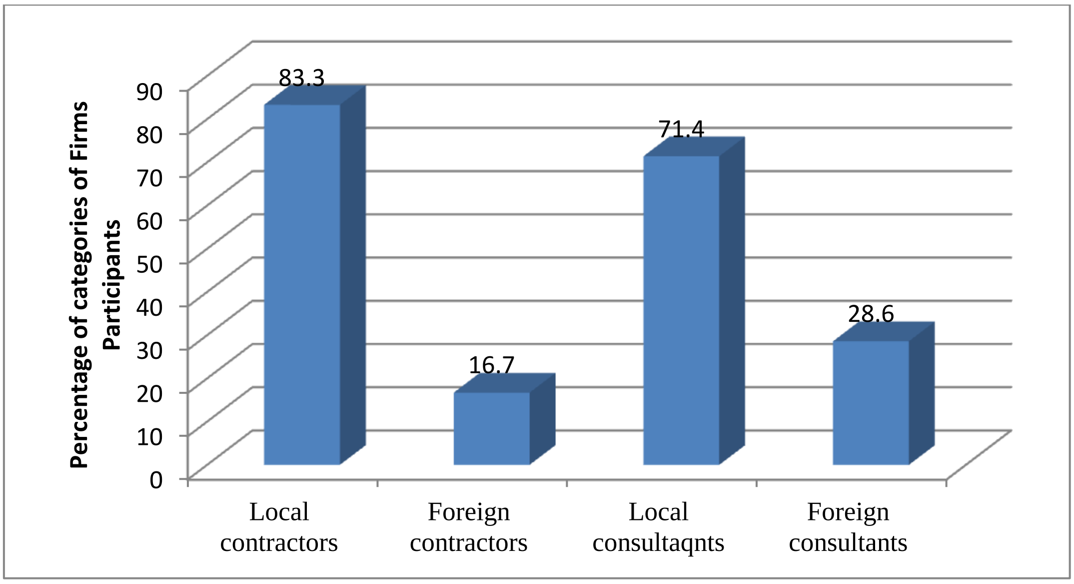


Figure 5.1: Firms Categories in the Business

Respondents holding highest positions in their firms were targeted and used. Therefore, they provided knowledge about the firm's practices (from the past, current and future) about projects process performance. Figure 5.2 shows types of respondents and their management positions in the firms. The management rank positions are: project managers 11(30.3 %%), site agent 17 (51.5%), directors 1 (3%), other professions included electrical and mechanical engineers 6 (16.4%) [Figure 5.2]. Therefore, majority respondents (84%) participated in the highest positions in their firms. This shows they knew better about the firm's operative practices.

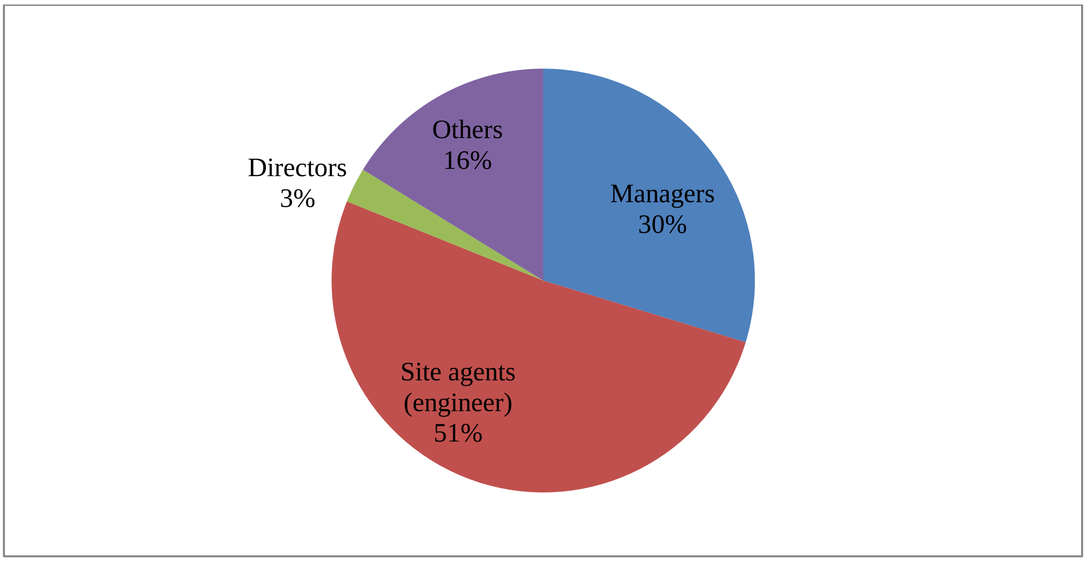


Figure 5.2: Percentages of Respondents in the Firm Management Positions

Respondents' careers were also determined in order to gauge the fact that information sought came from those who truly were project practitioners. This gives confidence that the attributes used in the study are shared with credible respondents. Therefore, there were 19 (54%) civil engineers, 11(31%) quantity surveyors, 2 (6%) architects, 2 (6%) mechanical engineers and 1 (3%) electrical engineer (Figure 5.3). Civil engineers had large share of career representation followed by quantity surveyors. This is because they are the careers highly involved in the site works.

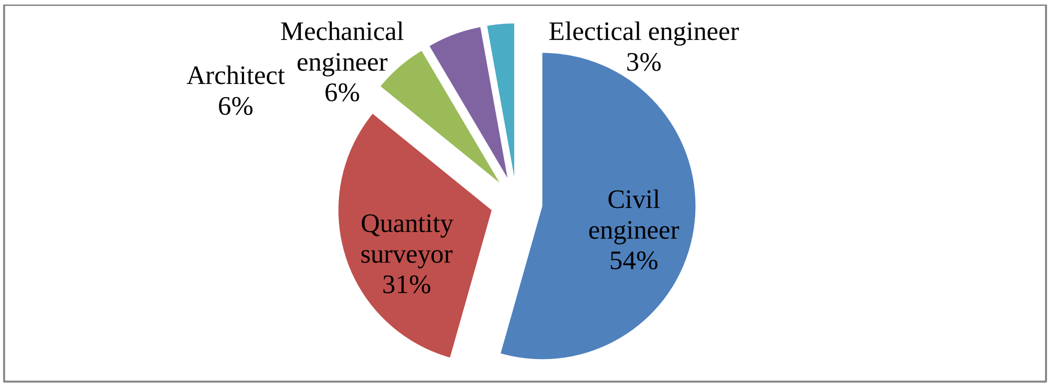


Figure 5.3: Percentages of Five Careers Involved in the Study

Experiences of the respondents in the firms helped provide insights that are credible since these respondents were engaged in the firm's day to day operatives. Experience in the industry helped to capture broad views of the project operations. Therefore, these experiences gave credible results, see Table 5.2.

Table 5.2: Experiences of the Respondents in the Firms As Well As in the Construction Industry

Years	**Below 2 years**	**2 - 5 years**	**6 – 10 years**	**11 – 15 years**	**16 – 20 years**	**More than 20 years**	**Total**
Years in the firm	5 (14.2%)	12 (34.2%)	10 28.6%)	1 (3%)	3 (8.6%)	4 (11.4%)	**35 (100%)**
Years in the construction industry	-	2 (5.7%)	13 (37.2%)	8 (22.9%)	3 (8.6%)	9 (25.7%)	**35 (100%)**

Table 5.2 shows numbers of years the respondents have been working in the current firm as well as in the construction industry. In this Table, 34.2 % and 28.6% of the respondents indicated that they had been in the respective firms for a period of 2 – 5 years and 6 - 10 years respectively. On the other hand, (11.4%) respondents had more than 20 years in the firms. Majority of the respondents that is, 37.2%, 22.9% and

25.7% respondents indicated to be in the construction industry business for periods of 6 – 10 years, 11 – 15 years and above twenty years respectively.

With these data, the indication is that majority of the respondents were experienced in the project implementation businesses in the construction industry than in their firm's context. Of importance is that, both experience contexts focus on project processes performance occurring within the hands of the contracting parties.

Generally, the results indicated that the majority of the respondents in the survey are civil engineers, work in management positions, have adequate experiences both in the firms they are working with as well as in the construction industry and are legally registered by their respective regulatory bodies (especially the contractors and the consultants). Given these findings, it is concluded that the respondents used in the research were sufficiently experienced in the construction business. Therefore, they provided data which are credible.

Before explaining data collection process, it is necessary firstly to explain on how the exercise was conducted, generally. As indicated in the firms' profiles, thirty five respondents were involved in the study. However, two respondents from two firms (consultant and contractor) could not fill-in questionnaire as required. They ticked almost all items in one score level; thus, their questionnaires were not considered in the analysis, leaving a countable questionnaires stand at thirty three in number. Next section is the presentation of analysis of attribute 'BPR foundation'.

5.3.2 Acceptability of Attributes for 'BPR Foundation'

The dimension 'BPR foundation' was intended to assess any firm that prepares to conduct BPR. In order to achieve this aim, respondents were asked to give opinions on acceptability of proposed eight attributes of BPR foundation. A five point Likert scale was used that indicate a range from 1 - strongly disagree to 5 strongly agree on acceptability of these attributes. A mean values of 3.0 and above were considered acceptable. In results, the mean values of each of the attributes are presented in Figure 5.4, indicating that all of them score above a mean value of 3.0 that is acceptable.

The attributes ‘appoint a person to lead and manage changes’, ‘appoint appropriate team to champion and enable the changes to happen’, and ‘establish programmes to train employees’ were ranked in the first and second positions, thus, they are most appropriate to guide BPR preparation with mean values of 4.9 and 4.8 respectively.

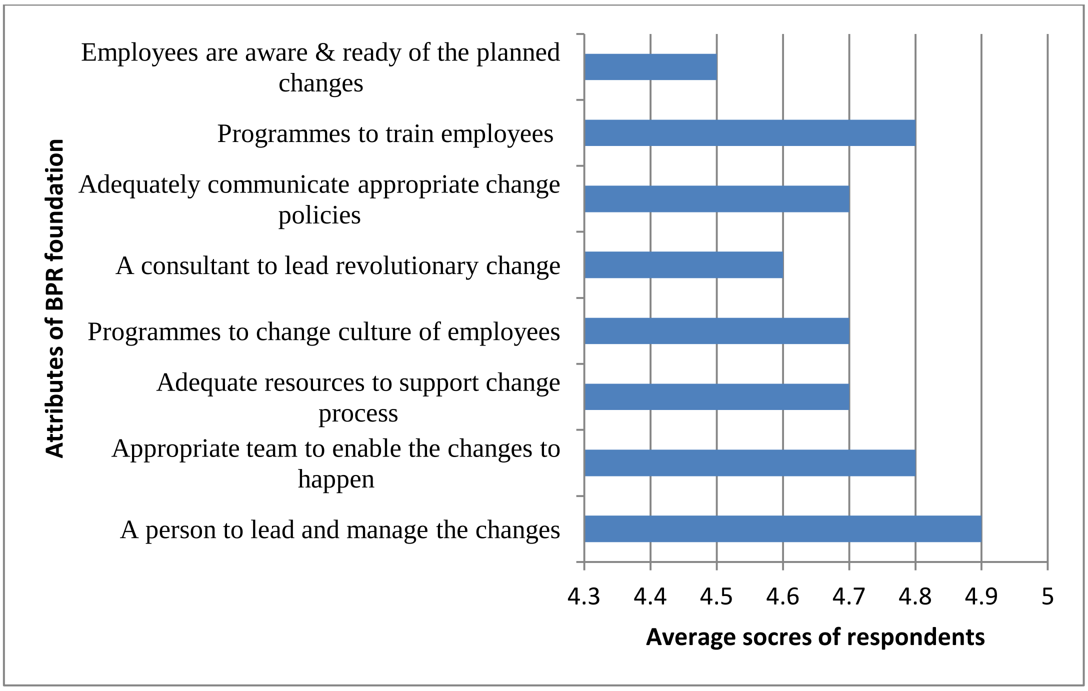


Figure 5.4: Respondents’ Results on the Parameter ‘Build BPR Foundation’

‘Appoint a person to lead and manage changes in the firm’ was ranked in the first position with a mean value of 4.9. It was considered most relevant attribute that guides a firm on the efforts to prepare to adopt BPR. The BPR preparation efforts are enhanced by a person with specified qualities: visionary, wisdom, self esteemed, respect, ability to manage changes, amongst others. This result concurs with other studies, for example, Marchand and Stanford (1997) and Guimaraes (1998) who provided evidence of the

BPR success initiatives that were supported strongly by visionary leaders in their firms. 'Appoint appropriate team to champion and enable the changes to happen' was ranked in the second position with a mean value of 4.8. This is so because team constitute talented individuals who may be involved with different tasks when implementing BPR changes. The team is formed based on criteria: uses a senior individual who has both the authority (as a leader) and commitment to rethink on about the changes, reasonable numbers, and representation of cross-functional roles amongst others (Pearman, 1999). Al-Mashari *et al*. (2001) support this view by pointing out potential work roles initiated by BPR team who implemented BPR in the USA and in the Europe.

'Establish a programme to train employees' was also ranked the second in the list with a mean value of 4.8. This is acceptable because it helps to provide exposure on different lessons that innovate process performance. It allows firms to conduct in-house training (e.g. conduct seminars, apprentice studies, allow employees sharing ideas, amongst others), where, things not known become known, new lessons become known, amongst others.

'Avails adequate resources to support change processes'- this attribute scored a mean value of 4.7. It was considered appropriate because it allows firms to plan about the needed resources in types and categories, availability, schedule and use. Sufficient resources guide the overall process performance (Zigiaris, 2000).

'Institute programmes to change culture of employees' – this attribute also scored a mean value of 4.7. It was found relevant because employees as human being, generally, exhibit slow or react to changes. Therefore, train programmes that explain why changes, which benefits of the changes expected, which aspects or layers of culture need to be changed are important.

'Formulate and adequately communicate appropriate change policies' also scored mean value of 4.7. This attribute had relevancies of deploying aspects of preparation, communication and effecting diverse policies such as BPR, quality, safety and environment policies that help implement BPR changes.

‘Use a consultant (where necessary) to lead revolutionary change’ scored mean value of 4.6. Considered that wherever new concepts or technology implementation is to be effected, a consultant/expertise may be involved for a certain period to equip local employees familiarize with the new concept/technology.

‘Ensures all employees are aware and ready of the planned changes’ had mean score of 4.5. This attribute was considered relevant because changes are implemented by the employees. Therefore, they must be informed clearly about the changes requirements. Once employees are aware of the types and the reasons behind the changes, they would add-up support of the change initiatives (Robson and Ullah, 1996).

Generally, ideas from respondents agree with the theoretical concepts that all eight attributes are appropriate and may be used to formulate ‘BPR foundation’ of the BPR model. Applying each and all these attributes help firms prepare and implement BPR initiatives.

5.3.3 Understand a Process and Identify Indicators that Improve a Project

- **Understanding Your Process**

‘Understanding your processes’ was aimed that respondents familiarize the BPR model structure and specific dimensions. In order to achieve this aim, the interview forums and questionnaire surveys were conducted involving seventeen meetings where process understanding was shared between a researcher and respondents. Four graphics were used as guides to discussions: Figure 3.6 – a BPR conceptual model, Figure 3.2 - map out of design process, Figure 3.3 - map out of procurement process and Figure 3.4 - map out of construction management process. Each of Figures 3.2, 3.3 and 3.4 contained indicators that are organized under critical inputs, critical activities and critical interfaces to assess design, procurement and construction management. The common understandings from all respondents were recorded and had reflections as summarized here:

i) A developed model improves project process performance because it incorporates almost all necessary activities/tasks that measure a project performance [in terms of inputs, activities and interfaces] from start to finish. This was responded by five respondents - two consultants, a developer, a client and a contractor). One of these respondents said,

> '*this model identifies and defines all the project activities, or tasks, and also it captures their relationships'*;

He further added:

> *'the model captures many aspects that majority of practitioners assume they are simple, or are straight forward, but, such aspects are usually overlooked during practices'. He cited usefulness of two interface indicators of the model (i) restricting fault jobs to progress to the next phase until necessary approval is given (constructability), and (ii) restricting commencement of actual works until project fund is available;*

ii) The model acts as a holist structure that improves a project performance (three respondents);

iii) Newness and potentials of the model. Talking with an experienced consultant from a foreign firm, he had views that, since there is no comprehensive model in the local construction industry that provide standardized framework for project performance improvement, this model may used instead.

iv) An experienced senior Architect had different view; he questioned the concept to bring-in contractor(s) during design stage, saying that such idea is costly if implemented. He was quoted as saying:

> ‘You know, d*esigners are ones who create constructability weaknesses. What happens is that, majority of them think only one side of design responsibility, forgetting or ignoring the other role of rethinking on how a designed element/product would operate in future – this is where a problem lies”. If designers would think from conceptual stage on how a product would function, the ideas of bringing in a contractor during design would be inappropriate’.*

These concepts were incorporated and used in the study in three ways: (i) designers think and rethink on what they design, how it will be built and operate, or (ii) contractor’s ideas are sought and used in the design stage or (iii) contractor(s) [physically] brought in the design stage(s) to share views with designers.

v) Some respondents, one contractor and two consultants had four views about the hindrances of the BPR model implementation: (i) lacking of financial support (ii) cultural change problems likely to be created by the implementers (iii) knowledge limitation of the users and (iv) lack of, or low support from the industry or government. However, all these aspects are tackled by the element of ‘BPR foundation and strategies for improvement’.

The findings from these interview forums concurs with the local theoretical findings that there is no framework that exist in the industry to improve holist project performance. Having identifying views that reflect understanding of the model structure, practitioners were also asked to identify indicators that improve project processes. Results are presented as follows.

- **Identifying Indicators that Improve a Project process**

A question to identify indicators that improve a project was aimed to make respondents understand better the relevant indicators that measure the project processes. Therefore, respondents had to provide a tick (√) if an indicator is a useful measure of a specified process [i.e. it links to the outputs], or put a cross (X), if an indicator do not measure a process [i.e. it does not link to the output], and NS (not Sure) if a respondent is not sure/do not know. In results, out of fifty five indicators proposed, forty indicators were agreed that they improve project process (Table 5.3). Of these, six indicators improve critical inputs in design, six indicators improve critical activities in design, four indicators improve critical interfaces in design, amongst others. In total, sixteen indicators improve design, nine indicators improve procurement and fifteen indicators improve construction management process. In the remaining fifteen indicators; three were marked with X and other twelve indicators were marked with not sure by the respondents, therefore, not included. Whereas the whole list of indicators that improve a project are given in Appendix G, results on appropriateness of indicators that identify weaknesses are given in the section that follows.

Table 5.3: Identified Indicators to Measure Core Project Processes

Categories of Indicators that measure processes of the project	No of clustered indicators	Total
Indicators that measure critical design inputs	6	16
Indicators that measure critical design activities	6	
Indicators that measure critical design interfaces	4	
Indicators that measure critical procurement inputs	4	9
Indicators that measure critical procurement activities	4	
Indicators that measure procurement interfaces	1	
Indicators that measure critical construction management inputs	6	15
Indicators to measure critical construction management activities	8	
Indicators that measure critical construction management interfaces	1	
Total	**40**	**40**

5.4 Appropriateness of Indicators that Identify Weaknesses

Forty indicators established to improve project process were then evaluated by practitioners on their appropriateness to identify weaknesses. Five point Likert scale was used with a range from: 1 strongly disagree, to 5 strongly agree. Indicators with mean values of 3.0 and above were considered acceptable. Results follow:

5.4.1 Average Rating of Indicators to Identify Weaknesses in Critical Design Inputs

Mean values of each indicator to assess critical design input weaknesses are presented in Figure 5.5. The results indicate that '*Inability* to evaluate *project financial needs* of the project by the *designers contribute* to *project delays', client's and users' needs inadequately evaluated by designers* create *more chances of producing fault jobs that lead to reworks', and* '*If designers' efforts are not recognized* and *motivated by the client*, it *contributes to slow speed of the work* were ranked in the first, second and third positions as the indicators that identify weaknesses with mean score values of 4.77, 4.76 and 4.65.

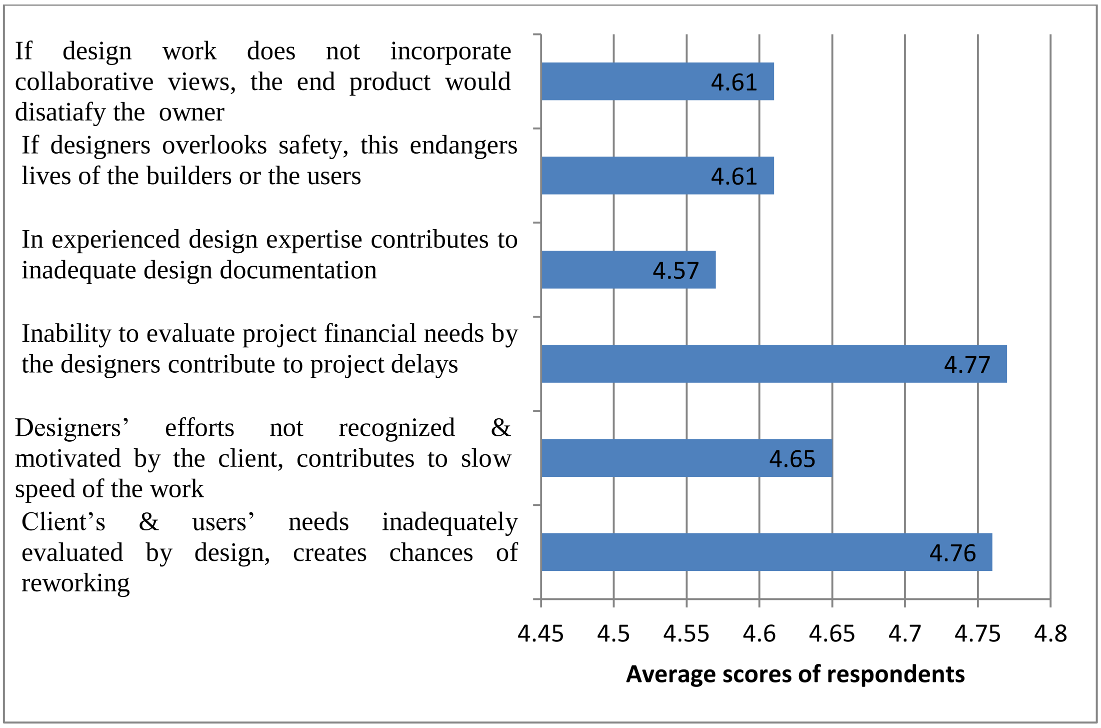


Figure 5.5: Average Rating of Indicators to Identify Weaknesses in Critical Design Inputs

'*Inability to evaluate financial needs of a project by the designers contributes to project delays*' was ranked first position with a mean value of 4.77. This indicator attributed highly in critical design input weaknesses by the fact that designers are ones responsible to evaluate client's financial status, and advice clients about its implications on project implementation. Therefore, if designers fail to conduct such evaluation early-on before work commencement, a project delay would be encountered. This result concurs with Alinaitwe (2008) who reported work delayed in the construction industry in Uganda due to project financial evaluation problems.

'*Client's and users' needs inadequately evaluated by designers create more chances of reworking'* was ranked second position with a mean score value of 4.76. This indicator highly attributes critical design input weaknesses due to the fact that the users' need help to point out the functional needs of their product (which is deployed early-on during design stage). Therefore, failure to identify such needs appropriately by the designers would contribute in inappropriate end product.

'If *designers' efforts are not recognized and motivated by the client*, it *contributes to slowing down speeds of the work or, it creates fault design documents'* was ranked the third position with a mean value of 4.65. This indicator highly attributes to critical design input weaknesses. The fact is that, designers are the expertise, initiate self commitments to meet design goals, therefore, if such attributes are not seen and recognized by the client, speed of the work may be interfered that delays the project.

'If *designers overlooks aspect of safety* (e.g. practicality, cost and functionality), this *would endanger lives of the builders or the users'*. Some respondents were in common agreement with Gray and Hughes (2001) agreeing that aspects of safety in design have control measures that need to be intergraded early on the design stage to eliminate or minimize risks to health throughout the process, therefore, they must be incorporated in the structure being designed.

Collaborative design needs - 'If *design work does not incorporate collaborative views of the key stakeholders*, such as design specialities, the end product wouldn't attract and meet the intended needs of the owner(s)'. This indicator attributes to design input weaknesses because, many key stakeholders (such as design specialities, owner(s) and, or user(s) and, any experienced (external party) have diverse contribution to design process successfulness. Their views needs to be sought, evaluated and used as may be appropriate so as to exceed the client's needs. This concurs with Pruett (2004) who suggest collaborations between different experienced individuals with origin designers to help manage buildability issues.

'In-experienced design expertise contributes to production of inadequate design documentation' was also observed appropriate in identifying weaknesses. Inexperienced designers may include designers who are fresh from schools who need to work under the experienced expertise; or those who meet a new job on the first time amongst others. They have high chances of creating design documents with omissions, errors or with mistakes which are weaknesses.

It is generally summarized that, six indicators are appropriate in identifying design inputs weaknesses. Each and all of these indicators is crucial to help in assessing design inputs' performance to identify weaknesses. These concepts are useful to formulate a BPR model.

5.4.2 Average Rating of Indicators to Identify Weaknesses in Critical design Activities

Mean values of each of the indicators in the critical design activities are presented in Figure 5.6. The results indicate that, '*lack of collaborative efforts* between designers detriment specific or overall design performance'; '*outputs of detail design process not forecasted early-on* contributes into inappropriate design documents'; and, '*design activities not well described* impacts common understanding between design team members' were ranked in the first, second and third positions as the indicators with highest scores in identifying weaknesses with mean values of 4.61, 4.53 and 4.52.

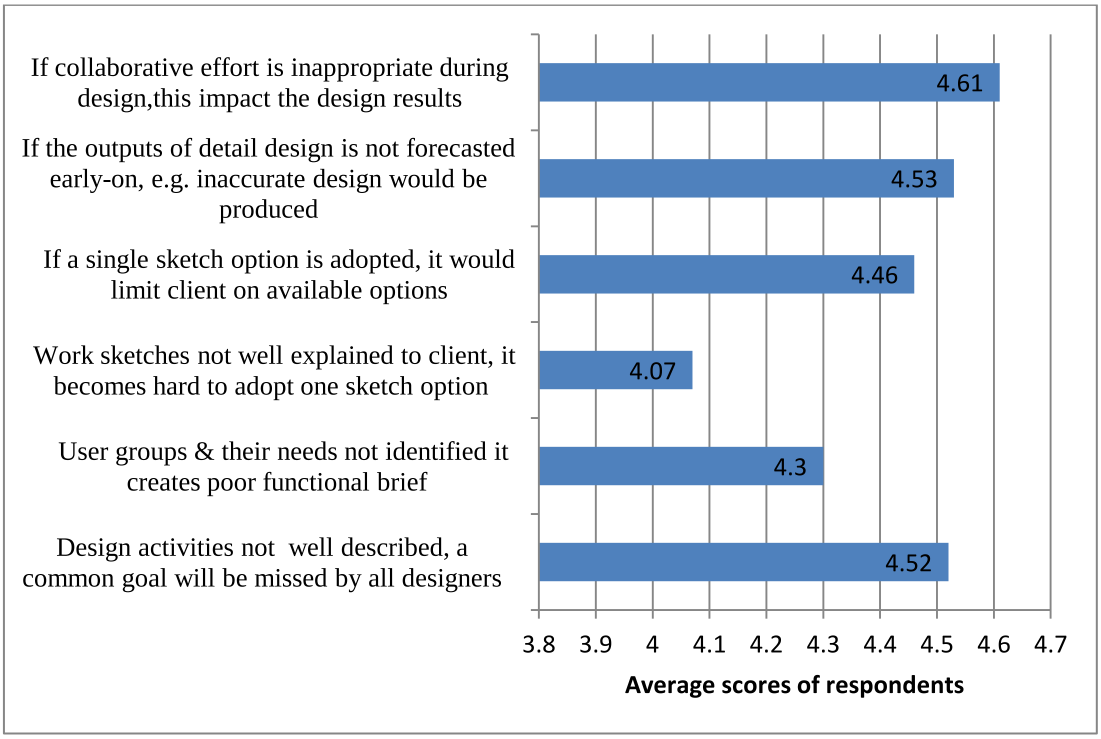


Figure 5.6: Average Rating of Indicators to Identify Weaknesses in Critical Design Activities

'Lack of collaborative efforts between design team members detriments overall design performance' was ranked first position with a mean value of 4.77. It was considered that this indicator highly attributes critical design activity weaknesses due to some reasons; one of them is highlighted here. When designers engage with a shared activity, for example, a beam section that incorporate multidiscipline operatives such as (electric conduit(s), ventilation pipe(s), etc.), and, a collaborative effort is missing, errors or mistakes may be created.

'*Output of an activity in a detail design that is not forecasted early-on contributes to inaccurate design documents'* was ranked second position with a mean value of 4.53. Outputs of an activity in a detail design process may include level of accuracy, for example, (performance standard) of a design document to be produced, number of design documents required etc. Therefore, if these outputs are not focused early-on, (so that the designers strive efforts to meet them), a chance to produce fault drawing document, or producing documents with omissions (a weakness) is created.

'*Design activities not clearly described create different understanding between design team members'* were ranked third position with a mean value of 4.52. Many factors may contribute to this aspect: design team may incorporate people with different work experiences, different levels of knowledge, amongst others. This creates effects of consuming more time by the team members trying to understand about the activity, or implement it wrongly. This result concurs with a work of Tzortzopoulos and Cooper in Emmitt (2007) who emphasized provision of definitions in the design management activities to aid productivity in the design process performance.

'If a single design sketch option is deployed to a client, it limits him in viewing other possible options available, thereby, making him dissatisfied'. This was considered important because many sketch options give clients an exposure onto various options available/possible that maximize level of his satisfaction. Indeed, the cost to produce these options is not so high as the costs of the changes later-on (if a single option is opted) (Eastman *et al.*, 2011). One respondent said; he experienced clients creating design changes as he continued seeing building products of other clients, (i.e. when he sees a new design model after his work was already done); this created modification that wasted resource. This model incorporates IT and BIM technology that allow visualization of diverse options.

'If user groups and their needs are not identified and recorded properly, this impacts a functional brief' was considered appropriate because any project has different user groups who must be known on the earliest stages, their needs interpreted, known and recorded to help formulate a functional brief. Therefore, if this is not done, an inadequate functional briefing would be prepared which is weakness.

'*If work sketches are not well explained to a client, it becomes hard for him (client) to select one appropriate sketch option'*. This was considered important due to the fact that, some clients are not acquainted with the project issues, and design graphics that provide sketches may not be very simple for them to grasp-in; therefore, if they are not well explained to these clients in terms of the building elements, aesthetic, cost, functionalities etc. an appropriate sketch option cannot not be identified adequately.

In summary, all six indicators are appropriate in identifying design activities weaknesses. The studied indicators help to measure design activities to identify weaknesses. They agree with Tzortzopoulos and Formoso (1999) who evaluated design process performance in small-sized house building companies in Brazil.

5.4.3 Average Rating of Indicators to Identify Weaknesses in Critical design Interfaces

Mean values of each of the indicators in the critical design interfaces are presented in Figure 5.7. The results indicate that '*interfaces between design activities* not well linked contribute to activity delays'; *review process not well conducted during design stage,* errors and *mistakes in documentations would emerge';* and '*design milestones not understood*, they *impact commencement of the upcoming design phase'* were ranked in the first, second and third positions as the indicators with highest levels of appropriateness in identifying weaknesses with mean values of 4.77, 4.69 and 4.38.

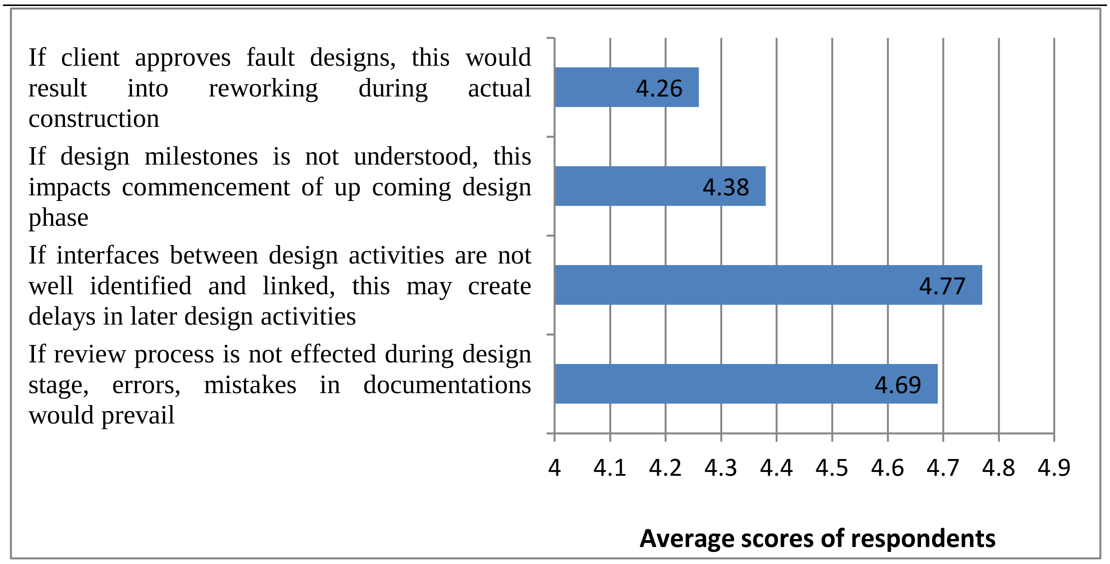


Figure 5.7: Average Rating of Indicators to Identify Weaknesses in Critical Design Interfaces

'*Interfaces between design activities not well interrelated contribute to overall design performance delays'* was ranked first position with a mean value of 4.77. It was considered as an indicator highly attributing to critical design interface weaknesses because each preceding design activities link with outputs of the succeeding design activities, this helps to plan and manage resource uses and the work method. Therefore, if the concepts of the linkages are missing, resources and work procedures cannot be deployed with the accuracies needed.

'If reviewing of a process is not effected during design stage, errors or mistakes in design documentations would emerge' was ranked the second position with mean score value of 4.69. The reason was that critical review efforts avoid approving fault design documents. Lacking of design review creates duplicate resources during actual construction, and may also cause unbuildable product (Pruett, 2004).

'*If design milestones are not prepared and understood early-on, this impacts commencement of upcoming design phase'* was ranked third position with a mean value of 4.38. Design milestone outlines what to be achieved in the current design phase and prepare for the upcoming design phase, to help target certain goals (e.g. complete a particular piece of design work, deploy certain potential resources for next activity, amongst others). Therefore, if, this is not deployed, the upcoming design phase may be interfered.

'If client approves fault design works, this creates reworks during actual construction'. The implication in some cases is that, clients mostly are not conversant with the designs; yet, they do not share views about quality design needs offered by the expertise such as construction managers. Therefore, if, such clients approve design regardless of their in-competencies; or, not sharing of the views, this increases chances of reworks.

In summary, four indicators studied are appropriate of use to identify design interfaces weaknesses. The studied indicators provide concepts that help to measure design interfaces weaknesses.

Generally, six indicators to assess critical design inputs, six indicators to assess critical design activities and four indicators to assess critical design interfaces are appropriate to be used to identify design performance weaknesses.

5.4.4 Acceptability of Indicators to Identify Weaknesses in Inputs in Procurement

Mean values of each of the indicators in the critical procurement inputs are presented in Figure 5.8. The results indicate that '*If procurement risk is not well evaluated, project delay is likely to occur*'; If *project characteristics, e.g. uniqueness, budget etc. are not well evaluated, poor contract would be deployed*, and '*Client who is not conversant with the project/one who do not share about the past projects is likely to interfere project decision making process*' were ranked in the first, second and third positions as the indicators with highest level of appropriateness in identifying weaknesses with mean values of 4.27, 4.16 and 4.15.

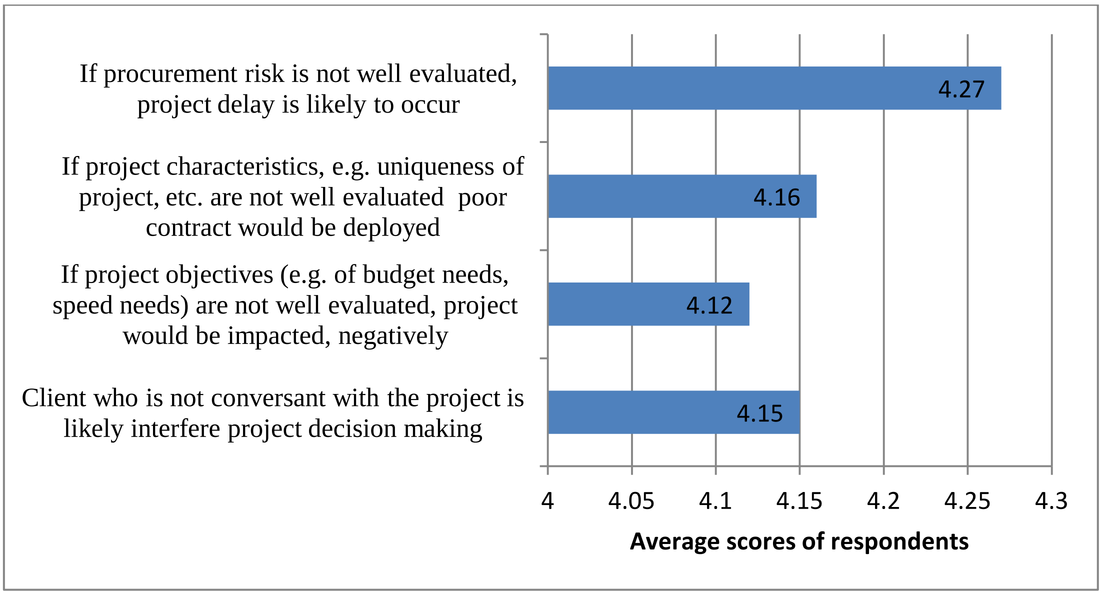


Figure 5.8: Average Rating of Indicators to Identify Weaknesses in Critical Procurement Inputs

'If procurement risk is not well evaluated, project delay is likely to occur', was ranked first position with a mean value of 4.27. Procurement risk relates such issues like attributes for evaluating project duration, costs, quality, fraud amongst others (Jackson, 2010). Therefore, if they are not well evaluated and worked-on, (for risks consequence and mitigation), project disputes are likely to be created.

'*If project characteristics, e.g. uniqueness, objectives, etc. are not well evaluated poor contract would be deployed'* was ranked the second position with a mean value of 4.16. This indicator was considered appropriate because such characteristics define specific issues of the project to make it understood, planed and managed. Therefore, if they are not well evaluated and understood, project cost and time overruns would hardly been avoided, amongst others.

'Client who is not conversant with project issues are likely to interfere decision making' was ranked in third position. This indicates that project features experienced are crucial, that is, the already experienced project aspects by the client guides/supports decision making conducted by other procurement team members. Lack of this client experience hams important decision making process.

'*Project objectives' attributes, e.g. budget needs, time need, etc. have negative impact in the procurement performance if they are not considered and evaluated*.' The reason is that if procurement team fails to explore the budget needs and time needs of the project, appropriate project delivery method would not be adopted. As a result, inappropriate project delivery method is deployed that create poor project performance.

The findings summarize that the studied indicators provide ideas useful to measure procurement inputs weaknesses.

5.4.5 Indicators to Identify Weaknesses in Critical Procurement Activities

Mean values of each of the indicators in the critical procurement activities are presented in Figure 5.9. The results indicate that '*If clients fail to evaluate contract types* right procurement option would not be deployed'; 'If procurement activities are not well evaluated by a client, this contributes to obtaining incompetent builder'; and 'If clients fail to evaluate and determine: work items, schedule of rates, lump sum, amongst others, it would be hard to deploy appropriate contract type' were ranked in the first, second and third positions as the indicators with the highest level of appropriateness in identifying weaknesses with mean values of 4.48, 4.36 and 3.7.

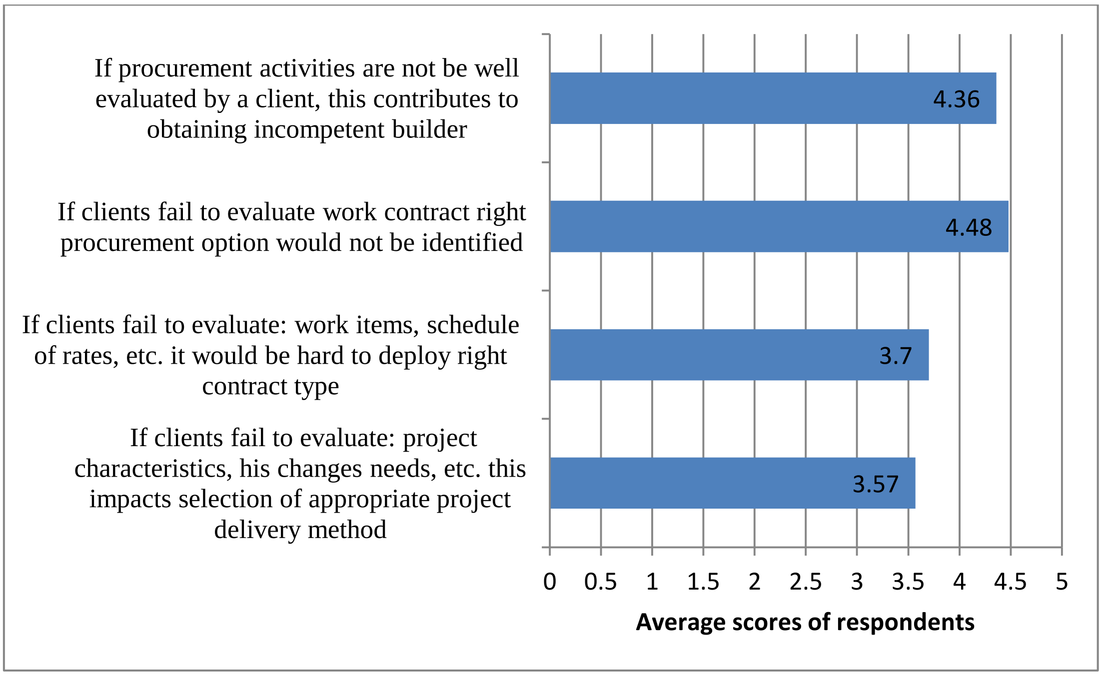


Figure 5.9: Average Rating of Indicators to Identify Weaknesses in Critical Procurement Activities

'If clients fail to evaluate contract types right *procurement option would not be deployed*', was ranked the first with a mean value of 4.48. This indicator was considered appropriate to identify weaknesses because, contract types can be defined and categorized (e.g. competitive tendering type, direct talk with the tender or perform negotiation, or combination). Therefore, failure to evaluate and decide the type according to requirements, it leads to adopting wrong procurement option which is weakness.

'*If procurement activities are not well evaluated by a client, it contributes to obtaining incompetent builder'* was ranked the second with a mean value of 4.36. Procurement activities involve advertisement, evaluation and negotiation that are heart to any procurement. Therefore, if they are not well evaluated, example, if a procurement effort does not address all qualities needed of the required builder, fails to deploy fair tender evaluation, amongst others, incompetent contractor may be obtained.

'*If clients fail to evaluate and determine: work items, schedule of rates, lump sum, etc. it would be hard to deploy appropriate contract type'* was ranked third position with a mean value of 3.7. This was considered as an indicator that shows weaknesses when clients fail to identify the contract types, e.g. BOQ contract, schedule of rate, cost reimbursement, amongst others. As a result, specific work scopes may not be contracted appropriately.

'*If clients fail to evaluate: project characteristic such as project changes needs, speed needs of his project, budget issues etc. this impacts selection of appropriate project delivery method'* was ranked fourth with mean value of 3.57. Clients may have variety of needs, for example, they may need changes after seeing a completed phase, or after impressed by a technological changes etc. If the expectations of future change needs are not communicated by the client, a project delivery method that does not accommodate such changes is likely to be opted; this creates misunderstanding between project team members (Halpin, 2006).

Generally, the opinions from respondents agree that the indicators are appropriate of use to measure procurement activities weaknesses. These concepts are useful in formulating a dimension of a BPR model.

5.4.6 Indicators to identify Weaknesses in Procurement Interfaces

One indicator to assess procurement interface weaknesses was established, named '*if either of the procurement activities are not checked for completeness or accuracies, this would dissatisfy a client'* responded at a mean value of 4.48. This explains the weaknesses that exist if procurement activities, for example, tender advertisement, tender evaluation processes etc. are not well evaluated for completeness or for realization of their achievement; this contributes to obtaining incompetent contractor.

In summary, four indicators to assess procurement inputs, four indicators to assess procurement activities and one indicator to assess procurement interfaces are appropriate of use to identify procurement performance weaknesses. Next section discusses results of indicators to identify construction management weaknesses.

As introduced in Section 5.3.4, twenty four indicators were established to identify weaknesses in construction management process. Since this number is somewhat large, only seven indicators [three highest ranked critical construction management inputs' indicators, three highest ranked critical construction management activities indicators and one identified construction management interface indicator) are described here. The reasons for selecting and discussing these seven indicators in detail are the fact that the explanation is similar to that for design and procurement processes, and also, a need to serve space in the study. Descriptions of these results follow.

5.4.7 Indicators to Identify Weaknesses in Inputs in Construction Management

Mean values of each of the indicators in the critical construction management inputs are presented in Figure 5.10. As introduced in Section 5.4.6, the results of **three highest ranked construction management inputs indicators** are described next.

'*If fairness in the contract is not deployed during work execution it creates disputes'* was ranked the first position with a mean value of 4.42. This indicator was considered appropriate because, as far as many parties are involved in the work execution, lacking of deploying contractual aspects, e.g. transparency, fairness etc. disagreement between parties are likely to occur that impact work productivity. This result concurs with the results of Khekale and Futane (2015) who studied construction projects' performance in Indian and pointed out the experienced effects of disputes between contractual groups caused by inadequate contracts practised.

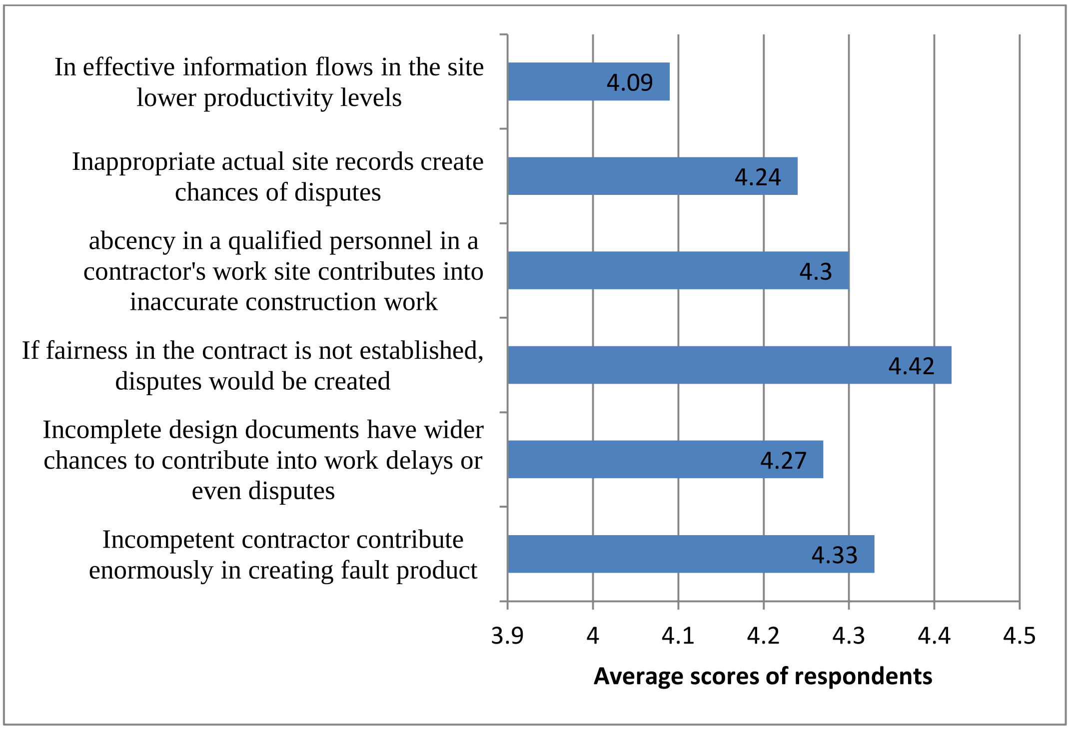


Figure 5.10: Average Rating of Indicators to Identify Weaknesses in Critical Construction Management Inputs

'*Using of incompetent contractor contributes to production of inferior jobs'* was ranked second position with mean value of 4.3. Incompetent contractor is the one who lack competent manpower, one who may not control jobs as needed, who cannot supply and control other needed resources (e.g. equipments, materials and finance) that are needed in the project accomplishment. This contributes to faulty jobs. This result concurs with the work of Aliyu *et al*. (2015) who report projects failure in Nigeria due to the use of incompetent contractor (i.e. one who failed to assign appropriate labour groups, inappropriate methods, inferior materials amongst others.

'*Absence of qualified personnel in a contractor's work site contributes to inaccurate construction work'* was ranked third position with mean value of 4.3. Absence of a qualified employee (in a constructor site) may cause employees remain idle awaiting instruction, or/and, employees continue with job without guidance that end-up with the faulty job that in-turn create reworking.

Generally, six indicators are identified to assess construction management inputs weaknesses. Three of them were described in detail. The concepts derived help to formulate a dimension of the BPR model.

5.4.8 Indicators to Identify Weaknesses in Construction Management Activities

Mean values of eight indicators that assess critical construction management activities are presented in Table 5.4. As introduced in Section 5.4.6, the results of three highest ranked indicators that assess the construction management activities are described.

'If *performance standard* is *not explained and views shared to the employees, defects in the final product* would be created' was ranked the first position with mean value of 4.67. This indicator was considered appropriate by considering the fact that performance standard is a crucial determinant for allowing satisfaction of the product to the client. At the same time, descriptions of these standards are in written specifications that are rarely accessed by the normal employees. Therefore, if these specified standards are not well explained to the employees who are the key implementers, the end product would be affected.

Resource acquisition: 'relating to *lacking of resources definition creates gaps in their acquisition,* lacking *of use of resource schedule influence site productivity* etc.' was ranked the second position with mean value of 4.62. This indicator was considered appropriate as it describes the weaknesses likely to exist if resources that are keys into accomplishment of any activities must be planned scheduled, and utilization monitored. If such resources are not managed, they create delays or inferior quality. This result concurs with Griffith and Watson (2004) who outlined the benefits of project productivity created by good resources management.

'*If an* activity is not *checked progressively against the planned and actual performance budget* this may *impact the final contract sum* was ranked the third position with mean value of 4.57. The indicator was considered appropriate because it describes the weaknesses that exist if activity budget is not monitored, as it has effect into all activities that also affect overall project sum.

Table 5.4: Average Rating of Indicators to identify weaknesses in Critical Construction Management Activities

Indicators/clustered indicators	**Description of Indicators**	Average Ratings	
Site Lay out	*Construction site spaces* not well planned and secured contributes to hardship operatives, or may cause accidents	4.45	4.38
	Site resources not well *organized* attributes to lowering site productivity	4.27	
	Lack of well planned temporary structures in the work sites impacts site productivity	4.42	
Resources acquisition	Lacking of resources definition create gaps in their acquisition	4.51	**4.62**
	Lacking of use of resource schedule influence site productivity	4.48	
	Lacking of resources utilization plan lowers site productivity	4.87	
Work implementation	lacking of work decomposition impact work clarity	4.25	4.28
	If resources, e.g. materials, equipments etc. are not properly checked for their deliveries, uses, amongst others, site productivity would be impacted	4.3	
Health and Safety	If Health and safety policies and their implementation initiatives are not properly deployed, injuries and accidental events will harm productivity	4.24	
Budget	If activity is not *checked progressively against the planed and actual performance budget* this may *impact the final contract sum*	**4.57**	
Activity duration	If activity delivery schedules do not conform to specified programme overall project duration would be delayed	4.48	
Activity quality	If *activity' performance standard* is *not explained and views shared to the employees*, defects in the final product would be created	**4.67**	
Project closeout	If minor works are not identified and effected, substantial completion would be impacted	4.48	4.4
	If commissioning is not well conducted, completed building components may exhibit malfunctioning	4.27	

Indicators/clustered indicators	Description of Indicators	Average Ratings	
	Lacking of the 'as built final project documentation' creates a knowledge gap to the future project(s)	4.51	3
	If works in the defect liability period are not well stated in the contract, the contractor may effect partial rectifications	4.54	
	If evaluation is not done of a project when completed, this limits project participants to gain lessons of future	4.36	

5.4.9 Indicators to Identify Weaknesses in Construction Management Interfaces

An indicator to identify weaknesses in critical construction management interface scored a mean value of 4.48. This was considered appropriate because it created diverse measures, i.e. '*if either of the construction management activities is not checked for completeness, accuracy, amongst others, the end product dissatisfies the owner'*. Such indicator addresses the weaknesses that exist when each and all construction management activities are not checked during actual work implementation to determine completeness and accuracy.

In summary, six indicators to identify the weaknesses in construction management inputs, eight indicators to identify the weaknesses in construction management activities and one indicator to identify the weaknesses in construction management interface were accepted by the respondents that they are appropriate.

Generally, a total of sixteen (16) indicators to assess design process, nine (9) indicators to assess procurement process and fifteen (15) indicators to assess construction management process (a total of 40 indicators) were agreed by respondents that they are appropriate to identify the weaknesses of the core project processes. These indicators provide ideas that help to formulate the third dimension of the BPR model.

5.5 Measures to Create Desired 'To Be' Project Processes

Specific objective three of the research was aimed 'to identify strategies for achieving improved processes'. The achievement of this objective has two stages;

firstly, identify measures to create desired (**To-Be**) process, and secondly, identify strategies for improved processes. Therefore, from interviews conducted, fourteen (14) measures with sixty (60) items of measures were identified to create desired (**To-Be**) project process. Of these, five (5) measures with twenty two items of measures create desired (**To-Be**) design process, five (5) measures with twenty four (24) items of measures create desired (**To-Be**) procurement processes and four (4) measures with fourteen (14) items of measures create desired (**To-Be**) construction management processes. The extent to which these measures were accepted to create desired (**To-Be**) process was assessed by using five point scale with the following translations: 1- strongly disagree, 2 - disagree, 3 - average, 4 - agree and 5 - strongly agree. As already introduced in Section 4.9.3, all indicators scored mean values above 3.0 were considered appropriate in creating desired (**To-Be**) processes. Note that the indicators under each core process were formed in the clustered groups (see Tables 5.5, 5.6 and 5.7). In order to provide a concise discussion and avoid duplication in discussing similar issues, the indicators ranked highest in every indicator-clustering-group are described in detail in the following sections.

5.5.1 Measures to Create Desirable (To-Be) Design Processes

As introduced in Section 5.5, five measures with twenty two items of measures were accepted by practitioners as the desired (**To-Be**) design processes (see Table 5.5). The results of the highest ranked items of measures in each measure group (as depicted in Table 5.5) are described in the following sections:

‘Competent and experienced design team’

A measure with the highest rank in this group was ‘*deploying competent and experienced design team to help identify, quantify and manage design process performance’* with a mean score of 4.53. This measure was considered acceptable to create desired (**To-Be**) design process because of a number of reasons. Competent and experienced design team constitutes all expertise needed in a specified project, and, they become utilized either as in permanent or temporary terms. As the team has multidisciplinary expertise, this helps in reviewing design works comprehensively i.e. studying the design work context, identifies risks in design activities, quantify risk consequences and plan mitigation measures, implement and improve the design (Haplan, 2006). This result concurs with the work of Formoso *et al*. (1998) who mapped out all design performance activities in Brazil and improved design performance.

'Value creation in design through conducting map out of design activities)'

The measure 'c*reating value in design through conducting map out of design activities*' *enables to identify and meet all users' requirements'* scored the highest rank with a mean score of 4.35. This is important because conducting the design process mapping helps to understand: scopes of the overall design work, activities and their boundaries, customers (those who implement design and the product receivers), their specific needs, meeting their needs and tracking the feedbacks (Koskela, 1992). Such measures create values in design process performance.

Table 5.5: Desired (**To-Be**) Processes to Improve Design Process

Measures	A five point scale was used on items of measures that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 - agree and 5 – strongly agree	1	2	3	4	5	Average ratings/ mean scores	Mean clustered indicators
Critical Inputs								
Design team competency	Provide appropriate *design process planning*	0	0	5	15	6	4.04	4.10
	provide appropriate *schedule and cost estimate*	0	0	5	14	7	4.07	
	Provide *advice on material selection*, *availability* and use	0	0	5	16	5	4.00	
	Identify, quantify and *manage risks* in design process performance	0	0	6	13	7	**4.53**	
	Share experiences, *intellectu*als amongst others, between design specialists	0	0	8	13	5	3.88	
Critical design Flows (activities and interfaces)								
Value	*Identify and meet all users*	0	0	4	9	13	**4.35**	

Measures	A five point scale was used on items of measures that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 - agree and 5 – strongly agree	1	2	3	4	5	Average ratings/ mean scores	Mean clustered indicators
creation in mapping out design activities	*requirements*							4.2
	concentrate in *doing each design activity at a time*, thereby, avoiding mistakes or errors	0	0	7	11	8	4.04	
	Ensure a *balanced deployment of resources*	0	0	4	13	9	4.19	
	Conduct *error proofing and conducting self inspection*	0	0	5	14	7	4.07	
	S*tandardize methods* and avoid variations	0	0	0	13	11	4.34	
IT and BIM technology	*Recording, storing, processing, manipulating and updating* design information	0	0	7	9	10	4.11	4.24
	Applying *database services* to quickly track information or items	0	0	6	13	7	4.08	
	Accessing *Internet* that accelerates design collaboration	0	0	4	11	11	4.27	
	Providing *platform for visualization of the graphics* that facilitate decision making	0	0	5	11	10	4.19	
	Effecting changes in an *automated way*; thus, creating accuracies in design documentations	0	0	1	13	12	**4.42**	
Constructability in design	Incorporating *constructible ideas* during *design stage* to avoid reworks	0	0	2	8	15	**4.34**	4.04
	Creating strict restriction on fault work to *progress* to the next phase	0	0	6	9	11	3.74	
Design management	*All design participants are well identified* subject to their engagements	0	0	3	10	13	3.85	4.12
	C*ollaboration* is enhanced by ICT facilities to bring in the dynamic teams	0	0	6	11	9	4.11	
	Designer is responsible to *appoint other consultants* with the *required expertise*	0	0	3	11	12	**4.34**	
	Design team leader is appointed who *deals with planning, coordinating* etc.	0	0	4	9	13	4.05	

Measures	A five point scale was used on items of measures that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 - agree and 5 – strongly agree	1	2	3	4	5	Average ratings/ mean scores	Mean clustered indicators
	Design *team adopts process control* that focus on overseeing the completeness of activities			5	11	10	4.19	

'IT and BIM Technology adoption in design'

The measure '*adopt IT and BIM Technology in Design Performance to enhance changes in an automated way to maximize* accuracy in design documentations' scored the highest rank with a mean score of 4.42. The BIM technology especially, operates in a digitized form, where-in, accuracy is maximized. A BIM tool once applied onto one design document for example, in plan, the changes would be propagated to related ones – sections, elevations etc., thus, reducing changes of errors or mistakes which could rarely emerge through traditional approaches (Dzambazola *et al.,* 2010). This result concurs with Azhar *et al*. (2008) who reports huge number of errors and mistakes avoided when BIM technology was applied in construction projects in Australia.

'Constructability in design'

The measure '*adopting constructability concepts in the design stage incorporates constructible ideas that avoids reworks'*, was ranked the highest with a mean score of 4.34. This was accepted because by reviewing design documentations (especially by a separate team than the one involved in the original design team (Prett, 2004) helps to oversee and identify any hurdles [un-buildable activity, omissions, amongst other discrepancies] that might be overlooked previously. Constructability reviews also strictly restrict faulty design approvals.

'Design Management Concepts'

The measure '*adopts design management in desired (**To-Be**) design process'* scored the highest mean value of 4.34. This measure was considered acceptable because it address many items, including, 'designer *appoints other designers* who have *required expertise', a* design leader appointed is the one who also is an expert in the specified design field to help managing decision reflecting technical judgements, allow plan and control of all design tasks, amongst others. This measure is important because it gives full power and recognition to the design expertise to manage their career.

In summary, five measures with twenty two items of measure are accepted to create desired (**To-Be**) design process. Each practitioner may assess such measures as: design team competency, design value creation through design map out, adopt IT and BIM, constructability and adopt design management to help create desired (**To-Be**) design process.

5.5.2 Measures to Create Desired (To-Be) Procurement Process

As introduced in Section 5.5, five measures with twenty four items of measures were established as the desired (**To-Be**) Procurement processes (see Table 5.6). The results of the highest ranked items of measures in each measured group (Table 5.6) are described in the following sections.

'A conversant public client(s) or, a client who shared views of past projects'

Using '*a conversant public client or one who shared views of the past projects help to offer experience of similar projects performed in the past'* was ranked in the highest position with mean score of 4.30. This measure was accepted because it seeks to value the contributions from a public client as a key input in the procurement process. As such, either a conversant or one who had shared views on the past projects may help in the decision making when discussing procurement approaches with the designer.

'Project delivery option (i.e. either of DBB, DB or CM or combination)'

The measure '*Adopting appropriate project delivery option (i.e. either of DBB, DB or CM) or combination helps to meet project change needing by the client'* was ranked highest with the mean value of 4.45. This was appropriate to meet project change needs by considering the fact that when a public client has the know-how of the project delivery options, this helps to understand and select the option e.g. DB that accommodates changes as the work progresses without dissatisfying the client (Halpin, 2006). This result concurs with Wardani (2004) who used USA's experience to emphasize the adoption of DB project delivery option when a client expects changes on project progresses.

Table 5.6: Proposed Measures to Create Desired (**To-Be**) Procurement Process

Clustered Indicator	A five point scale translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree	1	2	3	4	5	Average mean	Mean clustered indicators
Critical Inputs								
A conversant public client(s) or, one who shared views	*Gain experience of similar projects* to help understanding the project characteristics	0	0	5	13	15	**4.30**	4.09
	Gain *knowledge base to discuss and share* about *project delivery methods, contract types and procurement methods* to aid decision making	0	0	4	14	15	3.88	
Procurement activities and their flows								
Project delivery option (DBB, DB or CM)	A broad definition of *uniqueness of the project: complexities*, sizes, location etc.	0	0	4	13	16	4.36	4.3
	Evaluates and deploys his *funds requirements*, and have know how on the trends of his cash – flows	0	0	9	11	13	4.12	
	Knows *speed needs* of his project	0	0	5	10	18	4.39	
	Knows his *pace of needing changes* onto a project	0	0	5	8	20	**4.45**	
	Is aware of the project impacts caused by *external factors:* politics, social, economy etc.	0	0	9	11	13	4.12	
	Owner decides on, or not tak*ing risk of employing project manager* to guide him on the project	0	0	4	7	22	4.36	
	Owners critically evaluate the impacts of the *team communication*	0	0	6	14	13	4.21	

Clustered Indicator	A five point scale translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree	1	2	3	4	5	Average mean	Mean clustered indicators
	and collaboration							
	Owners defines the critically the *work roles of the parties into the project*	0	0	5	13	15	4.30	
	Owners critically evaluate the *occurrence and avoidance of the adversarial situations*	0	0	3	12	17	4.31	
	Owners defines and evaluates their i*nvolvemen*t into the project	0	0	4	13	16	4.36	
Contract type	All work items are well *defined and priced*, deploys BOQ contract	0	0	2	9	22	**4.60**	4.405
	A single total contract sum quoted, either a *BOQ or lump sum contract* may be adopted	0	0	4	12	17	4.39	
	One knows the work items' limitation, or work is needed urgently, (generally known as *schedule of rate contract*)	0	0	5	12	16	4.33	
	On the case where the *cost target is reimbursable*, target cost contract is adopted	0	0	5	13	15	4.30	
Procurement option	Many bidders are allowed to participate, a need is placed to adopt *competition method*	0	0	3	15	16	4.51	4.44
	When the job is urgent, and competent builder is *known, direct contact approach is useful*	0	0	4	15	14	4.30	
	Either, a *competition, direct, negotiation* is adopted	0	0	3	14	16	**4.56**	
IT and BIM technology in procurement	*Recording, storing, processing, manipulating and updating* information	0	0	6	14	13	4.21	4.28
	Applying d*atabase* to track information quickly	0	0	5	14	14	4.27	
	Accessing *Internet* services, and, for an intended purpose	0	0	3	13	17	**4.42**	
	Providing a *platform/interface where work processes are visualized*, by all, at the same time	0	0	8	13	12	4.12	
	Effecting *changes in an automated* way, thus, increasing accuracies and speeding up the work	0	0	3	15	15	4.36	

'Specific contract type or combination'

The measure 'adopt s*pecific contract type that allows all work items to be well defined and priced*, deploys *BOQ contract'* was ranked the highest position with a mean score of 4.60. This measure was accepted because it conveys knowledge to procurement participants to define project scopes and their boundaries, for example, identify and define all work items that easing in itemizing prices - a BOQ type of contract; state if work represents scopes of small magnitudes and its details are not well known - a lump sum contract; state if work is agreed on the basis of a fixed fee or percentage fees - cost reimbursement contract, amongst others.

'Specific procurement option'

The measure 'adopt s*pecific procurement option if either, a competition, direct, negotiation is adopted*' was ranked the highest position with a mean score of 4.60. The measure was accepted because it allows a public client who use a prior knowledge of 'contract type', to select either advertising the work on a competitive tendering, or, goes directly to the known builders to talk with them about the project's needs or conduct negotiations with them, or combinations. This has advantages that, knowledge of procurement options allow you to select the beneficial approach, saving time and budget waste.

IT and BIM technology in procurement

The measure 'a*dopting IT and BIM technology through allowing accessing the Internet services, and, in a beneficial way'* was ranked the highest position with a mean score of 4.42. This measure was accepted because such technologies allow the users to seek new knowledge over the world (facilitated by the Internet surfing system), conduct collaboration between project participants amongst others. The gained knowledge helps to add-up to supporting procurement performance. For example, tenders may be processed online; information may be conveyed geographically, amongst others to speed-up procurement operative performance (Rivard, 2003; Sommerville and Craig, 2006).

In summary, five measures with twenty four items of measures are accepted to create desired (**To-Be**) procurement process. Each practitioner may assess such measures as: conversant or a shared view with a client, project delivery option, contract type, procurement option and IT and BIM in procurement to help create desired (**To-Be**) procurement process.

5.5.3 Measures to Create Desired (To-Be) Construction Management Process

Four measures with fourteen items of measures were established as the desired (**To-Be**) construction management processes (see Table 5.7). The results of the highest ranked items of measures in each measure group (Table 5.7) are described in the following sections.

'Contractor experience'

An indicator '*deploy experienced contractor'* gives experience from previous projects to help manage the project in hand*'* was ranked the highest in the group with mean score rate of 4.15. This was accepted because an experienced contractor has full knowledge experienced from past projects, thereby, gaining ideas that help to modify the current project.

Table 5.7: Proposed Measures to Create Desired (**To-Be**) Construction Management Process

Clustered Indicator	Five point scale used on the items of measures that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree	1	2	3	4	5	Average mean	Mean clustered indicators
Critical inputs								
Contractor competency	*Qualified contractor* deploys knowledge used as a basis to understand and manage overall site operatives	0	0	7	18	8	4.03	**4.09**
	Experienced contractor gives knowledge from previous projects to help manage a project in hand	0	0	5	18	10	**4.15**	
Design documents	Completeness of design documents used in actual construction allow work progresses	0	0	6	16	11	4.18	**4.16**
	Accurate documentations – drawings and specifications guide work progressive as specified	0	0	6	16	11	4.09	
	Clarity on the documents – drawings, specifications helps to avoid avoidable disputes	0	0	2	18	13	**4.33**	
Construction management activities and interfaces								
Value	Contractor's engaging with *each*	0	0	5	13	15	4.30	

Clustered Indicator	Five point scale used on the items of measures that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree	1	2	3	4	5	Average mean	Mean clustered indicators
created through mapping out construction activities	*project activity at a time* helps in creating value							4.27
	Using of *resources schedules* help to balance the resource gap against resources needed	0	0	4	11	18	4.12	
	to highlight such events like work execution, site meetings, work records, etc. to help track work progresses	0	0	6	14	13	**4.39**	
	Conducting daily recording in the firms help in curbing claims, thus avoiding chances of disputes	0	0	5	15	13	4.23	
	Conducting work studies on all works operatives creates work site productivity	0	0	4	15	14	4.3	
IT and BIM technology	*recording, storing, processing and updating information*	0	0	4	14	15	4.33	4.33
	tracking information or items quickly through the use of *database*	0	0	5	14	14	4.27	
	accessing *Interne*t, and used meaningfully	0	0	3	14	15	4.24	
	Effecting changes in an *automated* way, thus, increasing accuracies and speeding up the work	0	0	6	11	16	**4.48**	

‘Clarity on design documents’

The measure ‘*clarity on design documents* – drawings, specifications help to avoid disputes was ranked highest with the mean score of 4.33. This measure was accepted as it helps project implementers engage with work progressively without interruptions for clarification or conduct reworks caused by fault documentations.

‘Value created through mapping out of construction management activities’

The measure ‘value creation through *map out of construction management activities help to understand the work contents and adopted procedures, such as: specific work to be executed, site meetings required, work record needs, etc. to help track work progresses*’ was ranked in the highest position with a mean score of 4.39. This was accepted to enable the users map out project tasks, understand the work scopes, schedule and conduct site meetings, prepare and keep records and use them to track work progresses.

'IT and BIM to support construction management'

The measure *'IT and BIM technologies to support construction management process' allows effecting changes in an automated way to increase accuracy in the work performance*, was ranked the highest position with a mean scope of 4.48. This was accepted because such technology use a digitized system model to define all project related elements, interrelating them and effecting automated changes that avoid errors or mistakes (Dzambazova *et al.*, 2010).

In summary, four measures with fourteen items of measures are accepted to create desired (**To-Be**) construction management process. Each construction practitioner may assess such measures as: contractor competency, design documents, value creation through mapping out of a process and adoption of IT and BIM technology to help create desired (**To-Be**) construction management process.

In summary, five measures with twenty two items of measures were created for a desired (**To-Be**) design process, five measures with twenty four items of measure create desired (**To-Be**) procurement process and four measures with fifteen items of measure create desired (**To-Be**) construction management process. In total, fourteen measures with sixty items of measures are accepted to be appropriate to create desired (**To-Be**) project process. These concepts contribute to form a four dimension of a BPR model developed in this study.

5.6 Acceptability of Attributes of 'Strategies for Improvement'

Seven (7) attributes of 'strategies for achieving improved process' were used to seek opinions from practitioners on how indicators can be used to identify weaknesses and also used to create desired (**To-Be**) project process (see Table 5.8). In order to obtain such opinions, a five points scale that translates into1- strongly disagree, 2 - disagree, 3 - average, 4 - agree and 5 - strongly agree was used in the assessment. Results as per highest ranking position (Table 5.8) are presented in the following sections

Table 5.8: Responses on the Attributes of Strategies of Improvement

Strategies to identify, evaluate weak process and deploy radical changes in a continuous way	Likert Scale value					Average ratings	Ranking
	1	2	3	4	5		
Institute continuous learning and perform benchmarking from best practice firms	0	0	2	4	27	4.75	4
Train employees on: on-job training, formal training and allow them participate in the seminars, etc.	0	0	2	4	27	4.76	3
Plan and set funds to manage changes in the firm	0	0	2	6	25	4.73	6
Plan to invest, or expand IT and BIM application in the firm	0	0	1	3	29	**4.84**	1
Recruit, retain and recognize manpower competencies	0	0	2	6	25	4.74	5
Seek and adopt the emerged management techniques such as BPR to help create changes in the firm	0	0	3	6	24	4.69	7
Conduct in-house training and adopt any major changes in stages to build capability (CMM)	0	0	2	2	29	4.82	2

A strategy '*Plan to invest, or expand IT and BIM application in the firm'* was ranked in the first position with a mean score of 4.84. Interviewed respondents maintained that many firms already have, and use IT facilities although not at a satisfactory level. In the survey, and with regard to BIM application, only two (foreign) consulting firms were observed to have use BIM technology. This strategy calls firms to invest fully in these two technologies to support project process performance through storing, processing, and presenting information. Evidence of processes succeed through supports of these technologies are well documented (Azhar *et al.*, 2008; Dzambazova *et al.,* 2010). IT and BIM adoption strategy needs funds, time and evaluation of the investments over time to help support process performance improvement; therefore, firms must radically change their processes in investing on such technologies.

A strategy, 'c*onduct in-house training and adopt any major changes in stages to build capability (CMM)*' was ranked the second position with a mean score of 4.82. This strategy calls management of the firms to conduct in-house training to their employees to equip them with new knowledge deployed by the BPR model. In-house training can range from conducting: seminars, work in teams, conduct apprentice studies amongst others to explore knowledge useful for implementing a BPR model.

Since it may take long for firms to embark into these changes, training concepts should also follow a CMM that enhance them to study own weaknesses, desired (**To--Be**) process, create changes and grow in stages (See also Mwishwa, 2014).

A strategy 't*rain employees on: on-job training, formal training and allow them participate in the seminars, etc.*' was ranked third position with a mean value of 4.76. This strategy enhances all types of skills and knowledge capturing [ranging from formal to informal] aimed to improve project performance improvement. This result concurs with the works of Kalulanga *et al.* (2001) who propose adoption of all sorts of trainings (whether it be formal or informal) to improve process performance.

A strategy, 'c*onduct continuous learning and benchmarking'* was ranked the fourth position with a mean score of 4.75. This strategy was accepted because project performance improvement is implemented by firms in a long term basis (using BPR model). Therefore, since technologies change overtime, and projects have different ranges of complexities, firms should continue to conduct continuous leaning to help effect technological changes. These lessons can be deployed through benchmarking studies that allow improvement through one knowing about own weak processes, learn best practice processes of others, adapt and compete in the business.

A strategy, 'r*ecruit, retain and recognize a manpower competency'* was ranked the fifth position with mean value of 4.74. This strategy was appropriate because of some reasons. For example, since the model incorporates new concepts such as adoption of constructability, IT and BIM technologies, amongst others, local employees require recruited, retained and recognized employees who help to master necessary long-term-technological-skills. Mazda (2000), states that, the lifelong benefit of the firms cannot be deployed if manpower competency is not recognized.

A strategy, '*plan and set funds to manage changes in the firm'* was ranked the sixth position with a mean value of 4.73. This was accepted due to the fact that any firm changes require funds to support the change of processes; it needs to plan how and where to acquire funds, how to use and manage cash flows, amongst others, to help support process performance (Kenley, 2003). This fact is supported by Sommerville and Craig (2006) who stated that any firm engages with technological innovation aspects that are in continuous changes, and such changes incur funds that must be planned and managed.

A strategy, '*seek and adopt the emerged management techniques such as BPR to help create changes in the firms'* had a mean value of 4.69. This strategy was accepted because, other than the management techniques such TQM, Six Sigma, and Lean, amongst others, BPR can be appropriate to create radical changes in the firms. BPR philosophy creates these changes as it adopts a process focus by: firm owner becoming a creative thinker, becoming innovative, using IT technology, conducting benchmarking amongst others. In BPR philosophy, radical changes are deployed through steps, e.g. create the **To-Be** process, identify current weaknesses, use strategies to meet **To-Be** goals (Pearman, 1999). Riley and Brow (2001) report BPR a philosophy initiative adopted in the contractor organization in the United Kingdom that enhanced the creation of radical changes of the processes.

In summary, seven strategies are accepted as appropriate of use to help firms to change from a weak to a desired (**To-Be**) project processes. These concepts are useful to formulate fifth dimension of the BPR model.

Generally, forty (40) indicators were accepted to be useful to identify weaknesses in design, procurement and construction management. When these weaknesses were identified, fourteen measures with sixty (60) items of measures were identified to identify desired (**To-Be**) project processes. In order to help firms to change from a weak to a desired (**To-Be**) process; thereby, creating radical changes, seven strategies were established and accepted by respondents to fulfil such needs. Overall response results on indicators and measures through a questionnaire survey are given as Appendix H. The results altogether, provide useful concepts to develop a BPR model for improving project process performance.

Based on the aforementioned results, specific objective two of the research that aimed to 'identify indicators to identify process weaknesses' of a project process, and, specific objective three, that aimed 'to identify strategies for achieving improved processes of a project' are achieved.

5.7 Validity of Data Collected and Analyzed from a Survey

The BPR conceptual model was developed based on the concepts that come from review and evaluation of relevant literatures. The literatures come from five sub-themes: projects' performance, contracting parties' performance trends, process measurement, BPR philosophy and organizational processes. Citations of the reviewed works appear in the texts and full reference list is given at the end of the document. In addition, the parameters of a BPR conceptual model were used by respondents through surveys to help determine whether the model operates in the local environment or not. Relevant respondents were sampled through non random sampling techniques. The reasons for this were that evaluation of BPR concepts demanded firms with systematic processes, i.e. the firms who: are the main project participants and had recently engaged with huge projects, follow process focus, had more than five years of experience, are registered by the relevant boards (e.g. contractors and consultants) amongst others. As such, the relevant firms used provided data that are valid and credible. In analyzing the data, statistical methods/procedures were used. The quantitative data were evaluated using Excel program which uses tools like pie charts; histograms etc. to present average mean scores of a studied theme by the respondents. Qualitative data were explained in texts following the idea in which a question was set and asked.

Generally, the use of the relevant literature provided helped to give valid data to develop a BPR conceptual model. In addition, by using relevant respondents, a non probability sampling, and analyzing the data by using statistical approaches; they provided reliable steps to develop the model.

After a BPR conceptual model is developed and tested, next step was to conduct validation. The validation results conducted through case study that follows:

5.8 Validation of BPR Model

Model validation was divided into three parts (i) Case study on a consulting firm represented by four embedded groups (highway, survey, structure and management) that implement an on-going road construction project (ii) comparison analysis of the BPR model against other models in literature (iii) checking that BPR model parameters identify and manages weaknesses in traditional process performance. Results follow:

Results in the case study: thirteen indicators were selected and studied. The reason was their perceived ability to bring out results rapidly to suit study needs. They include: expert competency deployment, work load assignment, planned task, work records, amongst others (see the study protocol, Appendix F). These indicators were studied to identify weaknesses, and, or desired (**To-Be**) process. In each case, either, or a combination of the methods: narration, observation, documentation and interview, were used.

Whereas, case study design is explained in Chapter Four, the results from four study-embedded-groups are presented. Note that, in order to save the space in the report, two indicators were selected and discussed in the text; further explanations are provided in Tables 5.9 through 5.11.

5.8.1 Case Study Results in the Highway Group

Twelve indicators were studied on which six identified process weaknesses and seven identified desired (**To-Be**) process. Two indicators to identify weaknesses and desired (**To-Be**) process are briefly explained in detail.

Indicators to identify weaknesses in the highway group

1: **Working load of the engineer**: in this indicator, the study investigated the extent to which an engineer was assigned and engaged with the work loads. In results, an engineer engaged with many tasks that are also diverse in nature. They include working in the: office, borrow pits, laboratory and actual road operations amongst others. In the office, he engaged with: review of documentations; plan the works; work on the “Request for Approval’ brought by the contractor, amongst others. These tasks had large scopes to be managed by a single engineer which was determined as a weakness.

2: **Linkage of activities**: in this indicator, an activity that is shared with two or more groups was studied on how its goal was agreed and approval made. The extent of not meeting the agreements was regarded as a weakness. Discussing this aspect in detail, three sections, highway, survey and structure were agreed to approve together the locations for new culvert lines, gabion positions, provision of road centrelines, amongst others. However, at one time, no sharing was made during placing new culvert line activity; thus, there was dissatisfaction on the highway group whom allocation approval was made on his absence. This is regarded as a weakness.

Indicators created desired (To-Be) processes in the highway group

1: **Competent expertise**: this indicator was studied to identify whether the group had a qualified and experienced engineer and this could contribute to meeting the intended process goal. In results, the highway studied group had a qualified highway engineer with more than five years of similar engineering projects, which is desired.

2: **Technology:** ‘Work procedures’, this indicator involved with studying how the respective section plans, extracts information (from master program), and prepare a daily work plan. In results, almost every day, the engineer had many assignments that made him too busy. But, in the evening, he prepared work plan that was reviewed, updated and used in a day that was scheduled. It helped to create works that are clear, flexible and systematic. This created savings in both time and budget.

Other indicators studied and identified weaknesses and created desired processes in the highway group are summarized in Table 5.9. Information presented in this Table helps to provide description of all indicators studied in the highway group.

Table 5.9: Indicators, Process Weaknesses and Desired (**To-Be**) Processes created in the Highway Group

Description of Indicators	**Indicators**	**Four questions asked and answered**		
		What actual weaknesses	**Actual desired (To-Be) process**	**Weak, or why changes**
Capability of the designer expertise	Competency (qualification and experience)	-	The engineer was competent and experienced in highway, this created time and budget savings	-
Technology deployment	Planning and work procedures/methods	-	Extract from master program helped to create daily work schedule that created flexibility.	-
	Work record /work clarity	-	Daily tasks were recorded and used to compile weekly reports	-
Time utilization	Time saving efforts	-	Work studies helped to create both time and budget serving	-
Interrelationships and Approvals	Links of activities and approvals	No shared plan was made on placing new culvert line, thus, work delays and dissatisfaction were created	- -	Firm/section lacked collaborative mechanism
Adopting risk management	Adoption of risk management	-	Daily work plans helped jobs to be done as appropriate	-
Availability and use of computer(s)	Use of computers	Computer was secured in the office, but it worked slowly, creating delays and inconveniences to the employees	-	No good attention was placed by management to provide a good working PC
Printing, photocopying	Printing and photocopying services	The facilities were placed in the secretary’s office thus, delay and inconveniences were created	At times the secretary was available, not busy, other services were accurate and fast	Little attention was placed by management to provide more flexible accessibility
Data base	Use of database	Not planned and not used, therefore, no benefit obtained	-	-
LAN	Use of LAN service	IT tools not connected, therefore, no benefits obtained	-	-
Internet use	Use of Internet	Internet not accessible	-	-

5.8.2 Case Study Results in the Survey Group

In this group, ten indicators were studied, where; they identified process weaknesses, and also identified desired (**To-Be**) process. The results from two indicators to identify weaknesses and desired (**To-Be**) process are explained in detail. The results of others remain indicators are described in brief in Table 5.10.

Indicators identified weaknesses in the survey group

1: 'W**orking load** of the surveyor', this indicator was studied to determine the extents of work overloads to a surveyor. If he was assigned too many tasks that he could not handle as per the requirement, this was a weakness. The results indicated that a surveyor was engaged with: prepare daily activities and schedules, survey new locations for placement of culverts and gabions, mark levels on the road formation, amongst others. These were huge tasks to be handled by this single person that resulted in a delay and dissatisfaction.

Despite these weaknesses, sometimes, there was a notion that, the contractor involved had sufficient experience in similar jobs. A surveyor, one time as said:

> '*This contractor had done same/similar jobs in several sites, and in this project alone, similar tasks have already been done, completed and approved'*

Such notion caused a surveyor let contractor sometimes proceed with the job without consultant's guidance, thus, causing faulty jobs, which also created reworking.

2: **Unclear/poor record** of the work: This indicator studied whether works were well recorded before work begins in a day or not. In results, it was investigated that some daily activities were recorded on the rough sheets without being transferred onto proper book; and, others were not recorded at all. For example, works were poorly recorded when the establishment of new culvert lines to be shared with other groups were deployed. This caused dissatisfaction to other groups. A surveyor, one time when asked to explain why inappropriate records exist, he had quoted as saying:

> ‘*Sometimes, records are not necessary to be taken in a daily basis, what matters most is to have a week record to enable compile weekly report needed by the management’*

Despite this say, at one time, he delayed weekly reports which caused inconveniency.

Indicators created desired (To-Be) processes in the survey group

1: **Competency**: this indicator was used to investigate availability of competent surveyors and the roles deployed to create improvement. It was found that the surveyor is qualified personnel. His competency helped to provide road marks, secure new culvert lines, level the inlets and outlets of culverts structures, amongst others that were completed as per work requirements.

2: **Computer use**: this indicator was studied on whether a computer facility was secured in the surveyor’s office and it is of good use order. It was found that a computer was secured in the office. Such computer was working well and information was recorded timely, helping to create work flexibility, serve time and budget also. Other indicators studied and identified weaknesses and created desired process in the survey section are summarized in Table 5.10. Information presented in this Table helps to provide description of all indicators studied in the highway group.

Table 5.10: Indicators, Process Weaknesses and Desired (**To-Be**) Process in the Survey Group

Description	**Indicators**	**Four questions asked and answered**		
		What actual weaknesses	**Actual desired (To-Be)**	**Weak, or why changes**
Technology deployment	Work planning and procedures	A surveyor and his assistant worked without appropriate plan, causing waste of budget, time and employee dissatisfaction.	-	-
	Work record /work clarity	Poor record of the daily works	-	-
Time utilization	Time serving efforts/ Time waste avoidance	Work study was sometimes not conducted, thus, operative time was not saved	-	Lacking of planning caused employees duplicative efforts
Studying possible cost avoidance	budget goal/ unnecessary cost	Work study sometimes was not done to save the waste of the budget	-	
Interrelationships of activities	Links of activities	No collaboration was deployed when approving the work; this created dissatisfaction	-	Firm/section lacked collaborative mechanism
Linking of activities	Approval of work	Lack of planning had caused dissatisfaction among employees	-	Firm/section lacked collaborative mechanism
Printing, photocopying	Printing and photocopying services	No flexibility on using these tools; therefore, delay was created	-	Little attention was placed to create flexible
Data bases	Use of data base	Were not used, therefore, no benefit would be gained	-	-
LAN	Use of LAN service	No connectivity was secured, thus, no benefits could be obtained	-	-
Internet	Internet use	No access to the Internet	Mobile phones were used for especially, emails	-

5.8.3 Case Study Results in the Structure Group

Ten indicators were studied, where all of them identified process weaknesses and four indicators identified desired (**To-Be**) processes. In the following sections, two indicators to identify process weaknesses and desired (**To-Be**) processes are selected and discussed. Results of other remain indicators are briefly described in Table 5.11.

Indicators identified weaknesses in the structure group

1: **Risk management adoption**: in this indicator, a selected activity was studied to identify weaknesses, and, desired (**To-Be**) process. If an activity was defined, tasks identified, consequence effects identified, and, mitigation measure effected, this was a desired process. In contrast, it was a weakness.

Although culverts construction was being carried out by a contractor, but, being aware that a consultant also had a role to play on it, such task was investigated. In results, no supervisory role was appropriately performed by either side (the contractor or the consultant). On a day studied, employees were carrying the culverts to the excavated hole, fixing them, and making concrete casting themselves. Although this may happen for committed employees, and if it was a management target; however, this situation was different. In two line culvert fixing operations, when employees were carrying the culverts without proper guidance, two of them were broken out. This creates extra budget to a client.

2: **Activities' linkages**: this indicator investigated the extent to which planning were conducted and effected on a shared work group. If the task was well planned and approved by all required groups, this was desired process. In contrast, it was a weakness. In this task, 'checking and approval of the new culvert line' was conducted by only two sections (structure and survey). The groups showed to be lacking collaborative arrangement. It thus caused misunderstanding and dissatisfied to the highway group.

Indicators created desired (To-Be) processes in the structure group

1: A**ctivity budget goal targeted**: an activity was selected and studied if it deploys budget-serve-goal target for an accomplished activity. If such target was met, this was a desired process. In contrast, it was a weakness.

Some groups that were sub-let gabion works in the contractor organization were studied. In results, these groups had plans and engage with the work roles that helped them to serve in operative time and budgets, which is a desired.

2: **Technology –'Work clarity and record',** this indicator was studied to determine whether, works were well recorded to create work flexibility or not. If they were clear and well recorded; this was a desired process. In contrast, it was a weakness. In results, it was identified that, although a group leader had low working experience, but, he had a tendency to record the daily works in recognized record book(s), which helped to create easiness in compiling weekly reports.

Other indicators identified weaknesses and created desired (**To-Be**) process changes in the structure group are summarized in Table 5.11. In this Table, indicators studied are outlined in column two, weaknesses identified are explained briefly in column three, indicators to identify desired processes are briefly explained in column four.

Table 5.11: Indicators, Process Weaknesses and Desired (**To-Be**) Processes in the Structure Group

Description of Indicators	**Indicators**	**Four questions asked and answered**		
		What actual weaknesses	**Actual desired (To-Be)**	**Weak, or why changes**
Capability of the designer (expertise)	Competency (qualification and experience)	A qualified engineer deployed, but had insufficient experience, and firm lacked culture that allows sharing of ideas.	-	-
	Working loads	A single engineer engaged with a lot of tasks he can't manage. Due to this work overload, work delayed and employees dissatisfied.	-	A firm need to deploy cultures of engaging with the balanced workloads
Technology deployment	Work planning and procedures	Some gabion works sub let (out sourced) who did not plan better their job, causing fault jobs	Planned works by the out sourced groups created work servings	-
Time utilization	Time saving efforts/ Time waste avoidance	work study sometimes were not conducted to create time saving	-	Little efforts deployed to study and assign qualifying and realistic and skilled work groups
Risk management	Risk management adoption	-	Huge amount of works were planned. This helped to create productivity	-
Use of computer(s)	Computer	No computer was secured in his office, causing delay and work inconveniences	-	No appropriate attention was placed by management to provide a PC in the office
Printing, photocopying	Printing and photocopying services	Inflexibility on using these tools. They were within the secretary's office, where sometimes delays and inconveniences were created	At times secretary was available, not busy with other jobs and no queuing, services were fast and accurate	Little attention was placed by management to provide more flexible accessibility
Data base	Data base use	Were not used, no benefit gained	-	-
LAN	LAN use	No connectivity were secured	-	-
Internet use	Internet	No access to the Internet	Mobile phones were used	-

5.8.4 Case Study Results in the Management Group

Seven indicators were studied, whereas five indicators identified both weaknesses and desired (**To-Be**) process. Two of these indicators - use of risk-registrar-book and LAN services identified only weaknesses.

An indicator identified weaknesses

'Use of risk registrar book': this indicator was studied to check whether risk-registrar-book was not available or was available but not used adequately. In results, it was identified that the firm did not have any risk-register-book. Firm claimed that drawings, specifications and master programme were sufficient to fulfil that need. However, it was learnt by the researcher that, if risk registrar book was utilized, it could avoid some project tasks delays that were not outlined in the registrar template.

The activity 'work overloads of the expertise' were not well thought-out, and therefore, remedial measures not taken (this was a role of management). There were only mere stories that other temporary expertise would be employed to reduce work overload problem, but, the new staff were not recruited.

Indicators that identified desired (To-Be) processes

Risk management adoption: a selected activity was studied to check if it has facets of risk management – definition, risks identification, etc.

An activity, '**ensure work site and office communication is effective'** was realized by deploying sufficient supervision vehicle to each section group leader. The vehicles were also well serviced, made full of fuel amongst others.

An activity, 'scheduling massive culvert works and compaction works': were set during periods not affected by rains' also have facets of the desired process.

Computers' use: in this indicator, computer(s) were investigated if they were secured in the offices and also worked as required. If there were no computer secured in the office, or, it was secured but not working properly, it was a weakness.

Two printers were available in the firm, one placed in the chief engineer's office and the other in the secretary' office and one photocopier machine placed in the secretary's office. They helped printing and photocopying services to be timely and budget served in these offices.

Database Services: Was investigated on whether database services are available and benefit the firm or not. If they were available and benefit the firm, this was translated a desired process, against which it could be a weakness.

Internet Services: a firm was investigated on whether Internet was secured and used by employees to surf project information or not. In results, Internet services were connected in the office of resident engineer, thus, simplifying his work operatives.

It is generally summarized that indicators studied from four groups (highway, survey, structure and management) identify sources of weaknesses such as: work overloads to the employees, incompetence of the experts, poor planning that create weaknesses. Types of weaknesses were: time delay, over budget, inflexible work operation, and duplicative efforts amongst others. Indicators also created desired (**To-Be**) processes such as using qualified expertise, giving balanced workloads, proper plans and record systems, amongst others which create time and budget serving, flexibility of the method, satisfaction to the employees or the user(s), amongst others.

5.8.5 Cross-Case Study Comparison Results

On each of all four studied (highway, survey, structure and management), results were replicated (Tables 5.9, 5.10 and 5.11). For example when the respective group deploys the expertise who lacks sufficient experience, who had huge amount of workloads, these created weaknesses such as: creating faulty jobs, work delayed, work created cost overruns, amongst others.

On the other hand, when competent and experienced personnel were deployed, for example, work plans, forecasting events and work flexibility, amongst others, were created. Generally, from all four studied groups, indicators identify sources of weaknesses, such as work overloads to the employees, lacking planning, etc. Indicators also identified types of desired processes such as: a balanced workload assigned to employees, planned works etc.

5.9 Validity of the Case Study Method Used

The case study involved studying road construction project inspected by four groups. Aspects of validity are achieved due to a well detailed case study design presented in Chapter Four: Section 4.11.6 – preparation of search questions, Section 4.11.7 – selection of cases, Section 4.11.8 – preparing protocol, Section 4.11.9 – describing the methods, data collected and analysis, and Section 4.11.10 – judging the quality of data collected and analyzed; all these facets address validity of the findings of the case study (Yin, 1993; Creswell, 2007; Ary *et al*., 2010).

5.10 Results on the Analysis of a BPR Model Compared with Other Models

5.10.1 Comparative Analysis (Overview)

Analytical comparison of a developed model with other models is a test used in this study to validate the model (Edward and Rykiel, 1996). The usefulness of the approach is supported by McCabe and Dixon (2000) who add that its appropriateness is maximized if validation criteria are well identified and evaluated. As for this, four model comparison criteria were established and used: model comprehensiveness, uniqueness of BPR steps, process flows improvement and firm controlling a project.

5.10.2 Comprehensiveness of the Models

Construction project performance is achieved through five stages, also termed as phases or processes. They include: planning, design, procurement, construction and commissioning. In order for a whole project to be improved, each and all these phases/processes need to be understood and improved.

In order to realize the whole project performance improvement the developed BPR model in this study reengineered three core processes: design, procurement and construction management. Design covers three activities: preliminary design, schematic design and detail design. In the preliminary design stage, the project conception and planning are deployed. In the construction management process, the actual works done and close out are covered. The inclusion of these activities are described in Chapter Two, Section 2.4, see also Figure 3.2 and 3.4 respectively. Indeed, these processes are implemented and managed by all three main contracting parties: client, consultant and contractor.

Brown and Riley (2000) reengineered the procurement and design processes. Their model dealt mainly with such processes as: inviting and incorporating views of the contractors during design stage to enhance constructability (design process) and establishing brief procedures to, and obtain the competent contractors (procurement). Parties involved are designers, a client and three contractors invited, and later on shortlisted to one in number.

Allweyer *et al.* (1996) reengineered a procurement process. This is the stage after construction documentations are completed, therefore, it includes the following tasks: advertisement, tender evaluation, negotiation and declare the winner who is the builder (Jackson, 2010).

Tookey (1998) reengineered the project planning process. This stage involves the following tasks: decisions of project objectives such as budget estimate, duration estimate, risks and uncertainty forecasts, amongst others (Haplan, 2006).

Looking at these models, it is apparently that the BPR model developed in this study covers comprehensively all key tasks, activities and processes of the construction project participated by all three main parties to a project as compared to other existing models: Brown and Riley (2000) who reengineered only procurement and design process participated by client, designers and contractors, Allweyer *et al.* (1996) who reengineered only procurement process and Tookey (1998) who reengineered only project planning processes. Therefore, a developed model fills the gap in the literature on streamlining improvement on all core project processes.

5.10.3 Uniqueness of the BPR Step towards Performing a Construction Project

Construction project performance improvement requires understanding of project processes/steps to be understood and outlined, including: planning, design, procurement, construction and commissioning together with their associated inputs, activities, methods, and outputs. This helps to conduct reengineering, prepare/understand the current process, **To-Be**, and strategies for improvement.

The developed BPR model mapped out each core project process – design, procurement and construction management. In these processes, in design for example, specific inputs (users needs, owners' needs, finances' needs etc) required to be used on the activities (example, preliminary design, schematic design etc) so as to produce a specified output (functional brief, option sketches etc.) were identified comprehensively. Using this project mapping out information, the model addressed specific project reengineering steps: understand current process, design **To-Be**, and strategies for improvement; they can be used to improve unique project performance.

Brown and Riley (2000) reengineered design and procurement processes. Reengineered steps include: designers' selection, designers produce outline design, three or two contractors shortlisted and tried on their deliveries, a competing contractor invited and worked hand in hand with the designers, the same contractor is considered to be used during work executions. This model gave detailed and specific tasks necessary to use in performing the steps - **As-Is**, **To-Be** and continuous improvement of design and procurement processes.

Manganelli and Klein (1994) provided five steps to implement project. They include: prepare to conduct BPR, develop **To-Be** process, develop business vision and strategy, identify the team and separate technical from social issues. The steps explain generic tasks to implement BPR initiative, for example, in designing **To-Be** process, one learns from best practice, conducts benchmarking, uses IT etc. these do not reflect specific project process.

Zigiaris (2000) provided eight BPR implementation steps: identify the team, employees trained, understand and measure the existing process, develop **To-Be** process, adopt IT strategy, envision by top management, implement, monitor continuous improvement. The model also addresses generic BPR project process.

Generally, the BPR model developed addresses unique project performance steps through understanding of specific inputs, activities, methods, interfaces and outputs for a corresponding design, procurement and construction management process. Like in BPR model, Brown and Riley (2000) provided specific tasks and steps for reengineering, however, they focussed design and procurement processes. Other models, Manganelli and Klein (1994) and Zigiaris (2000) presented generic steps that are not specific to implementing construction project performance. However, they provided lessons on how to conduct BPR.

5.10.4 Process Flow Improvement

The whole project accomplishment is improved through improving process flows. A process flow accounts for establishing all process activities on an iterate form, all such activities are well described together with ensuring to capture the links between such activities. The necessity is that all activities would be understood in terms of their scopes and effects, and or approval scrutinized and deployed.

The BPR model developed in this study identified three core processes on the iterate form – design, procurement and construction management. On each core process, activities are identified and described. They include, for example, design: preliminary design, schematic design, and detail design. Procurement: project delivery option, procurement option, contract type, etc. Flow process issues occur between these activities, for example, between preliminary design and schematic design, between schematic design and detail design stated on thier 'interfaces'. An interface between preliminary design and schematic design, 'functional brief accomplishment and approval', were realized. Interface between schematic design and detain design, option sketches to help client to choose alternative sketches of his needs together with the approval was given, amongst others.

Brown and Riley (2000) – reengineered design and procurement with activities: project need identified, designers appointed, outline design prepared, contractors invited to tender, two or three contractors are selected, selected contractors who preliminarily work with the designers, one contractor is shortlisted and works hand in hand with designers to refine the work for execution. Seven activities are identified to reengineer a procurement process and they appear to be somewhat described. For example, client is guided by a consultant to select two or three contractors whom they work together, and after sometimes, he shortlist one to continue with, on a design to share buildability concepts.

These activities occur in a sequence and are defined in a way that the designers and the invited contractors work together to achieve “a buildability issue’. However, in this model, specific preceding activities’ effects, or approvals are not addressed specifically. This may impact a project since critical efforts to evaluate the effect of preceding activity is not done, because of the lack of measurement indicator, thereby, creating rework.

Koskela and Sharpe (1994) modelled the project process with two processes: design and construction. Design process is described in three perspectives: in ‘conversation sense’, where, specification is refined through numbers of steps and needs transformed into client’s requirements. ‘Flow sense’, captures flow of information between stages and participants. The ‘value sense’, captures the conversation of client’s requirements to a design solution. In construction process, ‘conversion and flow sense’, deal with material flows to the site and the work processes deployed by the construction team. In ‘value sense’, a building as specified in the framework of time and cost target is given.

In this model, in design, specifications refined to meet the needs of the owner, and in construction, process ensures building is constructed based on time and budget needs. The exception is that procurement process is not addressed on its flow effects.

Riley and Brown (2001) reengineered a construction business of a contractor. The model deploys two perspectives of mapping out activities: at construction project business and at activity’s level. In the construction business activity level, six activities are identified with their relationships (flows). They include: marketing, tendering, purchasing, contract management, construction and plant and transport. Interrelationships between: marketing that recognize and inform existing and new customers about new projects. Therefore, this would be served when they tender for the projects. Construction takes successful tenders to make up a physical project, and, this can only be done when marketing is done and has impacted a tendering process. Activities and relationships are shown in Figure 5.11. In this Figure, iterate activities are linked together with the lines (flow process).

Construction project business

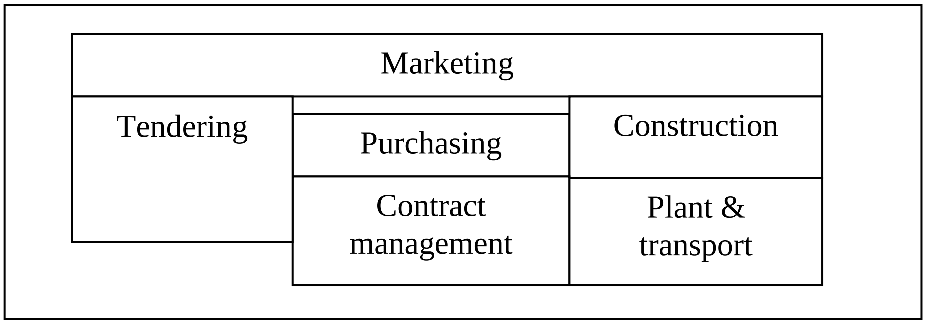


Figure 5.11: High Level of Construction Project Business (Adopted from Riley and Brown, 2001)

Perspective two of process mapping was the ‘activity networks’ in which tasks contained in these activities together with their inputs marked as input 1, input 2, input 3 etc, roles targeted and the outputs expected are identified and descried.

Generally, a developed BPR model presents process flows through identifying and describing three core processes, activities or sub-processes, inputs, activities and interfaces to accomplish a project done by three contracting parties: client, contractor and consultant. It captures process flow issues comprehensively. Koskela and Sharp (1994) analyzes only two project process flows – design and construction. Riley and Brown (2001) models construction project business of a contractor organization to describe flows of activities on macro and micro levels.

5.10.5 Controlling of Project Process Performance

Construction project is accomplished by the organizations mainly, client, consultant and contractor with the aim to create a final product on time, on budget and meet quality needs. As such, the construction industry needs to have a system with appropriate administrative and control roles that guide the core processes. Administrative and control process defines the future of the firm and guides the core process which is a day to day role of the firm. They must also be able to manage changes that prevail/occur in the world of business today.

A BPR developed model has two process management perspectives: administrative process, with five dimensions: strategies – stating the visions of the firm, objectives, policies, amongst others. It also has organization structure that vests authorities to the employees, assign and control the works. Organization structure and strategy are supported with the processes including: information, technology, and finance. Administrative process manages and controls the core project processes.

In this model, the administrative roles are presented in dimension one ‘BPR foundation’ and dimension five ‘strategies for improvement’. They guide core process presented in the model as dimensions two ‘understand a process, measure process to identify weaknesses and created a desired (**To-Be**) process. The three core processes include: design, procurement and construction management.

Riley and Brown (2001) reengineered a construction business managed by a contractor. The company is a firm-owned by family members with administrative role (strategy and organization structure) of providing future direction, decides the way operations are conducted amongst others. The firm has organization structure that defined vision of future that is implemented by the modelled structure: how to conduct marketing, how to manage contract, etc. This is managed through or via the activity level on which inputs, work roles and the outputs are defined and implemented. It therefore, provides concepts for a firm controlling a project.

Soares (2013) provides attributes to radically change the way a firm is managing a construction project (project control). His model outlines four dimensions of firm's project control and management:

- Embodying clear communication, integrated teams, contribution of knowledge sharing, collectivists and trust;
- Adoption of design build project delivery;
- Deployment of Building Information Modelling (BIM); and
- Adopt lean concepts to scan value and waste in construction project.

It is summarized that BPR model developed addresses in detail the administrative and control process used to guide core project processes performance. Riley and Brown (2001) addressed the organization structure and strategy that control project operative business at macro and micro levels. Soares (2013) modelled project control through adopting: knowledge share and effective communication, adopt design build, BIM and lean concepts.

Generally, a BPR model compares (by agreeing and slightly disagreeing) with other existing models. It has comprehensive steps/phases to improve project performance; other models reengineer one or two steps/phases. BPR mode and Brown and Riley (2000) both comprise detailed and specific steps to improve project process. Manganelli and Klein (1994) and Zigiaris (2000) has generic reengineering steps, amongst others. A BPR model therefore, compare with other models.

5.11 Parameters of a BPR Model that Identified Weaknesses of Traditional Process Performance

Four parameters of BPR model were tested to determine that they solve weaknesses of a traditional project process performance. Results follow:

5.11.1 Competent Team's Involvement in Solving Ill Briefing of Projects

In the traditional process ill-briefing prevailed because of using non conversant client and lack of incorporating all design teams to solicit information. In the current BPR model, conversant client and design team involvement were studied on the ongoing project to solve ill-brief information problem. Results follow:

The project was named 'Construction of Theatre and Sterilization Unit at Mbeya Regional Hospital'. Public client was represented by a civil engineer. Design team was represented by the architect, quantity surveyor and a civil engineer.

Brief project information was presented by the client and the users; this was made to the design team. Design team continued soliciting information as appropriate.

Designers then prepared sketches and submitted them to a client on the 15/02/ 2016. They were then presented (through power point) to client and users on 19/02/2016, where additional inputs were received and were divided in two parts A and B:

Part A: Ground floor plan (clinical care unit and sterilization)

- at the entry point, allow a separate entry for patients and staff;
- allow a Linen and Sluice in the critical care and sterilization unit;
- in the critical care unit, every ward (gents, ladies and children) should have six beds and burse station;
- there must be oxygen plant; and
- in the sterilization unit there must be emergent door and stair case which connect between sterilization unit and theatre.

Part B: First Floor plan (Theatre)

- provide five theatres, two major, emergency and two small theatres;
- provide sealing on the windows within theatre rooms to restrict the dust but allows lighting;

- major theatres should have main dimensions 7.0 meter by 7.0 metre;
- toilets in the operating theatres should be removed.

These comments were incorporated in the sketches in two weeks' time from 16/2/2016 to 04/03/2016, and then re-presented to a client and users. This presentation covered the contents: site layout plans, floor plans, sections, elevations, roof plan and 3 Dimension views.

Generally, consultants solicited information frequently, incorporated needs of clients and users (Mbeya hospital employees and Ministry of Health). Thus, well project brief information was approved by the clients. Although the project is still on progress, this study has views that frequent project changes might be minimal, partly due to appropriate briefing conducted.

Thus, the parameter 'deployment of a conversant public client and competent design teams' solve the problem of ill project brief that prevail in the traditional process where partial information were given, that also contributed to reworks.

5.11.3 Option Sketches Reducing Chances of Rework caused by Single Sketch Option

In the traditional process reworks are partly caused by deployment of a single sketch option. The current BPR model studied adopted option sketches to reduce chances of these reworking. Results follow:

From a bungalow building sketched, the three options adopted were on serial order that were printed and the views of drafts shared between a architect and a client. In the first print out (option one), the portion was marked A showing that the veranda was placed near master bedroom; where after discussions a corridor was created to make separation. In the second print out (option two), the portion was marked B, where store appeared to be near the dining room; and they were then modified making them far-apart. In print out three (option three), dinning and lounge initially appeared as one long room that had then improved with the wall introduced to separate them.

The final document was then drawn in a 3D format to give visual perspectives to widen understanding of the client and the users (see two pictorials). The pictorials helped to create addition changes in the sketches to meet client's needs: adding wall extras (at the corners), changing gray colour on the plinth to be black, introduce flowers, trees, change colour on the corrugated iron sheets, amongst others.

Of importance on the option sketch is that the changes are effected early-on, these incur low cost than deploying them during actual implementation as it is usually been done in the traditional sketch option. Therefore, the two or more sketch options helped client to bring-in information from: own, users and learn from others, and also use support of IT and BIM technology that maximized visualization that avoided reworks.

5.11.4 Constructability Studies to Identify Hurdles before Actual Project Implementation

In traditional process, errors, mistakes and omissions in construction document prevail. The current BPR model studied buildability and enforceability issue to identify and eliminate hurdles in construction documents before work commences. The study was conducted by an engineer selected and a researcher who stand as new team than those involved in the design stage. Results follow:

Build-ability: defined ‘missing section drawing and written-off drawings’. Two sections in the drawings of the first floor and a detail on a column-beam intersection of the second floor were missing. Therefore, employees had to wait reproduction of these documents that cause delay and inconveniences. Written off drawing: a detail drawing was deteriorated (i.e., it worn out). Other than a delay created for waiting new document production, it also had risks of transferring wrong information.

Enforceability: on a **‘**bill of quantity’ document some work items lacked clarity. One item reads ‘*prepare and apply internal and external plaster* with *cement mortar* ‘*as per engineer’s satisfaction’* (see also Appendix J). In this statement, thickness sizes of internal and external plaster and the proportions of the mortar materials are not stated. Other work items in the BOQ, is quoted ‘replace new..…*complete* with all *necessary ironmongeries’.* Ironmongeries types were not mentioned, thus, create ambiguity in the contract. Other item, ‘Supply and fix 1000 litre storage tank in…above the beam constructed’. In this work, formwork to support concrete of the beam was overlooked. Other item state, ‘allow *additional pipe work* …’ and replace *the worn out taps*’ have ambiguity since the numbers, sizes amongst other specifications are not indicated.

Generally, BPR model allowed two expertises (other than those involved in the design stage) to review construction documents under two indicators - buildability and enforceability. They helped to identify hurdles (of omissions, errors and mistakes, lack of clarity etc.) that exist in the traditional process.

Although these efforts may incur more payments to these other expertise, such cost is considered low compared to conducting physical changes on the product.

5.1.5 Deploy either of Procurement Options - Competition, Negotiation, Direct or Combination' to Create Work Flexibility

Traditional process adopts more on competitive option that limit flexibility procurement that meet client needs. Current BPR model studied deployment of procurement option for TARURA – Mbeya who procured fifty seven projects in financial year 2017/2018. Results follow.

One (1) project amounting to Tshs 374,409,280.00 was implemented through single source (direct talk). The reason was that, it was the only one firm in Mbeya city who owned asphalt plants required to accomplish this project. Other firms could even had high costs because of not owning the equipment as they could rely on hiring it.

Forty five (45) projects were implemented successfully through national competitive procurement option.

Eight (8) projects were implemented through competitive quotations (negotiations). They were initially advertised through competitive process but some of them were not responded, some had higher rate than the engineer estimate, amongst others.

Three (3) projects were implemented through quotation method on which contractors, whom their competency is known were given BOQ, visited the site and fill-in BOQs that were also evaluated rapidly to meet emergency need. The emergent were caused by the excessive rain fall that deteriorated road infrastructure.

Generally, the adoption of procurement option (competitiveness, negotiation and direct or combination) allow better utilization of project efforts that serve budget, time and satisfy the client's needs.

5.12 Chapter Summary

This Chapter presented study findings and discussions. Dimensions of a conceptual model have been outlined. Respondents profile is also presented. The findings from questionnaire surveys are well discussed that helped to develop the model. Data from case study are also well discussed in this Chapter, indicating that the indicators studied identify weaknesses, identified desired (**To-Be**) processes and improve traditional process performance.

Chapter Six presents BPR model development. The model is based on the conceptual BPR model, on which, its appropriateness is suggested by the key project participants.

CHAPTER SIX

DEVELOPMENT OF BPR MODEL

6.1 Introduction

Previous Chapter presented study findings and discussions. The findings from interview and questionnaire surveys together with case study are well discussed in the previous Chapter. This Chapter develops a BPR model to be used by the contracting parties to improve construction project processes performance in Tanzania. The BPR model developed comprises of three main stages, the: BPR conceptual model, BPR model, and a validated BPR model. These stages follow a rational deductive approach in which the intuitive/conceptions are framed together, tested, verified and validated. Clearly, these discussions are given following a step by step mode by which four specific objectives of the research were established and met. Each stage is described chronologically.

- to formulate a BPR conceptual model for improving 'project processes performance';
- to analyze indicators that identify weaknesses of project processes and their performance;
- to formulate strategies for achieving improved 'project processes'; and
- to develop a model for undertaking BPR to improve performance of project processes

6.2 Proposed BPR Conceptual Model

The BPR conceptual model was formulated based on the literature on the related study sub-themes: project performance, contracting parties' performance trends, process measurement, BPR philosophy and organizational processes. Therefore, a BPR conceptual model with five dimensions was developed. They include: BPR foundation; Understand Current Process; Weaknesses of Current Processes; Desired (**To-Be**) Processes and Continuous Improvement. The BPR conceptual model is presented in Figure 3.6, Chapter Three.

6.3 BPR Model Development

In order to develop a BPR model, BPR conceptual model was used as guidance. Since BPR conceptual model has five dimensions, [BPR foundation; Understand Current Process; Weaknesses of Current Processes; Desired (**To-Be**) Processes and Continuous Improvement], they were used to develop the model. Therefore, in order to develop a model, data in the form of opinions were collected through interviews and questionnaire surveys. The obtained data showed the acceptance of the respondents on each model dimension, descriptions follows:

6.3.1 BPR Foundation

In order to institute any profound changes in the organization it is important to prepare guidelines, resources and a team to lead those changes. Likewise, in order to prepare to, and institute Business Process Re-engineering initiative, the model proposes building a BPR foundation. This BPR foundation constitutes three parameters, team, resources and policies. Each parameter was intended that it represents correct attributes that measure its functionalities. For example, a leader of the team should give the leading roles; a BPR policy document provides guidance to implement BPR, amongst others. These attributes can be measured by using ordinal scale of measures, where the mean scores aid decisions.

In this study, analysis confirms that the three established parameters of BPR foundation are appropriate in preparing to implement BPR, (Table 5.3 and Figure 5.4). It requires that a firm must use a person who can lead and manage changes, use a team to champion and enable the changes to happen, amongst others. Using results from thirty three respondents, (see Table 5.3 and Figure 5.4), the study identifies that all three parameters enhance firms to prepare and conduct BPR. When the mean score value of the attributes was obtained and expressed in percentages of a respective parameter for the purposes of making comparisons, extent to which an attribute influence the parameter can be identified (see Table 6.1). In the Table, each attribute indicates the extent to which it influences the BPR changes. By using these percentage values, this study interpret that attribute ‘leadership’ can be highly needed to guide other attributes on preparing to implement BPR.

Table 6.1: Relative Influence of the Variables towards ‘Build BPR foundation’

Measurement attributes	influential	Parameters	
A person to lead and manage changes	50.52%	Leadership	Built BPR foundation to prepare firm to implement BPR
A team to champion and enable the changes to happen	49.48%		
Adequate resources to support change process	33.57%	Resources	
Programmes to change culture of employees	33.57%		
A consultant (where necessary) to lead the change	32.86%		
Communicate appropriate change policies	33.57%	Policies deployment	
Programmes to train employees	34.28%		
Employees are aware and ready of the planned changes	32.14%		

The BPR preparation and implementation may be done as follows:

i) BPR team maps out the BPR preparatory efforts;

ii) BPR policies to implement the changes effected, and BPR failure factors and successes factors identified and deployed (Al-Mashari and Zairi, 1999; Al-Mashari *et al*., 2001); and

iii) BPR resources are ensured to be available depending on their use in the firm’s operations, e.g. required expertise, skills, equipments, finance, amongst others.

The BPR foundation therefore, forms dimension one of the model.

6.3.2 Understand your Process and identify Indicators that Improve a Project

It is well understood that understanding a process is very important to any person wanting to improve it. Therefore, after the team, resources and formulating policies, the next important stage was to ensure that all organizational processes and core processes are understood, identified and improved.

Processes in organizations are divided in two parts, organizational processes and core processes. Organizational processes are further divided into two parts, administrative processes such as strategies and organizational structure that engage with firm's administrative roles. The other group is the support processes that include information, financial and technology that support administrative processes when guiding the core processes. Therefore, in any firm, the organizational processes engage with controlling core processes.

Within the construction industry, and particularly in this study, the core process is a project process. A project has three core processes: design, procurement and construction management. Design process is a core because it is within this stage the client's requirements are defined, interpreted, documented and the final product agreed conceptually. Procurement represent a stage in which project ideas are critically evaluated to help identify best contractor, consultant and a fair contract that ensures construction management is deployed as per client's need (Jackson, 2010).

In order to improve design, procurement and construction management, procedures are the same as those for improving any process. In order to improve these core processes, one should focus on improving their outputs. Pzedek (2003) suggests that, an appropriate way to improve process outputs is simply to improve critical inputs, critical activities and critical interfaces. Therefore, the critical inputs in design include: competent designers, user's needs, owner's need, and financier needs amongst others. Critical activities in design include: preliminary design, schematic design and detailed design. Critical interfaces in design include: approval of functional brief, and production of optional sketches amongst others. Critical inputs in procurement include: project objectives, project characteristics amongst others. Critical activities in procurement include: project delivery method, and contract types, tender documents preparation, and tender evaluation amongst others. Critical interfaces in procurement include: appropriate project delivery method deployment, and appropriate contract type deployment amongst others. Critical inputs in construction management include: design documents, and contracts amongst others. Critical activities in construction management include: site lay out, and resources planning, amongst others. Critical interfaces in construction management include: site organized and resource gap identified, amongst others.

As introduced earlier, in order to improve three core processes, design, procurement and construction management, their critical inputs, critical activities and critical interfaces should be improved. Therefore, from the interviews conducted, it was accepted by the practitioners that forty (40) indicators improve project processes (See Chapter Five).

Out of forty indicators identified, six improve critical inputs in design (e.g. competent designer, user's needs etc.), six indicators improve critical activities in design (e.g. evaluating the user's needs, deploying optional sketches etc), four indicators improve critical interfaces in design (e.g. functional brief approved); these make a total of sixteen (16) indicators.

Four indicators improve critical inputs in procurement (evaluate project objectives, project characteristics etc.), four indicators improve critical activities in procurement (e.g. uniqueness of a project, project characteristics etc.), and one indicator improves critical interfaces in procurement (i.e. deployment of right project delivery option); these make a total of nine (9) indicators. Seven indicators improve critical inputs in construction management (e.g. design documents, competent contractor etc.), eight indicators improve critical activities in construction management (e.g. resource scheduling, resources acquisition etc.), one indicator improves critical interfaces in construction management (i.e. construction activities approved); these make a total of fifteen (15) indicators. Overall list of forty (40) indicators to improve three core project processes are presented in Figure 6.1. These indicators measure three core processes of the project.

Indicators for Critical inputs in design Users' requirements; designer's work efforts; financial requirement; qualification and experience; Collaborative design needs; Safe design regulators	**Indicators for Critical activities in design** Collaboration between design team members; forecasting the output of a design activity; design activities' description; single sketch design option; identification of user groups and their need; work sketches explanations	**Indicators for Critical interfaces in design** Interrelationships of interfaces between design activities; design process review; design milestones preparation; client approving design works
Indicators for Critical inputs in procurement Procurement risks evaluation; project characteristics evaluation;' a conversant, or a client with past project's shared views; project objectives	**Indicators for Critical activities in procurement** Client *evaluates contract types*; client evaluates *procurement activities; client evaluates procurement option; clients evaluates project characteristics*	**Indicators for Critical interfaces in procurement** Procurement activities are not checked for completeness or accuracies
Indicators for critical inputs in construction management *Fairness in the contract;* Contractor competency; *Absence of qualified personnel in a contractor organization; design documents; information flow; actual site records*	**Indicators for Critical activities in construction management** *Site Lay out;* resources acquisition; work implementation; health & safety; activity budget; activity duration; activity quality; project closeout	**Indicators for Critical interfaces in construction management** Construction management activities checked for completeness and accuracy

Figure 6.1: Overall List of Indicators to Improve Core Project Processes

6.3.3 Weaknesses of the Current Process

After understanding a process, next, practitioners should use indicators to identify core processes weaknesses. For this aim to be achieved; two criteria were set forth; that indicators established should: [i] have causation effect – i.e. if it measures the critical input, or critical activity or critical interface, this must have effect on the corresponding output [ii] Any project activity is usually shown on the construction documents and described on a specification document about its performance standard required. Therefore, these indicators are intended to show (prior to actual work) that they perform contrary to specified requirements. They help practitioners understand the weaknesses of the project processes. Descriptions are given in the following sections (see also Figure 6.2 and Table 5.13, Chapter Five).

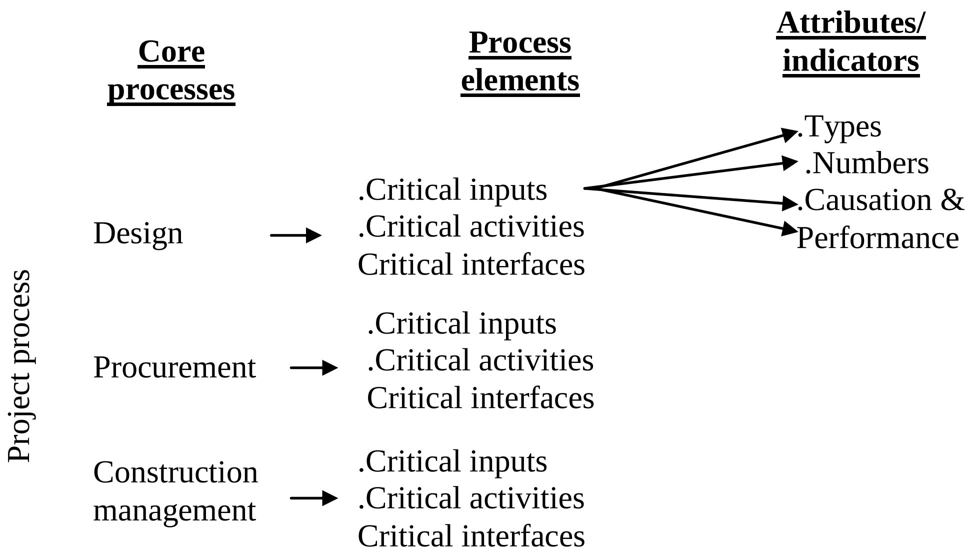


Figure 6.2: Indicators to Assess Core Project Processes

Criterion one: This criterion shows that the indicators established to identify weaknesses must have causation effect on the process outputs. Since all established indicators measure the process elements (critical inputs, critical activities or critical interfaces), the indicator(s) must impact the outputs of the core process. For example, a ‘competent designer’ as an indicator for a ‘critical input in design’ causes impacts in the design output in that, by adopting an incompetent designer', this creates 'inaccurate design documents; and incomplete design documents amongst others'.

Criterion two: Indicators in this group show that a process element .i.e. an input, an activity or interface is performed contrary to adequacies. Therefore, such inadequacies indicate a process weakness. The identification of inadequacies (weaknesses) also helps in the establishment of the desired processes.

Having described the criteria upon which the indicators may be used to identify weaknesses, results from questionnaire surveys accepted that out of fifty five indicators established to identify weaknesses, forty indicators identify weaknesses. These are described in the following sections.

Critical inputs' weaknesses in design occur when incompetent designers are used, financier's needs of the project are not well evaluated by the designers, users' needs are not well evaluated by the designers; these cause fault design documentations. Critical activities' weaknesses in design occur when preliminary design tasks are not well evaluated, schematic design tasks are not well evaluated and detail design tasks are not well evaluated. Critical interfaces' weaknesses in design occur when functional briefs are not well prepared by the designers; optional sketches are not well prepared to give choice flexibility to the clients amongst others. As a result, they may create reworking.

Critical inputs' weaknesses in procurement occur when project objectives, project characteristics, and project speed needs amongst others are not well evaluated by the procurement team. Critical activities' weaknesses in procurement occur when project delivery options, contract types, tender preparation, tender evaluation amongst others are not well evaluated. Critical interfaces' weaknesses in procurement occur when appropriate project delivery option is not approved; contract type to be deployed is not approved by the client amongst others. These contribute in selecting incompetent contractor, or in deploying unfair contract.

Critical inputs' weaknesses in construction management occur when incompetent contractors (builders) are used; fault design documents are used amongst others. Critical activities' weaknesses in construction management occur when site is poorly laid out, poor resource planning, poor work implementation are deployed amongst others. Critical interfaces' weaknesses in construction management occur when fault resources (e.g. equipment), deteriorated materials are deployed in the site amongst others. These contribute in producing fault construction product that dissatisfies a client.

In summary, from the interview and questionnaire survey, forty indicators were accepted that they are appropriate to be used to identify weaknesses in design, procurement and in construction management. Of these, sixteen indicators identify the weaknesses in design, nine indicators identify the weaknesses in procurement and fifteen indicators identify the weaknesses in construction management (see Section 5.4 and also Table 3.1, Column, two).

In using these indicators, practitioners should take into account the following points. That, from a dimension of the model 'process understanding', a project process was well mapped out. Therefore, three core processes identified, processes elements (critical inputs, critical activities and critical interfaces) identified together with the forty indicators to identify weaknesses. Since a process is well detailed, major process weaknesses identified, perhaps, a problem remains on the capability of the implementers. They are therefore, argued to place more attention on that area.

6.3.4 Identifying the Desired (To-Be) Processes

When process weaknesses are identified, next step is the identification of a (**To-Be**) process. A **To-Be** process stage is the desired or excellent stage/level practitioners would be required to deploy. This performance level can be met through achieving two tasks: (i) since the firm knows its own process weaknesses, this can be converted into an opposite side - i.e. focusing to meeting performance specifications. For example, if a core process had a weak process, 'incompetent designer' who create fault design documents, its corresponding desired (**To-Be**) process is deployment of 'a competent designer' who provides complete and accurate design documents. (ii) adopting best practices. In Table 3.1, Column three, the desired (**To-Be**) processes were proposed for deployments on three core project processes.

In order to prepare a desired (**To-Be**) process, questionnaire survey established sixty measures with items of measures to improve design, procurement and construction management. The measures to create desired (**To-Be**) design, procurement and construction management are described in brief as follows:

Five measures with twenty two (22) items of measures create desired (**To-Be**) design process; five measures with twenty four items of measures create desired (**To-Be**) procurement process. Four measures with fourteen items of measure create desired (**To-Be**) construction management process. These give sixty items of measure to create desired (**To-Be**) core project process.

In a measure, 'design team competencies', practitioners should deploy knowledgeable, skilful and experienced designers, who help in planning both budget and schedules, advice on materials selection amongst others. Create values after design map out of activities to help identify all users, scan a process needs, conduct self proof of activity delivery amongst others. In deploying IT and BIM technology, practitioners need to store operatives in computers, deploy data base, use Internet positively amongst others. In constructability (**To-Be**) process, practitioners should ensure evaluations of the work items that are constructible all the time of a project life cycle. In design management, adopting design management, practitioners should ensure that all design participants are well identified, collaboration is enhanced in the design process, design team leader is appointed who coordinate all design activities amongst others. The five measures with twenty two items of measuring desired (**To-Be**) design process are depicted in Table 5.7, Chapter Five. The five measures with twenty four items of measuring desired (**To-Be**) procurement process are depicted in

Table 5.8, Chapter Five. The four measures with fourteen items of measuring desired (**To-Be**) construction management process are depicted in Table 5.9, Chapter Five. For detailed reference, the five measures with the items of measure in design and the mean scores are presented in Figure 6.3. They help to outline attributes that form desired design process improvement.

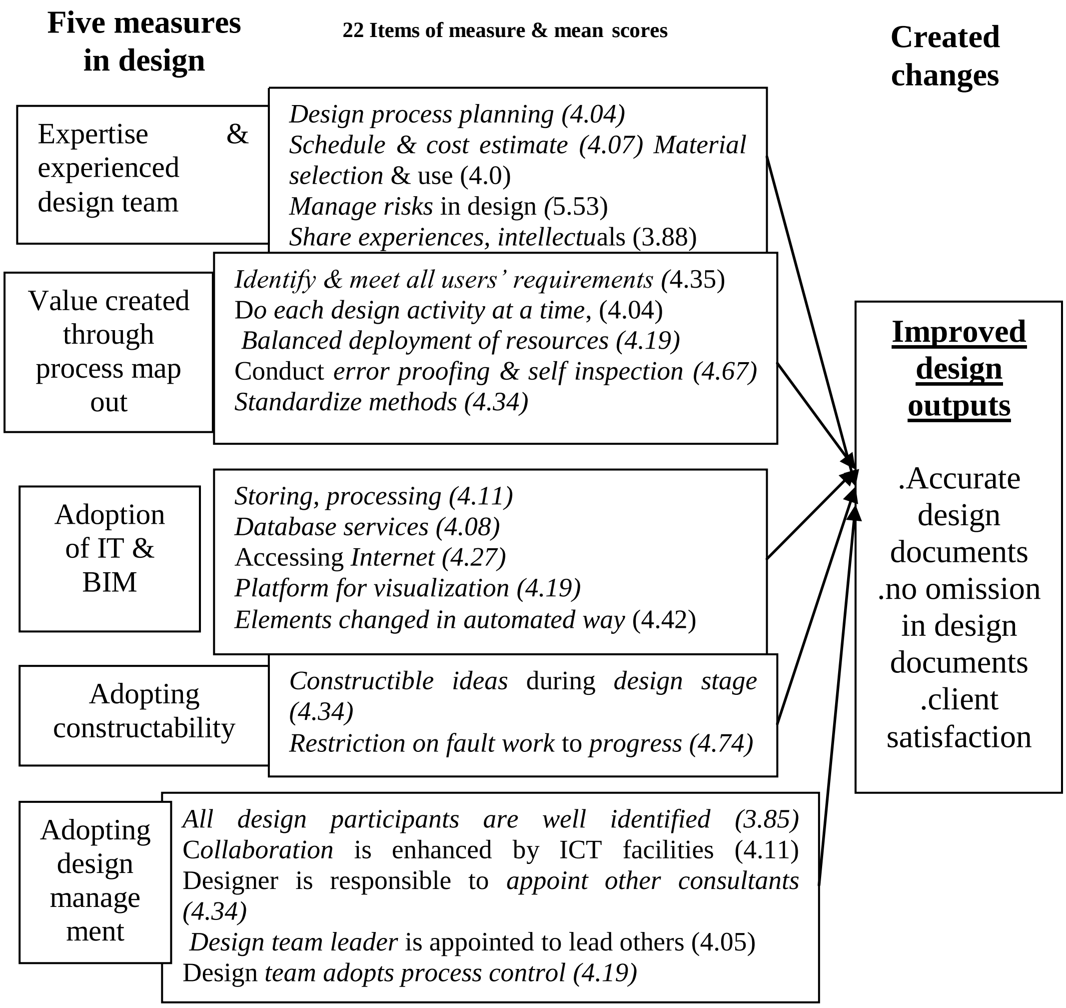


Figure 6.3: Measures that create Desired (To Be) Design Process

6.3.5 Strategies for Achieving Improved Process

This last step of BPR model development was a dimension 'strategies for improvement'. This dimension was aimed at enabling practitioners identify strategies that are used to perform four tasks, to: (i) evaluate weak identified processes, (ii) understand and identify desired (**To-Be**) process, (iii) enable the process changes from a weak to a desired (**To-Be**) process step and (iv) perform continuous process improvement.

In order to help practitioners understand and use the proposed indicators to identify weaknesses certain strategies may be useful. They include: conduct benchmarking studies, conduct trainings, use a recognized and long-term employee, amongst others.

In order to understand and identify the desired (**To-Be**) process, such strategies as: conducting benchmarking studies on best practices, conducting trainings, using a recognized and long-term retained employee, using IT and BIM technologies, amongst others, may be appropriate. IT and BIM helps to create work flexibility, e.g. its potential on automation process (Sommerville and Craig, 2006).

In order to enable changes from a weak to a desired (**To-Be**) process, the following strategies are appropriate: plan and set funds – changes are expensive, but, returns are attractive; thus, firms should set strategies to acquire and deploy funds to support changes; train employees how and when to effect changes, conduct benchmarking, use management techniques such as BPR to create radical changes and used CMM to allow changes in steps, amongst others.

When weaknesses are identified, desired (**To-Be**) process identified, strategies for radical changes created, next is BPR implementation and conduct continuous improvement. Appropriate strategies for this task are: use IT and BIM technology to allow systematic recording of information, conduct continuous learning amongst others. The other incremental management techniques such TQM, Six Sigma, Lean, Kaizen amongst others may be used to help practitioners perform continuous improvement.

Therefore, the model deploys seven strategies for improvement. Each strategy has attributes that rely on its functional roles. The attributes can be measured by using ordinal scale on which a mean score value aids on the decision of deployment. These attributes can be used based on the three criteria established and briefly described:

i) Correctness of the attribute: deploy correct attributes that clearly evaluate and identify the weak process, desired (**To-Be**) process and radical change methodology.

ii) Number of attributes: deploy only attributes that are needed to measure a respective strategy, for identifying weaknesses, for identifying desired (**To-Be**) process amongst others.

iii) Causation of the effect on performance: translates that a respective attribute achieves a required functionality, for example, in-house training conducted to the employees must be ensured that from such training, knowledge required was gained and used positively to create radical changes.

In supporting the results for BPR model development, the results of the thirty three respondent firms (through questionnaire survey) were used. They provided mean scores of ‘strategies for improvement’ with value above 3 suggesting that they were accepted. Therefore, the results of the seven ‘strategies for improvement’ in terms of the corresponding attributes and mean response scores are outlined in Table 6.2. From the table, the mean scores show the extent to which the attributes are agreed with respondents on potentials to improve processes on a continuous way.

Table 6.2: Attributes of Strategies for Improvement and the Average Scores

Attributes of Strategies for improvement	Average scores	Roles/ functionalities
Institute continuous learning and benchmarking	4.75	.Evaluate process weaknesses .Evaluate desired (To Be) process .Create radical changes . Enhance in performing continuous improvement
Train employees on: on-job training, formal training and allow them participate seminars, etc.	4.76	
Plan and set funds to manage changes	4.73	
Plan to invest, or expand IT and BIM application	4.84	
Recruit, retain and recognize manpower competencies	4.74	
Seek and adopt emerged management technique (BPR)	4.69	
Conduct in-house training and adopt CMM	4.82	

From results in Table 6.2, the highest mean score was 4.84 (advocating firms to plan to invest, or expand IT and BIM use to support process changes. The minimum mean score was 4.69 (advocating firm to seek and adopt appropriate emerged management techniques (BPR) to facilitate changes in the firm. However, all attributes had mean score above 3 for the acceptability by respondents on their usefulness.

Therefore, for a firm to deploy ‘strategies for improvement’, it should: plan and set funds to manage changes in the firm, continuous learning and benchmarking, deploy CMM, amongst others. A step ‘strategies for improvement’ forms fifth dimension of the BPR model. Presentation of these results achieves objective three of this research.

6.3.6 Appropriateness and Functionality of the Overall BPR Model

After discussions on acceptability of each of five dimensions of the model, next, is discussion of the appropriateness of the holist BPR model. The appropriateness of a holist BPR model structures was obtained from the practitioners' responses on five dimensions of the model. They responded to one question posed 'give any general overview on the functionality of the model – anything that may hinder its operatives, make a model function more appropriately and any other view to improve the model. While results on these questions appear in Chapter Five, they are hereby summarized in five bullets. The practitioners' views with regard to a developed BPR model are:

- A developed model improves project process because it incorporates almost all important tasks of the project. One foreign firm respondent said,

  > '*The model developed identifies and defines all the core project tasks and their relationship', it can therefore used as a tool to guide project execution in the local construction industry'*

- The model defines and elaborates key process elements (critical inputs, critical activities and critical interfaces; of design, procurement and construction management. They said that such elements are considered simple by practitioners, but impact performance;
- Model incorporates constructability ideas with the intention to avoid reworking;
- Model incorporates IT and BIM concepts that support process improvement;
- The model may only work if the industry practitioners change their culture, set funds, and, agree to implement changes.

Using a BPR conceptual model that was used as a basis, combining this with the actual data that come from interview forums and surveys, the BPR model was developed to improve project process performance. A BPR model has five dimensions: BPR foundation, understand current process, weaknesses of current process, desired (**To-Be**) process and strategies for continuous improvement.

6.4 BPR Model Validation

6.4.1 Overview of the Model Validation

Model validation is conducted in order to achieve the intended purposes (Fellow and Liu, 2008). In this study the model was validated in three perspectives: to enable practitioners to: (i) use the developed indicators to identify process weaknesses and create desired (**To-Be**) processes (ii) BPR model improves traditional process performance and (iii) BPR model compares with other models Validating the model through indicators that identify weaknesses and in creating desired processes, case study on four groups in a consulting firm was conducted, on which, number of indicators studied within each group are indicated in brackets and results explained: highway (12), survey (10), structure (10) and management (7). A brief description of the findings is presented as follow.

6.4.2 Indicators to Identify Weaknesses from Highway Section

- **Working load of the engineer**

In this indicator, the engineer was investigated on the amount of work loads assigned to him. Results revealed that he engaged with many tasks that include: works in the office, borrow pits, materials in the laboratory and road inspections amongst others.

In the office, he revised documentations; planed the works; received, prepared and handled the ‘request for approves, amongst others. In the borrow pits, he engaged with: selecting the portions of appropriate borrow pit materials, control of the materials to be blended, amongst others. In the laboratory, he was engaged with: overall checking of the material tests, results obtained, reports submissions, amongst others.

All these tasks were huge enough to be handled by a single person; therefore, this created a weakness.

- **Linkage of activities and work approvals**

In this indicator, three sections, highway, survey and structure were agreed together that any cross cutting activity (such as installing new line culverts, positioning of gabions, amongst others) must be approved by all leaders of these groups. At one time, no shared plan and action was made. The two groups (structure and survey) alone approved the work themselves; this created dissatisfaction to the highway group.

6.4.3 Indicators to Identify Desired (To-Be) Process in a Highway Group

- **Competent expertise**

In this indicator, the use of competent and experienced engineers was studied and checked on how their deployments contribute to creating desired (**To-Be**) process. In the results, the engineer was a graduate highway engineer with more than five years experience. This competency helped to plan and schedule daily activities, conducts works on time and met specified standards.

- **Technology 'Work procedures'**

In this indicator, daily works were studied on whether they were appropriately extracted from the master program and deployed or not. The results indicate that although the engineer was busy in many assignments, however, in the evening, he started preparing tomorrow's work plan that was reviewed and updated in the morning of the next day. This helped to prepare accurate plans that incorporated all concerned activities of the day.

It was generally revealed that all twelve indicators studied in this group identify weaknesses such as: time delay, over budget, duplication of the efforts, amongst others. They also identified their contribution to creating: time saving, flexibility on the used method(s), satisfaction to the employees, budget saving amongst others.

6.4.4 Indicators to Identify Weaknesses in a Survey Group

- **Competency and working load of the surveyor**

In this indicator, the leader of a group was studied on whether he balanced workloads or not. It was identified that a single surveyor was a qualified land surveyor and engaged with the following tasks: preparing daily work activities and schedules, surveying locations for new culverts lines and gabions, provide levels on the road formation, amongst others. These created a delay and dissatisfaction.

- **Unclear/poor record of the work**

In this indicator, the study was conducted on whether works were well recorded before daily operations. It was investigated that some daily activities were recorded on the rough sheets without being transferred in a proper book; and, others were not recorded at all. For example, works were recorded poorly when the establishment of new culvert lines was done which created misunderstandings to the other employees. At one day in time, section leader went to a site with incomplete information, which created difficulties on managing daily activities.

6.4.5 Indicators to Identify Desired (To Be) Process in a Survey Group

- **Competent surveyor**

This indicator was used to investigate the availability of competent surveyors and its contributions towards creating desired process. It was identified that the surveying works were conducted by the qualified surveyor, and, he provided road marks, secured new culvert lines, levelled the inlets and outlets of the culverts’ structures, amongst others, that were completed on time and budget.

- **Use of computer(s)**

In this indicator, it was studied on whether a computer facility was secured in the surveyor's office and used purposely to support the process improvement. From the results, one computer was secured in the head of group's office. Such computer was working well and information was recorded timely, helping to create work flexibility, serve time and budget also. At one time a contractor's document was recorded, printed and approved by the resident engineer in around ten minutes as compared to twenty minutes used to the same event in other groups which did not had this facility.

Generally, all ten studied indicators identified weaknesses such as: time delay, over budget, inflexible work operation, amongst others. They also contributed to creating: time serving, flexibility on the work method used, and creating satisfaction to the user, amongst others.

6.4.6 Indicators to Identify Weaknesses in a Structure Group

- **Activities' relationships and approvals**

This indicator was investigated on the extent to which planning was prepared and a multi-disciplined task shared and approved by responsible parties. On this task 'check and approval of the new culvert line' on which decisions and approvals were to be shared between three groups (structure, highway and survey), only two groups (structure and survey) participated. This problem showed that the group leaders lacked planning and collaborative arrangement. Such weaknesses caused misunderstanding which was resolved by giving other time to the highway group (not participated previously) to approve the work.

6.4.7 Indicators to Identify Desired (To-Be) Processes in a Structure Group

- **Budget goal**

In this indicator, some groups that were sub let gabion works in the contractor organization were studied on how they plan and engage with the work roles to save operative budgets. This was done because, it was the role of a consultant to also ensure that appropriate work approaches and budget saving are created. Within some of these groups, structure group helped provide decision analyses, thereby, sublet gabion work to qualified and well known operative gabion groups.

- **Technology 'work clarity and record'**

This indicator studied whether in this section, works are well recorded to create work flexibility. It was identified that, although group leader had little experience of below one year, but, he recorded appropriately the daily works that also created easiness in compiling weekly reports.

It was generally identified that ten indicators studied identify weaknesses such as: time delay, over budget, inflexible work operation, duplication of the efforts amongst others. They also contribute to create: time saving, flexibility of the method used, satisfaction to the employees or the user(s), budget serving amongst others.

6.4.8 Indicators to Identify Weaknesses in a Management Group

Risk management (Risk registrar book availability and use)

This indicator was studied to check on whether a risk registrar book was available and used in the firm or not. It was identified that the firm did not have any risk register template/book for recording potential risk events. Respondents stated that since the drawings, specifications and master programme are followed, they fulfil this need. However, it was learnt by the researcher that the lack of the risk register book contributed to variety of firm's operative problems. For example, the firm experienced long time delays of the project operation caused by a contractor who stopped some jobs due to financial problems (also caused by the client). This problem could be reduced if it was recorded in the register template which also offers columns to effect mitigation measures.

6.4.9 Indicators to Identify Desired Processes in a Management Group

- **Availability, Record, Store and Process Information through Computers**

Office computers were secured in the offices for a resident engineer, secretary, and highway, etc. For such cases, it was possible to process information rapidly, thus, saving process operative time, budget amongst others.

- **Printing and Photocopying Services**

In the two printers available in the firm, one was placed in the chief engineer's office and the other in the secretary' office and one photocopier machine placed in the secretary's office. It was identified that it was possible for a chief engineer to access printing and photocopying services fast and easily. In addition, and, particularly in printing functionality, when works were typed by other technical personnel and carried (for printing in the secretary's office) using the flash disk(s); and, secretary was available, and, a computer scanned the flash disc instantly, the printing was conducted fast, serving operative time and created work flexibility.

Generally, from all studied groups, indicators identified the weaknesses, such as time delay, exceeding budget, inflexible work operation, amongst others. They also outline desired (**To-Be**) process, creating: time serving, work speed exceeded, flexibility of the method used, amongst others. Using these results, the conclusion is that the developed model identifies weaknesses as well as desired processes.

6.4.10 Results to Confirm a Developed BPR model Improves Traditional Process

Four parameters were used to investigate that a BPR model when used in practice may identify weaknesses that exist in a traditional project process performance. Parameters studied were: performance briefing, deploy sketches, constructability and adoption of procurement option. Results are presented as follow:

i) **Conversant client and design team involvement to avoid ill briefing problem**

The project 'Construction of Theatre and Sterilization Unit at Mbeya Regional Hospital' was studied. Public client was represented by a civil engineer/architect. Design team was represented by the architect, quantity surveyor and a civil engineer. Brief project information was presented by the client and the users. Designers then prepared sketches that were presented (through power point) to client and users, where additional inputs were given that include: (i) separate entry for patients and staff at the entry point (ii) provision of Linen and Sluice in the critical care and sterilization unit (iii) provision of six beds and burse station in the critical care unit and (iv) provision of oxygen plant, amongst others.

These comments were incorporated in the sketches and then re-presented to client and users. The presentation covered the contents: site layout plans, floor plans, sections, elevations, roof plan and 3 Dimension views.

Generally, the presented project brief information was done by a conversant client, consultant represented by the teams (engineer, architect and quantity surveyor) that helped to obtain well project briefing. The project was viewed to have minimal changes, partly due to appropriate briefing conducted.

ii) Option sketches reduce chances of rework caused by single sketch option

From a bungalow building sketched, the three options adopted were on serial order that were printed and the draft views shared between the architect and the client. In the first print out, the veranda was placed near master bedroom; where after discussions a corridor was created. In the second print out, where store appeared to be near the dining room; they were then made far-apart. In print out three, dinning and lounge initially appeared as one long room, they had then improved with the wall introduced to separate them.

The final drawing document was then drawn in a 3D format to give visual perspectives to widen understanding of client and users. The pictorials helped to create the following changes: adding wall extras (at the corners), changing gray colour on the plinth to be black, introduce flowers, trees, change colour on the corrugated iron sheets etc. (see Chapter Five)

Therefore, the two or more sketch options helped client to bring-in information from: own, users and learn from others, and also use support of IT and BIM technology that widen understanding of project to client. Therefore, adoption of more sketch option reduces chances of making changes during actual project implementation.

iii) Constructability (defined by two indicators ‘build ability and enforceability) identify hurdles before actual project work

The current BPR model studied buildability and enforceability issue on a project to determine how they eliminate hurdles in construction documents. Results follow.

Build-ability: dealt with identifying ‘missing section drawing and written-off drawings’. Two sections in the drawings on the first floor of a building and a detail on a column-beam intersection of the second floor were missing. Therefore, employees had to wait reproduction of these documents that cause delay and inconveniences. The written off drawing was deteriorated (i.e. it worn out). Other than a delay created for waiting new document production, it also had risks of transferring wrong information that would later on create reworking.

Enforceability: on a **'**bill of quantity' document some work items lacked clarity. One item reads '*prepare and apply internal and external plaster* with *cement mortar* '*as per engineer's satisfaction'* (see also Appendix J). In this statement, thickness sizes of internal and external plaster and the proportions of the mortar materials are not stated. Other work items in the BOQ, was quoted 'replace new..…*complete* with all *necessary ironmongeries',* a statement which is relative, i.e. is not descriptive.

Generally, BPR model allowed two expertises (other than those involved in the design stage) to review construction documents under two indicators - buildability and enforceability. They helped to identify hurdles (of omissions, errors and mistakes) that exist in the traditional process.

iv) **Deploy procurement options - competition, negotiation, direct or combination' create work flexibility and meet client's needs**

Current BPR model studied deployment of procurement option for TARURA – Mbeya who procured fifty seven projects in financial year 2017/2018. These projects were procured flexibly as follow:

One (1) project was implemented through single source (direct talk). The reason was that, it was the only one firm in Mbeya city who owned asphalt plants required to accomplish this project. Other firms could even had high costs because of not owning the equipment as they could rely on hiring it. The other forty five (45) projects were implemented successfully through national competitive procurement option. In addition, eight (8) projects were implemented through competitive quotations (negotiations). They were initially advertised through competitive process but some of them were not responded, some had higher rate than the engineer's estimate, amongst others. Moreover, three (3) projects were implemented through quotation method on which contractors, whom their competency is known were given BOQ, visited the site and fill-in BOQs that were also evaluated rapidly to meet emergency need. The emergent were caused by the excessive rain fall that deteriorated road infrastructure.

It can be summarized that the adoption of procurement option allow better utilization of project efforts that serve budget, time and satisfy the client's needs. This is necessary than deploying a traditional performance that give rigidity on only one preferred procurement option (completion).

Generally, four parameters have been showing potentials to address weaknesses in the traditional process. Conversant client and design team involved provide well project brief information, adopting sketch options widen client understanding on his project, thereby, reducing chances of reworking, constructability studies identify and removes hurdles in construction documents and adoption of procurement options create flexibility of project implementation and satisfies the client. These parameters address weaknesses of the traditional project performance.

6.5 Comparative Analysis of a BPR Model against other existing Models

Four model comparison criteria are used to validate the model, described follows.

6.5.1 Comprehensive of the Model

With regard to comprehensiveness of the model, a **BPR model** reengineers three core processes: design, procurement and construction management. Design covers three activities: preliminary design, schematic design and detail design. Procurement has activities, project delivery option, contract type, procurement option, advertisement, evaluation etc. Construction management allows to implement, quality control, budget control etc. All these activities and processes give comprehensiveness of project. Other models, Brown and Riley (2000) reengineered only two processes, procurement and design process. Allweyer *et al.* (1996)

reengineered only procurement process. Tookey (1998) reengineered only project planning phase. Their models reengineer some processes of the project.

Therefore, the BPR model developed in this study covers comprehensively all key tasks, activities and processes of the construction project participated by all three main parties to a project as compared to other existing models.

6.5.2 Uniqueness of the BPR Step towards Performing a Construction Project

In **BPR model**, each core project process explains the tasks contained in detail to help improve specific project performance. Brown and Riley (2000), a design and procurement processes, where they also go into detail to help improve such two processes. Other models, for example, Manganelli and Klein (1994) and Zigiaris (2000) provide steps that are generic in nature, they must be adapted before using them.

6.5.3 Process Flow Improvement

The **BPR model** identified three core processes on the iterate form – design, procurement and construction management. Within each core process and its associated activities, the interfaces were identified that capture the effects of the preceding activity against the succeeding ones. Brown and Riley (2000) – proposed design and procurement with activities: project need identified, designers appointed, outline design prepared, contractors invited to tender, amongst others. Koskela and Sharpe (1994) modelled a project process with two processes: design and construction process. On each of these processes, conversion, flow and value creation were identified, defined and deployed to improve project process flows. In Riley and Brown (2001) reengineered a construction business of a contractor. The model deploys two perspectives of mapping out activities: at construction project business macro level and at activity (micro)'s level.

Although the existing model do not mention out explicitly the activities contained, however, like the developed model, they explain the linkage (flow process issue) between activities.

6.5.4 Controlling of Project Process Performance

BPR model has two process management perspectives: administrative and control processes that guide implementation of the core project processes. Riley and Brown (2001) give a model that defined vision of future that is implemented by the modeled structure: how to conduct marketing, how to manage contract, etc. This is managed through decompositions of, or at activity level. In Soares (2013) provides attributes to radically change the way a firm is managing a construction project: (i) embodying clear communication, integrated teams, contribution of knowledge, etc. (ii) adoption of design build project delivery (iii) deployment of BIM and (iv) adopt lean concepts on a construction project.

Generally, a BPR model agrees partly with other models, example, by giving detailed steps to improve project processes. It contracts with other models when such models give generic steps to improve project processes.

6.6 Proposing a Model for Undertaking BPR to Improve Project Process Performance

The BPR conceptual model was formulated in Chapter Three, Figure 3.6. This BPR conceptual model was used as a guidance to develop the model. By using data from interviews and questionnaire surveys a BPR model was developed. This model has five dimensions:

- BPR foundation – has three parameters: BPR team, resources and policies;
- Understand current process – three core processes, design, procurement and construction management are established which are assessed by the three process elements - critical inputs, critical activities and critical interfaces.

- Weaknesses of the current process – forty indicators are established to identify process weaknesses;
- Desired (**To-Be**) process - thirteen measures with sixty items of measures create desired (**To-Be**) processes; and
- Strategies for continuous improvement – seven strategies evaluate and change a process from weak point to a desired (**To-Be**) processes stage.

The developed model was validated, and ensured to identify process weaknesses, create desired (**To-Be**) process and improve traditional process performance. A BPR model to improve project performance is given in Figure 6.4. This model compares and differentiates with other models as outlined.

6.7 A Model for Undertaking BPR Compared with a BPR Conceptual Model as Well as the Traditional Project Process

A BPR model developed was compared with the BPR conceptual model (Table 6.3). From this Table, dimensions of the model, basis criteria, aspects of BPR conceptual model and aspects of the developed BPR model are outlined and described in brief. They help to bring out aspects that differentiate the two models. Example, fifty five indicators were used in formulation of BPR conceptual model against forty indicators that developed the BPR model (Table 6.3).

On the other hand, a BPR model was compared with a traditional project process (Table 6.4). From this Table, aspects that differentiate the two models are outlined and described in detail. For example, attributes of traditional project process include, designers produce: ill-briefing of the project, single sketches, design documents with errors amongst others (see column two, Table 6.4). These aspects were confirmed to be improved by using conversant client, competent design team and adopt constructability concepts deployed in the developed BPR model (column three and four, Table 6.4).

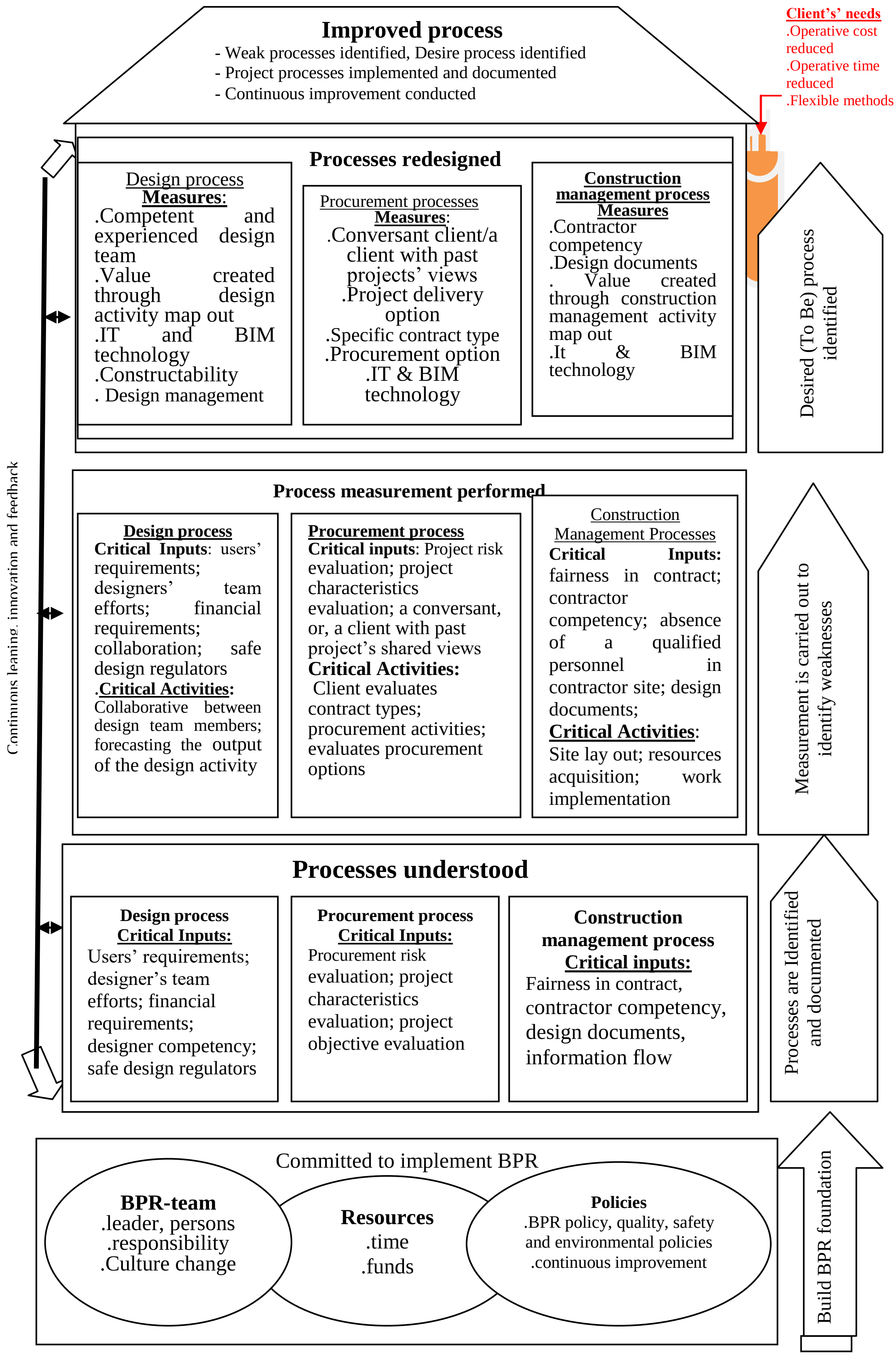


Figure 6.4: BPR Model to Improve Performance of Project

Table 6.3: A BPR Conceptual Model Compared with the Proposed BPR Model

Dimension of the model	Basis Criteria	BPR Conceptual Model	Proposed BPR Model
BPR foundation	Parameters and attributes	Parameters: team and leadership, resources (manpower, materials and equipment) and policies (BPR, quality, environment, health and safety)	.Parameters: team and leadership, resources (manpower, materials and equipment) and policies (BPR, quality, environment, health and safety). .Incorporated – leaders to give overall guidance to all parameters .BPR policy to be prepared and trained to employees
Understand current process	Core processes and process elements	Design: preliminary, schematic, and detailed design (each of them measured with): critical inputs, critical outputs and critical interfaces	Design: preliminary, schematic, and detailed design (each of them measured with): critical inputs, critical outputs and critical interfaces.
Weaknesses of current processes	Numbers of indicators	Fifty five (55) indicators to identify weaknesses of project process: seventeen (17) identify weaknesses in design, ten (10) indicators identify weaknesses in procurement and twenty eight (28) indicators identify weaknesses in construction management	Forty (40) indicators to identify weaknesses of project process. Sixteen (16) identify weaknesses in design process, nine (9) indicators identify weaknesses in procurement process and fifteen (15) indicators identify weaknesses in construction management
Desired (To Be) process	Numbers of measures and the respective items of measures	Fourteen (14) measures with sixty three (63) items of measures to create desired (To Be) project process. Five (5) measures with twenty three (23) items of measures create desired design process, Five (5) measures with twenty five (25) items of measures create desired procurement process, and, four (4) measures with fifteen (15) items of measures create desired construction management process .Constructability done when contractor invited in site physically to share views with the designers	Fourteen (14) measures with sixty (60) items of measures to create desired (To Be) project process. Five (5) measures with twenty two (22) items of measures create desired design process, Five (5) measures with twenty four (24) items of measures create desired procurement process, and, four (4) measures with fourteen (14) items of measures create desired construction management process .Construability incorporated in three ways: (i) contractor physically invited during design, (ii) only his concepts sought and used and (iii) designers rethink constructability themselves
Continuous improvement	Attributes of strategies for improvement	Recruit, train, retain employees, perform benchmarking, continuous learning, CMM amongst others	Recruit, train, retain employees, perform benchmarking, continuous learning, CMM amongst others
Overall Model functionality		.Five dimension .Built-in with theoretical constructs	.Five dimensions with detailed attributes .The model incorporate phenomenon of the local construction industry

Table 6.4: A Traditional Project Process Performance Compared with the Developed BPR Model

Core process	Traditional project performance	BPR Model	Facets of improvement
Design	ill briefing: caused by *public client who gives partial project information* and (ii) *project information is not sufficiently solicited by consulting firms*. Also, clients approve ill brief reports	(i) Conversant public client (ii) Competent and experienced design team (iii) Map out of preliminary design activity (iv) IT and BIM technology (v) Constructability	(i)Ensured to incorporate all project experts when needed (ii) A mapped out activity help to determine and highlight which inputs. E.g. who client, his/her knowhow of the project, to help even in approving evaluated project briefs. Who, consultant(s) and expertise needed (iv) store, update and brief project information (iv) re-review briefing work before making approvals
	Designer(s) produce single sketch option to a client. This creates changes later-on that is rework	(i)Competent and experienced design team (ii) Map out of preliminary design activity and use option sketches (iii) IT and BIM	(i)Team suggest incorporation of option sketches that limit chances of reworks (ii) map out project options (iii) IT and BIM allow processed information rapidly and accurately
	Omissions, errors or mistakes in design documents	(i)Competent and experienced design team (ii) Map out of preliminary design activity (iii) IT and BIM technology (iv) Constructability	(i) shared knowledge and experience of design team solve the problem (ii) mapped out design process help to address design inputs and activities requirements (iii) Information captured, recorded, stored and processes to serve time and create quality documents (iv) review works handles and fault work
	Lacking innovative- designers use traditional drawing boards and CAD, therefore, sometimes accuracies miss	(i)Use competent and experienced design team and (ii) deploy IT and BIM technology	Competent and experienced design team allow the use of shared knowledge and deploys IT and BIM technology that allow adoption of automated processes. This increases accuracies, serves time and budget also.
Procurement	No or low extents of evaluating project delivery options. As a result, more efforts are placed to deploy traditional method. Therefore, project risks, objectives are not well evaluated	Scans project delivery options: DBB, DB, and construction management or combination. In these options	In the project delivery options adopted, project change needs, project budgets issues, project change need can be accommodated, for example when DB is deployed
	Low extent of evaluating contract types. It gives chances of creating disputes not all specific works are defined/guided by specified	Deploy contract types or combination on a specified project – BOQ contract, lump sum, schedule of rate, etc	When work contents are well defined and accommodated in a contract required, misunderstanding that create quarrels or disputes are avoided

Core process	Traditional project performance	BPR Model	Facets of improvement
	contract(s)		
	No or low extents of evaluating procurement options. Main emphasis placed on competitive tendering causing unnecessary delay that can be avoided on other options	Deploy procurement options: competitive, approach direct personnel, perform negotiation or combination	Flexibility on the procurement option helps to meet project requirement. If, a project is urgently needed, a known firm/person may be contacted and perform negotiation for the work. This serve time and avoid delay inconveniences
	Lack innovativeness: major emphasis placed on, for example, advertising the tenders through newspapers, notice boards, words of mouth etc. Sometimes information may not reach to all potential bidders. It also adds chances of selecting incompetent contractor	Allowing the use of IT and BIM technology	IT and BIM technology allow such issues like advertising tenders on line where potential bidders would access information where they are aware of getting information in this method. This method serves in conveying information geographically, no biased between bidders and it serves time and also maximise accuracies.
Construction management	Poor site planning: caused by selecting incompetent contractor	(i) Contractor competency (ii) Value created through process map out	Contractor competency plans the construction work. He also maps out project work execution to identify right inputs – equipments, manpower, materials etc.
	Resources acquisition problem	) Contractor competency i) Value created through process map out	Resources types and categories are identified based on the process mapping out. This makes works flexibility and conducted on time and to a required standard
	Inefficient site management	) Contractor competency i) Value created through process map out ii) IT and BIM technology	Each task is defined; right resources are identified and assigned. Progressive performance is done as all tasks are recorded, updated and communicated to all involved employees
Organizational processes	Poor organizational processes – lack of organizational structure, strategies, technology	Six organizational processes: organizational structures, strategy, people, culture, technology and information	Right organizational structure vests authority and assign jobs to right personnely. Strategy sets all long, medium and short term goals as project requires. Right people are recruited, assigned right jobs, valued and allowed to share views.

6.8 Procedures for Implementing the Model

- The BPR model was developed to improve project accomplished by three main contracting parties: clients, contractors and consulting firms;
- In order to implement the model, these contracting parties should adopt the following steps:
    - Learn the dimension ‘BPR foundation’ and prepare to conduct BPR;
    - Understand the core processes – design, procurement and construction management, and their elements - critical inputs, critical activities and critical interfaces;
    - Use indicators established to identify weaknesses;
    - Create own desired (**To-Be**) processes;
    - Use strategies to change from a weak to a desired (**To-Be**) process and conduct continuous improvement.

BPR model implementation procedure is summarized in Figure 6.5. This procedure would guide practitioners when needing to implement the BPR model.

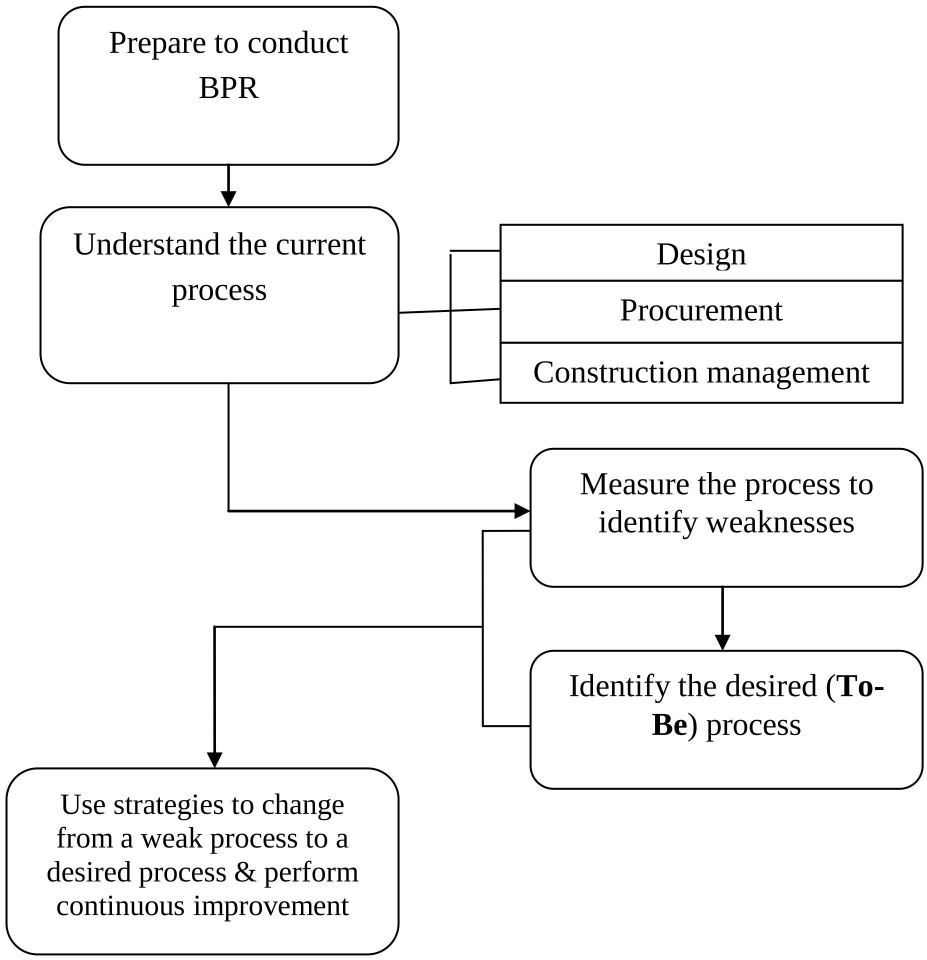


Figure 6.3: Steps for Implementation of BPR Model

6.9 Chapter Summary

This Chapter proposed BPR model to improve project processes performance in Tanzania. The BPR model was developed through three stages: developing BPR conceptual model, BPR model and BPR model validation. The next Chapter presents conclusions, contribution to the knowledge and suggests avenues for future researches and recommendations.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This study was aimed at developing a BPR model for improving construction project performance in Tanzania. In order to achieve this aim, the study was organized into Seven Chapters. The introduction to the study and objectives are presented in Chapter One. Literature review relating to the performance measurement - project process performance, BPR philosophy and organizational processes are discussed in Chapter Two. BPR Conceptual model is presented in Chapter Three. Chapter Four presents research methodology adopted to achieve the study objectives. Study findings, analysis and discussions are presented in Chapter Five. The BPR model development and validation are presented in Chapter Six. Finally, this Chapter presents conclusions, recommendations, research contributions and avenues for future research.

7.2 Conclusions

In order to achieve the main objective of this research, four specific objectives were formulated. Each of these objectives together with the key findings and the conclusions drawn are briefly explained in the sections that follow.

7.2.1 BPR Conceptual Model Formulation

The first objective of this study was to formulate a BPR conceptual model for improving project processes performance. Review and evaluation of the relevant literatures, i.e. literature relating to construction projects, contracting parties, process measurement, BPR and organization process were conducted. From review works, a BPR conceptual model was developed with five dimensions. They include: BPR foundation, understand current process, weaknesses of current process, desired (**To-Be**) processes and continuous improvement. This concludes achievement of objective one of this research.

7.2.2 Indicators to Identify Weaknesses

The second objective of this research was to analyze indicators to identify process weaknesses. In order to achieve this objective, the questionnaire surveys were conducted to the selected construction project participants' organizations. In these surveys, dimension three of the BPR conceptual model 'the weaknesses of the current process' were identified. Fifty five indicators were established to: (i) identify the fact that they improve project process and (ii) identify weaknesses.

The study concluded that out of fifty five indicators proposed, forty indicators improve project processes. In these forty, Sixteen (16) identify weaknesses in design process, nine (9) indicators identify weaknesses in procurement process and fifteen (15) indicators identify weaknesses in construction management process.

Three indicators (from each core project process) were accepted with highest score values on identifying weaknesses in critical inputs; critical activities and critical interfaces of design, procurement and construction management, descriptions are given in the sections that follows:

Inability to evaluate financial needs of a project by the designers contribute to project delays, lack of collaborative efforts between designers detriments overall design performance, and interfaces between design activities not well interrelated contributes to the overall design performance delays.

Procurement risks not well evaluated by project team members increases chances of project delay, failure of a client to evaluate contract types, appropriate procurement option cannot be deployed and a procurement activity not checked for completeness or accuracies dissatisfies a client.

Use of incompetent contractor contributes to producing faulty jobs, lacking of resources utilization plan in the construction site creates resource acquisition problem, and a construction management activity not well checked for completeness and accuracies contributes to creating faults end product.

It was generally concluded that forty (40) indicators identify weaknesses in core project process. Based on these results, specific objective two of this research was achieved.

7.2.3 Strategies for Improvement

The third objective of this study was to formulate strategies for achieving improved process. In order to achieve this objective, two tasks were performed (i) identifying the measures that create desired (**To-Be**) process and (ii) identifying strategies for achieving improved process.

The questionnaire surveys were conducted to the selected construction project participants' organizations. In these surveys, dimension four 'create desired (**To-Be**) processes and dimension five 'continuous improvement' of the BPR model was assessed. Using these dimensions, opinions from respondents were sought on the established thirteen measures and sixty three items of measures to identify desired (**To-Be**) process. Opinions were also sought from seven strategies for improvement on their acceptability to improve a process in a continuous way.

The study concluded that in fourteen measures and sixty three items of measures proposed, the fourteen (14) measures with sixty (60) items of measures create desired (**To-Be**) process. Out of these, five (5) measures with twenty two (22) items of measure identify desired (**To-Be**) design process. Five (5) measures with twenty four (24) items of measures identify desired (**To-Be**) procurement process. Four (4) measures with fourteen (14) items of measures identify desired (**To-Be**) construction management process.

Three items of measures (from each core project process) accepted with highest score values on creating desired (**To-Be**) process are given in the sections that follows:

Deploying competent and experienced design team helps to identify, quantify and manage risks in design process performance. One way to obtain specific contract type is to ensure all work items are well defined and priced (this forms a BOQ contract), and, Deploying competent and experienced contractor provides timely and accurate operative performance to increase site productivity.

It is generally concluded that fourteen measures identify desired (**To-Be**) project processes.

With regard to strategies for improvement, the study concluded that in order for project participants' firms to change the process from a weak to a desired (**To-Be**) level, seven strategies are useful. They should: plan to invest, and, or expand IT and BIM application, conduct continuous learning, conduct benchmarking studies, deploy CMM, plan and use funds to enable changes to happen, and recruit, train and retain employees. This concludes achievement of specific objective three of this research.

7.2.4 Develop a Model for Undertaking BPR to Improve Project Performance

Based on the study findings that led to attainment of objectives one, two and three, this helped to develop a BPR model. The model was validated though conducting case study on a road project conducted in the four groups (highway, survey, structure and management) within a consulting firm as well as studying the ongoing project to improve traditional process.

In the case study, number of indicators studied in the respective group is presented in the brackets against a group involved: highway (12), survey (10), structure (10) and management (7). Each indicator was investigated on the extents to identify weaknesses and creating desired (**To-Be**) processes.

The study concluded that, in the highway group, six indicators identified weaknesses and seven indicators created desired (**To-Be**) processes. In the survey group, all ten indicators identified weaknesses and two indicators created desired (**To-Be**) processes. In the structure group, all ten indicators identified weaknesses and four indicators created desired (**To-Be**) processes. In the management group, seven indicators identified weaknesses and five indicators created desired (**To-Be**) processes.

The indicators studied identified types/categories of weaknesses, such as time delay, exceeding budget, inflexible work operation, duplicative efforts, and inconveniences, amongst others. The indicators also identified desired (**To-Be**) process such as creating: time serving, exceeding work speeds, flexibility of the work method used, satisfaction to the employees or, and users, budget serving amongst others.

The indicators studied in the four prescribed groups replicated results, this gave confidence that the indicators identify weaknesses and created desired (**To-Be**) processes (see Chapter Five).

With regard to a developed BPR model improving traditional process, four parameters of BPR model were tested to determine that they solve weaknesses of a traditional project process performance. Results were concluded as follow:

i: in regard to c**onversant client and design team involvement to solve ill briefing problem**: a conversant public client and design team represented by the architect, quantity surveyor and a civil engineer provided well brief information in a 'Construction of Theatre and Sterilization Unit at Mbeya Regional Hospital project'.

Deployment of such complete team contributes to making well project brief, thus avoiding reworking.

ii: **Option sketches reduce chances of rework caused by single sketch option:** a building sketch using three options and a final drawing deployed through 3D format provided visual aid to client to widen understanding of his project. The pictorial views helped to create changes from initial stages: change gray colour on the plinth from grey to black, introduce flowers, trees, amongst others. These options reduce chances of making changes during actual project implementation.

iii: **Constructability (defined by two indicators 'build ability and enforceability) identify hurdles before an actual project work:** the BPR model allowed two expertises (other than those involved in the design stage) who helped to review construction documents under two indicators - buildability and enforceability. They helped to identify hurdles of omissions, errors etc. that exist in traditional process.

iv: **Deploy procurement options:** the adoption of procurement option (competitiveness, negotiation and direct or combination) allow better utilization of project efforts that serve budget, time and satisfy the client's needs. This is necessary than deploying a traditional performance that relies on competitive process that limit flexibility of procurement.

Where a BPR model compared with other models, the BPR model agreed with such existing model by providing specific steps to improve project performance. It also contrast with the models that provide generic steps to implement reengineering.

It concludes that specific objective four that states 'develop the model for undertaking BPR to improve project performance' of this research is achieved.

7.3 Recommendations

7.3.1 BPR Conceptual Model

In order to improve project process performance through a BPR model, it is necessary to review and evaluate literatures relevant to the study's sub-themes. Based on the findings of this study, the study recommends the use of five dimensions to formulate a BPR conceptual model: BPR foundation, understand current process, weaknesses of current process, desired (**To-Be**) process and continuous improvement. They guide in the development of the BPR model.

7.3.2 Indicators to Identify Weaknesses

Any construction project can be mapped out on three core processes: design, procurement and construction management. Each of the core processes then were measured by the process elements (critical inputs, critical activities and critical interfaces). This study recommends that, construction practitioners should use proposed indicators to measure critical inputs, critical activities and critical interfaces of design, procurement and construction management to identify own process weaknesses.

7.3.3 Strategies for Improvement

Each construction practitioner intending to improve project performance is advocated to build own capability to identify process weaknesses and also establish desired (**To-Be**) processes. When these two tasks are preformed (based also on the findings of this study), the study recommends that a practitioners should use strategies to guide the changes from a weak to a desired (**To-Be**) process stage. They should conduct continuous learning; plan and use the funds to facilitate a changes; use IT and BIM technology; perform benchmarking; use CMM to make changes, amongst others.

7.3.4 BPR Model Developed

The results of this study indicate that there is great improvement in the project process performance obtained through identification of process weaknesses, creation of the desired (**To-Be**) processes and deployment of strategies for continuous improvement. In order to realize this improvement: the study recommends construction practitioners to select careful a BPR team, resources and deploys relevant policies which guide BPR implementation. It further recommends that the BPR team should use indicators to assess critical inputs, critical activities and critical interfaces of design, procurement and construction management to identify weaknesses. A team should also used measures to create desired (**To-Be**) process and deploy strategies of improvement. The indicators and measures used should focus firm's specific performance, not just base on the experience of business as usual.

7.4 Research Contributions

In construction industries in developing countries, particularly Tanzania, there is a range from few to non reengineering studies that have been conducted. Many of the existing models outline the generic BPR implementation steps without focus to specific sectors of the economy such as a construction. Further, the existing BPR models on construction pay attention to some specific processes of a project, (e.g. reengineering procurement, reengineering project planning, amongst others,). These limit knowledge of improvement of the overall project performance. This study filled this gap as follows:

- The study develops a holistic BPR model which will provide a good understanding of three core project processes, design, procurement and construction management. Each of the core processes would be measured by the indicators which assess core processes' critical inputs, critical activities and critical interfaces; thereby, improving overall project process performance.

- Using this model, construction project implementers such as clients, consultants and contractors may extract information for making up their policies and the implementation actions towards 'project process' performance improvement.

7.5 Study Limitation

This research developed a BPR model to be used in the public projects performance deployed by three main contracting parties: clients, contractors and consultants. The model will help firm understand how to conduct BPR, understand current process, identify process weaknesses, identify desired (**To-Be**) processes and use strategies for achieving improved processes. It examined in detail, the project processes: design, procurement and construction management using their critical inputs, critical activities and critical interfaces, each of them, assessed by the established indicators. Due to constraints of time and funds, some study limitations were encountered.

- Information pertaining to project process weaknesses or improvement that come from other firms than clients, consultants and contractors is not covered in this study
- The case study investigated in detail the indicators that assess four groups (highway, survey, structure and management) in a consulting firm; groups within a constructor and a client were not studied in detail.
- Likewise, IT and BIM technologies, despite their potentials to support process improvement; they were not studied with sufficient detail. However, they are addressed to motivate firms to adopt them due to their potentials.

7.6 Future Studies

Three areas provide avenues for further studies, they are outlined as follows:

- The developed BPR model was validated 'at a construction management stage alone supervised by a consulting firm'. Validation of a holist BPR model participated by all project participants is proposed as the other avenue of future research;

- IT and BIM technology create supports in the project processes performance. The two elements, particularly BIM technology, had been used at low rates within the local construction industry - only two consulting firms agreed to practice it, and had experienced practicing it outside the country. Therefore, wider researches are advocated on BIM and IT; and
- Studying organizational processes in detail including validation such that, they can be used as a control to core project processes.

7.7 Papers Published During PhD Research Work

During preparation and efforts of this thesis six papers were published. They are as indicated below:

i) **Published in International Journal**

(a) Mwishwa, Y. H. B., Samson, M. and Lema, N. M. **(2014**) Developing Model for Reengineering Sub-processes of Construction Projects 'The Case of Developing Countries', *International Journal of Applied Research and Studies (iJARS), Vol. 3, Issue 3, March.*

(b) Mwishwa, Y. H. B., (2014) A Framework for Improving Capability of Tanzanian Contracting Parties through Adopting three Philosophies: Lean, BPR and Capability Maturity Model, *Journal of Business Management and Applied Economics, Vol. III, Issue 2,* March.

ii) **Presented and Published in International Conferences**

(1) Mwishwa, Y. H., Samson, M And Lema, N. M. (2012) *Review Of The Business Process Reengineering (BPR) For Adaptation By Tanzanian Construction Industry Businesses,*: in Nani, G (Eds) Procs, 1st Applied Research Conference In Africa (ARCA) Conference , 29 - 31 August 2012, Elmina, Ghana, Pp. 441-451.

(2) Mwishwa, Y. H, Samson, M And Lema N. M (2013a) *Improvement Of Tanzanian Construction Project Processes Through Adoption Of The Business Process Reengineering (BPR) Philosophy,* 2nd International

Conference On Infrastructure Development In Africa (ICIDA), 17 – 19 March, Johannesburg, South Africa, Pp.309 – 318.

(3) Mwishwa, Y. H. B, Samson M. and Lema N. M (2013b) *Adapting Business Process Reengineering And Lean Concepts To Develop Desired Contracting Processes For Improving The Performance Of The Tanzanian Construction Industry*, In Nkun, R. K. (Eds), 2nd Applied Research Conference In Africa (ARCA) Conference, 8th – 10th August, 2013,Kumasi, Ghana, Pp. 63 – 76.

(4) Mwishwa, Y. H. B. (2016) *Systematic Identification of Construction Processes and their Prioritization for Redesigning: Lessons to the Firms that Prepare to Conduct Reengineering*, the 5th RVTTI International TVET and Interdisciplinary Conference, May, Eldoret, Kenya.

REFERENCES

Association for Advancement of Cost Engineering (AACE)., (2009) Schedule Constructability review, TCM Framework: 7.2 – Schedule Planning and Development, 11.5 Value Management and Value Improving Practices (VIPs), *International Recommended Practice* No. 48R-06

Addo-Abedi, F. Y., (2006) *Supporting the Local Consultants Industry for the Effective and Efficient Management of the National Road Network*. Available at: http://www.acet.or.tz/gama/Supporting_local.htm (Accessed: 30 March 2009)

Albizu, E., and Olazaran, M., (2006) BPR Implementation in Europe: The Adaption of a Management Concept, *New Technology, Work and Employment, Vol. 21,* Pp. 43-58, March, Blackwell Publishing Ltd, UK.

Alinaitwe, H. M., (2008) An Assessment of Client's Performance in having an Efficient Building Process in Uganda, *Journal of Civil Engineering and Management,* 14 (2): 73 – 78, http:www.jcem.vgtu.it

Aliyu, A. A., Adamu, H. Abdu, A. A., and Singhry, I. M., (2015) Influence of Building Contractors' Performance on Construction Process in Nigeria: A Review of Emerging Literature, Journ*al of Energy Technologies and Policy, Vol. 5, No. 8,* ISSN 2225-0573 (online)

Al-Mashari, M., and Zairi, M., (1999) Implementation Process: An Analysis of Key Success and Failure Factors, *Journal of Business Process Management*, vol. 5, no. 1, Pp. 87 – 112, MCB University Press

Al-Mashari, A. M., Irani, Z., and Zairi, M., (2001) Holistic Business Process Reengineering: An International Empirical Survey, *Proceedings of the 34 Hawaii International Conferences on System Sciences,* IEEE

Allweyer, T., Babin-Ebell, T., Leinenbach, S., and Scheer, A. W., (1996) *Model-based reengineering in the European Construction Indusry,* Paper W78-1996-21 of the Construction Information Digital Library, German

Amasi, S. O., (2014) *Assessment of the Application of Project Time Management Principles and Practices in Two Selected Roads Construction Projects in Tanzania*, Masters (Construction Management) Dissertation, University of Dar es Salaam

Amoroso, D. L., (1998) *Developing a Model to Understand Reengineering Project Success, Department of Information Systems*, Austin Bluffs, Colorado, 1060-3425/98

Amrita, M. A., and Sheriff, A., (2016) An Investigation of Perception of Business Process Reengineering in Indian Manufacturing Industry, *European Journal of Business and Management*, Vol. 18, No. 4, www.iiste.org, Accessed on 10th January, 2017

APQC., (2010) Measurement Frameworks, The International Resource For Benchmarks and Best Practices, KO2247, Accessed on 13th May, 2015

Ary, D., Jacobs, L. C., and Sorense, C., (2010) *Introduction to Research in Education*, 8th Edition, Wadsworth Cengage Learning, USA

Ashcraft, H. W., (2009) Building Information Modelling: A Framework for Collaboration, *A Paper Presented to the Society of Construction Law International Conference, London*, www.scl.org.uk, Accessed on 23rd May, 2014

Atkin, B., (1998) Unravelling the Value Chain in Construction, *Proceedings of IGLC '98*, The Royal Institute of Technology, Stolckholm. http://www.ce.berkeley.edu/-tommelein/IGLC-6/Atkin.pdf (Accessed on July, 2009)

Austen, A. D., and Neale, R. H., (1984) *Managing Construction Projects; A Guide to Processes and Procedures*, International Labour Office, Geveva

Azhar, S., Nadeem, A., Mok, J., and Leung, B., (2008) Building Information Modelling (BIM) A New Paradigm for Visual Interactive Modelling and Simulation for Construction Projects, *First International Conference on Construction in Developing Countries (ICCIDC-1), Advancing and*

Integrating Construction Education, Research and Practice. August 4-5, Karachi, Pakstan

Balaji, M., (2004) *Reengineering an Education Institute: A Case Study in New Zealand, Working Paper no. 2* http://www.crie.org.nz/researchpaper/M.Balaji_WP2.pdf Accessed in September, 2010.

Bambanza, G. Y., (2011) *Awareness and Application of Variation in the Management of Construction Industry in Tanzania, The Case of Dar es Salaam Building Projects*, Masters of Engineering Management (Project Mgt), Dissertation, University of Dar es Salaam

Baradyana, J. S., (2000) *Measures to Improve the Performance of the Construction Industry in Developing* Countries: *The Case of Tanzania*; Unpublished Dissertation, University of Leoben, Australia.

Bell, J., (1999) Doing Your Research Project: *A Guide for First Time Researchers in Education and Social Science,* Third Edition, Berkshire, McGraw-Hill

Bennett, F. L., (2003) *The Management of Construction*, Butter worth-Heinemann, Burlington

Bernard, H. R., (2006) *Social Research Methods*: *Qualitative and Quantitative Approaches*, Sage Publication, Thousand Oaks

Betts, M, Clark, A., and Walker, S., (1997) Re-engineering the Construction Process and its Implications for Construction Management Research, *Construction Process Reengineering Conference Proceedings, pp. 3-11*,

Bitok, P. K., (2013) Business Process Re-engineering and Process Time among Selected Large Manufacturing Firms in Nairobi, *Master of Business Administration (MBA), School of Business*, University of Nairobi, Kenya,

Bjorklof, F., Klingberg, BT., Muhegi, B., and Temba, A., (1992), *Birches don't grow in Serengeti. An Evaluation of Development Policy and Nordic Support to the Construction Sector in Tanzania:* 1975 – 1990, SIDA, Stockholm, Sweden

Bose, T. K., (2012) Application of Fishbone Analysis for Evaluating Supply Chain and Business Process – A Case Study on the ST James Hospital, *International Journal of Managing Value and Sully Chains* (IJMVSC), Vol.3, No. 2, June

Brinberg, D., and McGrath, J, E., (1987) *Validity and Research Process*, Sage Publications, Inc, California

Brown, D. C., and Riley, M. J., (2000) The Application of BPR: A Case Study in Construction, *Journal of Knowledge and Process Management*, Vol. 7 (4) pp. 217-223.

Bryson, J., Ackermann, F., and Eden, C., (2007) 'Putting the Resource-based View of Strategy and Distinctiveness Competencies to Work in Public Organizations', Public *Administrative Review, Vol. 67,* pp. 702-717

Buckley, J. W., Buckely, M. H., and Chian, H., (1976) *Research Methodology and Business Decisions, National Association of Accountants,* University of South Florida, USA, (Accessed 29 June, 2016)

Byabato, A., and Addo-Abedi, F., (2004) Challenges Faced by Local Contractors in the Global Market, Proceedings, *Annual Consultative Meetings, Globalization: A Challenge to the Local Contractors*, 10 – 11, June, Dar es Salaam.

Caliskan, E. N., (2010) The Impact of Strategic Human Resource Management on Organizational Performance, *Journal of Naval Science and Engineering, Vol. 6, No. 2,* pp. 100 – 116

Caron, R., Jarvenpaa, S. L., and Staddard, D. B., (1994) *Business Reengineering at CIGNA Corporation*: Experiences and Lessons Learned from the first five years, MIS Quarterly Report, USA

Charoenngam, C, Ogunlana, S. O., and Ning-Fu, K., (2004) Re-engineering Construction Communication in Distance Management Framework, *Journal of the Business Process Managemen*t, Vol.(10), no. (6) pp. 645-672, Childe, S. J., Smart, P. A., and Weaver, A. M., (1995) *The Use of Generic Process Models for Process Transformation*, University of Plymouth, UK

Childe, S. J., Maull, R. S., and Bennett, J., (1994) Frameworks for Understanding Business Process Reengineering: *International Journal of Operations and Production Management*, Vol. N0. 14, Issue no 12, Pp 22-34,

Churchill, G. A., (1979) 'A Paradigm for Developing Better Measures of Marketing Constructs', *Journal of Marketing Research*, Pp. 65 – 73

Contractors Registration Board (CRB)., (2008) Corporate governance: A Key to Successful Contracting Business. *Proceedings of the CRB Annual Consultative Meeting*, 17th –18th July 2008, ST. Gasper Hall, Dodoma

Contractors Registration Board, (CRB)., (2008) *List of Registered Contractors*, Dar es Salaam.

Contractors Registration Board (CRB)., (2008) Corporate governance: A Key to Successful Contracting Business. *Proceedings of the CRB Annual Consultative Meeting*, 17th –18th July 2008, ST. Gasper Hall, Dodoma

Contractors Registration Board (CRB)., (2009), *List of Registered Contractors*, Dar es Salaam.

Costa, D. B., Lima, H. R., and Formoso, C. T., (2005) Performance Measurement Systems for Benchmarking in the Brazilian Construction Industry, *Federal University of Rio Grande do Sul*., Brazil

Creswell J. W., (2007) *Qualitative Inquiry and Research Design, Choosing Among Five Approaches*, Second Edition, Sage Publishing, Thousand Oaks, London.

Davenport, T. H., and Short, J. E., (1990) *The New Industrial Engineering: Information Technology and Business Process Redesign*, Sloan Management Review, , vol. 31, no. 4, Massachusetts Avenue

Davis, P., (2008) CRC Construction Innovation, Building our Feature, Report on Capital Works Procurement, *The Selection of a Building Procurement Method*, Royal Melbourne Institute of Technology, Australia

Davis, P., Love, P., and Baccarini, D., (2006) CRC Construction Innovation, Building Our Future, *Report on Building Procurement Methods, Research Project No. 2006-034-C-02,* Cooperative Research Centre for Construction Innovation, Australia

Dawson, C., (2002) *Practical Research Methods*, *A User-friendly Guide to Mastering Research Techniques and Projects,* British Library Catalogues, United Kingdom

Department of Transportation Washington State., (2014) Project Risk Management Guide, *Engineering and Regional Operations*, *Development Division*, Design Office, SAEO, USA

Digaga, A. R., (2010) *Establishment of Factors Towards Achieving Value for Money in Construction, the Case of Local Government Projects*, Masters (Dissertation Mgt), University of Dar es salaam

Dosi, G., Nelson, R. R., and Winter, S. G., (2000) The Nature and Dynamics of Organizational Capabilities, *Oxford University Press Inc*., Network

Ducan, R. W., (1996) *A Guide to the Project Management Body of Knowledge*, *PMI Standards Committee*, Project Management Institute, Four Campus Boulevard, USA

Dzambazova, T., Krygiel, E., and Demchak, G., (2010) *Introducing REVIT Architecture 2010 BIM for Beginners,* Wiley Publing, Inc., India

Eastman, C., Teicholz, P., Sacks, R, and Liston, *K.,* (2011) *A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers, and Contractors, BIM Handbook*, Second Edition, John Wiley and Sons, Inc., Canada

Edward, J., and Rykiel, J., (1996) Testing Ecological Models: The Meaning of Validation, *Ecological Modelling 90*, Pp 229 – 244, Elsevier

Emmit, S., (2007) Architectural Engineering and Design Management, Aspects of Building Design Management, *Architectural Engineering and Design Management*, *vol. 3,* pages 5 - 16

Engineers Registration Board (ERB)., (2008) *Engineering Consulting Firms*. Available at: www.erb.go.tz (Accessed: 07 January 2009).

Engineers Registration Board (ERB)., Anniversary (2018) *16th Annual Engineers Day Report, 50 Years of Engineers Contribution to the Nation: Achievements, Challenges and Way Forward*, Dar es Salaam, Tanzania

Fabricio, M. M., Melhado, J. B., and Baia J., (1999) Brief Reflection on Improvement of Design Process Efficiencies in Brazilian Building Projects, *Proceedings of IGLL* – 7, Sao Paulo University, Brazil

Fellow, R., and Liu, A., (2008) *Research Methods for Construction*, 3rd Edition, Willy-Blackwell Publishing, UK

Fiss, F. C., (2008) Configurations of Strategy, Structure and Environment, A Fuzzy Set Analysis of High Technology Firms, *University of Southern California,* USA

Flower, J., (1993) Healthcare Forum, We Can Do it Better, *Healthcare Forum Journal*, *Vol. 36*, Issue 1

Flynn, B. B., Schroeder, R. G. And Sakakibara, S. (1994) A Framework for Quality Management Research and an Associated Measurement, *Journal of Operations Management*, Vol, 11, Pp. 339 - 366

Formisano, R. A., (2004) Manager's guide to Strategy, *McGraw-Hill*, NewYork

Formoso, C. T., Tzotzopoulos, P., Jobim, M. S. S., and Liedtke, R., (1998) Developing a Protocol for Managing the Design Process in the Building Industry, *Proceedings IGLC'98, Federal University of Rio Grande do Sul*, Brazil.

Fryman, M., (2002) *Quality and Process Improvement*, Delmer: Thompson Learning

Galos, J. V., and Schein, E. S., (2006) *Organization Development*, A Jossey-Bass, A Willey Imprint, San Francisco

Gray, C., and Hughes, W., (2001) *Building Design Management*, Butterworth Heinemann, Great Bretain

Griffith, A., and Watson, P., (2004) *Construction Management, Principles and Practice,* Palgrave Macmillan, New Tork

Guimaraes, T., (1998) Important Factors for BPR Successes in Manufacturing Firms, , *Institute for Technology Management, Tennesee Technological University*, Gestao and Producao Vol. 5, no. 1, pp 1-17

Habib, M. N., and Shah, A., (2013) Business Process Reengineering: Literature Review of Approaches and Applications, *Proceedings of 3rd Asia-Pacific Business Research Conference,* 25 – 26, February, Kuala Lumpur, Malaysia

Halpin, D. W., (2006) *Construction Management*. 3rd Edition: John Wiley and Sons, United State of America

Hallway, A., (2001) Experiences and Challenges of the NCC's Consultants Training Programme, *Construction Industry Development for Tanzania Social and Economic Transformation*, Construction Industry Forum, Karimjee Hall, 3rd – 5th April, Dar es Salaam

Hancock, B., (2002) Trent Focus for Research and Development in Primary Health Care: *An Introduction to Qualitative Research*, Trent Focus.

Harrington, H. J., (1997*) Business Process Improvement, The Breakthrough Strategy for Total Quality, Productivity and Competitiveness*, McGraw-Hill, Inc., New Delhi

Harvey, J., (2008) Performance Measurement, Topic Gateway Series No. 9, *The Chartered Institute of Management Accountants,* London, www.cimaglobal.com, Accessed 20th December, 2017

Heap, J., (1989) *The Management of Innovation and Design*, Cassell, London

Hirano, H., (2009) *JIT Implementation Manual: the Complete Guide to Just-In-Time Manufacturing*, Second Edition, Tailor and Francis Group, Boca Raton

Hurley, W. L, Denegar, R., and Hertel, J., (2011) *Research Methods, A Framework for Evidence-Based Clinical Practice,* Lippincott Williams and Wilkins, Charlollesville, Virginia, China.

Improvement Skills Consulting (IS)., (2008) *Measuring Process Performance*, Blind Lane, Flakwell Health

Ireland, V., (1994) *Process Re-engineering in Construction*, T40 Report, Fletcher Constructions, Sydney, Australia, May.

Jackson, B. J., (2010) Construction Management, Jumpstart, 2nd Edition, *The Best First Step Toward a Career in Construction Management, Wiley*, Wiley Publishing, Inc.

Jirasukprasert, P., Garza-Reyer, J. A., and Soriano-Meier, H., (2012) A Case Study of Defects Reduction in a Rubber Gloves Manufacturing Process by Applying Six Sigma Principles and DMAIC Problem Solving Methodology, *Proceedings of the 2012 International Conference on Industrial Engineering and Operations Management*, Istanbul, Turkey

Joseph H., and Haule J., (2008) *Challenge and Opportunities in the Development of the Construct Industry Personal, The NCC Experience*: Construction industry forum; theme, education and training needs for the Construction industry in the new millennium, 12nd – 13rd September, Karimjee hall-Dsm.

Joshi, C.S., and Jangwal P. G., (2012) Management of Business Process Reengineering Projects Study, *Journal of Project, Program and Portifolio Management*, Vol. 3, N0 1, 2012, PP. 78-89

Kagioglou, M., Aouad, G., Cooper, and Hinks, J., (1999*) The Process Protocol: Process and IT Modelling for the UK Construction Industry,* University of Salford, UK

Kagioglou, M., Cooper, R., Aouad, G., and Sexton, M., (2000) Rethinking Construction*: The Generic Design and Construction Process Protocol, Engineering, Construction and Architectural Management*, Vol. 7, 2, 141 - 153

Kalulanga, G. K., Koutcha, W., McCaffer, R., and Edwin-Fotwe, F., (2001) ‘Construction Contractors Claim Process Framework’, *Journal of Construction Engineering and Management, Vol. 127,*Pp 309 - 3014

Kangwaya, F. R., (2008) *Assessment of Project Management Factors Constraining Successful Public Project Implementation in Tanzania Construction Industry, A Case of Project Manager’s Performance*, Masters in Engineering Management Dissertation, University of Dar es Salaam

Kaschek, R., (2011) The Evolution of Conceptual Modelling, From a Historical Perspective towards the Future of Conceptual Modelling, *State –of-the art Survey, Sringer-Verlag*, Berlin Heidelberg

Kato, T., (2014) *Evaluation of Contractor’s Equipment Management Practices in Road Construction Projects,* Masters (Construction Management),

Kenley, R., (2003) *Financing Construction, Cash Flows and Cash Farming*, Spon Press, London

Kettinger, W., and Grover, J., (1997) Business Process Change, Reengineering Concepts, Methods and Technologies, Idea Group Publishing, Austin

Khekale, C., and Futane, N., (2015) Management of Claims and Disputes in Construction Industry, *International Journal of Science and Research (IJSR), Paper ID:SUB154227*, www.ijsr.net (Accessed on 12 January, 2017)

Kontio, J., (2007) Business Process Reengineering: A Case Study at Turku University of Applied Sciences, *Proceedings of European Mediterranean Conference on Information Systems* EMCIS, 24 – 26, June, Polytechnic University of Valencia, Spain

Korb, K. A., (2014) Calculating Reliability of Quantitative Measures, University of JOS, http://korbedpsych.com/LinkedFiles/524_03_ReliabilityValidity.pdf

Koskela, L., and Sharpe, R., (1994) Flow Process Analysis in Construction, *Automation and Robotic in Construction XI*, Elsevier Science, B.V

Koskela, L., (1992) *Application of New Production Philosophy to Construction*, CIFE Technical Report, Stanford University

Kothari, C. R., (2004) *Research Methodology; Method and Techniques,* Second Revised Edition, New Age International Publishers, New Delhi

Krejcie, R. V., and Morgan, D., (1970) Determining Sample Size for Research Activities, *Educational Psychological Measurements,* 30, PP. 607 -610, https://home.kku.ac.th/sompong/guest_speaker/KrejcieandMorgan_article.pdf Accessed, January 2015

Kumar, R., (1996) *Research Methodology; A Step by Step Guide for Beginners,* SAGE Publications, Thousands Oaks, New Delhi

Kumar, R., (2008) *Research Methodology, A Step by Step Guide for Beginners,* 3rd Edition, Sage, NewDelhi

Kumar, S. A., and Suresh, N., (2008) Production and Operations Management (With Skill Development, *Caselets and cases), Second Edition, New Age International (P) Limited,* Publishers, Mumbai

Kwakye, A. A., (1997) *Construction Project Administration in Practice*, London, Addison Wesley Longman

Laswai, M. J. M., (1998) The Role of Contractors Registration Board in Managing the Contracting Industry, *Managing Construction Industry Development in Developing Countries , Report on the First Meeting of the CIB Task Group* 29 (TG 29), Arusha, Tanzania

Lema, N. M., and Mutabazi, M., (1988) *The need for Bid Evaluation Framework Review, IET Annual Seminar on the Role of the Construction Industry in the Economic Recovery Programme,* Arusha, Tanzania

Lema, N. M., Likumbo, S. S., Maro, W. E., and Moshi, H. P., (1992) Analysis of Cost Effectiveness in Construction Projects Delivery Process. *Seminar Proceedings Research and Development Issues,* 18th – 19th August, Dar es Salaam.

Lema, N. M., (1995), An *Introduction to Civil Engineering Procedures*. Faculty of Engineering, Printing Unit – University of Dar es salaam, Manuscript NO FOE/CE/MAN/12/9

LEVY, S., (2010) C*onstruction Process Planning and Management, An Owner's Guide to Successful Projects,* Elsevier Inc., USA

Lo, Y. H., (2012) Managerial Capabilities, Organizational Culture and Organizational Performance: The Resource-based Perspective in Chinese Lodging Industry, *The Journal of International Management Studies, Vol. 7., No.* 1,

Magutu, P. O., Nyamwange, S. O., and Kaptoge, G. K., (2010) Business Process Reengineering Competitive Advantage, Key Factors that may Lead to the Success of Failure of the BPR Implementation (The Wrigley Company), *African Journal of Business and Management (AJBUMA),* University of Nairobi.

Mamiro, J. G., and Kasuwi, A. O., (2005), Management of Public Funded Construction Projects: A Case Study. *Proceedings of Pre-requests for Competitiveness of the Tanzanian CI: Lessons from the South*, 25-27, Dar es Salaam

Manganelli, R. L., and Klein, M. M., (1994), *The Reengineering Handbook: A Step by Step Guide to Business Transformation*, AMACOM Books, United States of America

Mari, L. P., (2005) *Models of the Measurement Process*, Leniversita, Cattaneo, Castellanza, Italy, John Wiley and Songs, Ltd

Marchand, D. A., and Stanford,M. J., (1994) Business Process Redesign: *A Framework for Harmonizing People*; *Information Technology*

Marwah, A. K., Thakar, G., and Gupta, R. C., (2012) Implications of Performance Measurement Approaches on Supply Chain Performance, *National Conference on Emerging Challenges for Sustainable Business,* MIT, Ujjain

Mayer, R. J., and DeWitte, P, S., (1999) Delivering Results: Evolving BPR from Art to Engineering, in Elzinga, J., Gulledge, T. R., and Lee, C, (Ed.) *Business Process Reengineering: Advancing the State of the Art*, Kluwer Academic Publishers, USA

Mawenya, A. S., (2011) 50 Years of Construction Industry Development in Tanzania; the Contracting Subsector, *Proceedings of the Annual Consultative Meeting,* 50 Years of Independence: Empowering Contractors to Meet the Challenges Ahead, Mlimani City, Dar es Salaam.

Mazda, F., (2000) *Engineering Management*; Pearson Education Asia Limited, India

McAdam, R., (2003) Radical Change: A Conceptual Model for Research Agenda, *Journal of Leadership and Organization Development*,, pp. 226-235, MCB UP limited

McCabe, C and Dixon, S. (2000) Testing the Validity of Cost Effectiveness Models, *Sheffield Health Economics Group, Phamacoeconomics*, Vol. 17, (5), Pp 501 - 513

McFadzean, E., (1999) Encouraging Creative thinking, Leadership and Organizational Development, *Journal*, 20 (7), 374 -383

Mendez, R. O., (2006) The Building Information Model in Facilities Management, *Degree of Master of Science, Thesis*, Worcester Polytechnic Institute

Mhando, B., Y., Mlinga, R. S., and Alinaitwe, H. M., (2017) Perspectives of the Causes of Variations in Public Building Projects in Tanzania, *International Journal of Construction Engineering and Management*, Vol 6, Issues 1, pp 1-12.

Ministry of Works (MoW)., (1977), *Local construction industry study, General Report*, MoW, Dar es Salaam, Tanzania

Ministry of Works [MoW]., (2003) *Construction Industry Policy*, Dar es Salaam, Tanzania

Ministry of Finance (MOF)., (2014*) The Economic Survey*, August, Dar es Salaam, Tanzania

Ministry of Finance (MOF)., (2011*) The Economic Survey*, August, Dar es salaam, Tanzania

Ministry of Finance (MoF)., (2013) *Government Budget for Financial Year 2011/2012, Citizens Budget Edition*, Ministry of Finance in Collaboration with Policy Forum, www.mof.go.tz/mofdocs/budget/citizensBudget/CITIZEN_ENGLISH_2011_12_FINAL.pdf Accessed in December, 2013

Mlinga, R. S., (2005) Public Procurement Reform and Support to the Growth of the Construction Industry. *Forum Proceedings, Pre-requests for competitiveness of the Tanzanian CI, Lessons from the South*, 25-27 Karimjee Hall, Dar es Salaam.

Msemwa, F., (2016) Exclusive *Interview with Fred Msemwa, Chief Executive Officer of the Watumishi Housing Company (WHC)* http://tanzaniainvest.com/construction/realestate/interview-fred-msemwa-ceo-whc,www.twitter.com/tanzaniainvest (accessed, Sept, 2016).

Msita, K. M. I. M., (2001) *Regional and International Trade Regime: Challenges of the Local Construction Industry and the Way Forward. Construction Industry Forum, Construction Industry Development for Tanzania Social and Economic Transformation*, Karimjee Hall, Dsm 3rd -5rd April

Muhegi, B. C., (2011) a Perspective of Contractor Regulation, Development and Performance over Fifty Years and Challenges of Empowering Contractors, *Proceedings of the Annual Consultative Meeting*, 50 Years of Independence: Empowering Contractors to Meet the Challenges Ahead, Mlimani city, Dar es Salaam.

Muhegi, B. C., (2003) Status of Implementation of Recommendations from the CRB Annual workshops 2002, *Annual Consultative Meetings, Proceedings*, *CRB's Five Year Corporate Plan; Goals and Strategies*, 5 – 6, June, Dar es salaam

Muhegi, B. C., (2007) An Overview of the Contracting Industry: Achievement and Challenges, *Proceedings, Annual Consultative Meetings***,** *10 Years of CRB: Empowering Contractors to Meet the Challenges Ahead*, 16th – 18th October, Diamond Jubilee Hall, Dar es Salaam,

Mukama, B. C., (2005) *Engineers Registration Board Capacity Building Programme for Engineers after Graduation*, Annual Consultative Meeting, CRB, Diamond Jubilee Hall, Dar es Salaam

Mushi, E., (2007) Issues for consideration: Small contracting firms: *Proceedings of 10 years of CRB: Empowering Contractors to Meet the Challenges Ahead*, Diamond jubilee Hall, Dar es Salaam, Tanzania

Muthu, S., Whitman, L., and Cheraghi, H., (1999) Business Process Reengineering: a Consolidated Methodology, *Proceedings of the 4th Annual International Conference on Industrial Theory, Application and Practice*: USA

Mwamila, B. L. M., and Mkamba, A. O., (2001) The Role of Engineers Registration Board (ERB) in the Development of the Local Construction Industry. *Construction Industry Development for Tanzania Social and Economic Transformation*, Construction Industry Forum, Karimjee Hall, 3rd – 5th April, Dar es Salaam

Mwankusye, J., and Fundi, Y., (2005) Labour Practices in Construction in Tanzania; *Forum Proceedings, Pre-requisites for Competitiveness of the Tanzanian Construction Industry: Lessons from the South*. 25-27 August, Dar es Salaam

Mwishwa, Y. H. B., (2014) A Framework for Improving Capability of Tanzanian Contracting Parties through Adopting three Philosophies: Lean, BPT and Capability Maturity Model, *Journal of Business Management and Applied Economics, Vol. III, Issue 2,* March.

National construction council (NCC)., (1997) *Workshop to Formulate Objectives and Strategies for Enhanced Participation in Work Opportunities by Local Consultants and Contractors,* White Sands Hotel, 4th – 5th June, Dar es Salaam

National Construction Council (NCC)., (1984) *Client's Role in the Implementation of Construction Projects*, Seminar Report, 18th – 19th July, Dar es salaam

Ngowi, J. A. F., (2014) *Development of Stakeholder Management Framework For Application in Road Construction Projects in Tanzania, A Case Study of Roads Construction Projects under TANROADs*, Masters of Engineering Management dissertation, University of Dar es salaam

Ntyakunze, S. K., (2011) Conflicts in Building Projects in Tanzania: Analysis of Causes and Management Approaches, *Unpublished PhD. Dissertation*, Stockholm, Sweden.

Oakland, J. S., (2003) *Total Quality Management, Text with Cases*, 3rd Edition, Butterworth-Heinemann.

Oakland, J., and Marosszeky, M., (2006) *Total Quality in the Supply Chain*, Butterworh-Heinemann, Burlin

Otoki, B, M., Munala, G. K., and Meena, V. W., (2018) Factor Affecting Quality of Reinforced Concrete Building Construction in Dar es salaam, Tanzania, *International Journal of Novel Research in Civil Structural and Earth Sciences, Vol. 5, Issue 1,* pp 10-18

Patel, K. Palil, S., and Paul, A., (2005) *Assignment on business process reengineering*, National Institute of Construction Management and Research, University of New York, www.netlib.com

Paulk, M. C., Weber C. V., Curtis, B and Chrissis, M. B., (1993) 'The capability Maturity Model: *Guidance for Improving the Software Process'*, Addiso-Wesley

Pearman, R. F., (1999) *Implementing business process reengineering*, CASEwise 1999

Perez, G. L., Shuman, L., Wolfe, H., and Sacre, M. B., (2001) Measuring Continuous Improvement in Engineering Education Programs: A Graphical Approach, National Science Foundation Grant, Engineering Education: *Proceedings of the 2001 American Society for Engineering education Annual Conference and Exposition*, American Society for Engineering education

Pettee, R. S., (2009) Constructability Reviews – An Introduction, Constructability%20Reviews%20-%20a%20primer%206-6-12%20versionFINAL.pdff, Accessed 20th January, 2017.

Project Management Institute (PMI)., (2000) *A Guide to Project Management Board of Knowledge (PMBOK)*, Newton Square, Pennsylvania USA.

Pruett, K., (2004) Constructability Review: Case Study of Bid Document Errors and Omissions, *Construction Management Association of America*, CMeJournal

Public Procurement Regulatory Authority (PPRA)., (2008) Annual Performance Evaluation Report for the Financial year 2008/2009, *Report, Dar es Salaam*, Tanzania

Pulaski, M. H., and Horman, M. J., (2005) Organizing Constructability Knowledge for Design, *Journal of Construction engineering and Management*, Vol. 131, No. 8, August, ASCE

Pyzdeck, T., (2003) *The Six Sigma Handbook, Revised and Expanded, A Complete Guide for Green Belts, Black belts, and Managers at all levels*, McGraw-Hill, Toronto

Rever, H., (2002) *Applying the DMAIC Steps to Process Improvement Projects "Define, Measure, Analyze, Improve, Control" the Road Map to Improving Processes*, LiL, www.iil.com Accesses on November, 2016.

Riley, M. J., and Brown, D. C., (2001) Case study of the application of BPR in an SME contractor, *journal of knowledge and process management,* Vol. 8 (1) pp. 17-28. John Wiley and Sons Ltd, United Kingdom.

Rivard, H., (2003) "A survey on the Impact of Information Technology on the Canadian Architecture, Engineering, and Construction Industry." *Electronic Journal of Information Technology in Construction (ITcon)*, http://itcon.org

Robson, M., and Ullah, P., (1996) *A Practical Guide to Business Process Reengineering.* Gower Publishing Ltd, Hampshire.

Robinson, S., (2004) *Simulation: The Practice of Model Development and Use*, John and Sons, ltd, England

Roffe, I., (1999) Innovation and Creativity in Organizations: A Review of Implications for Training and Development, *Journal of European Industrial Training, Vol. 23, No. 4.* Pp. 224 – 237

Samson, M., (2003), Development of Contractors Performance Measurement Framework: A Strategy for Improvement, *Unpublished Msc Thesis*, University of Dar es Salaam, Tanzania.

Sekaran, U., (2003) *Research Methods for Business, A Skill-Building Approach*, Fourth Edition, John Wiley and Sons, Inc., United States of America

Seng'enge, R., (2011) Bridges and Roads Construction and Development in Tanzania for the Past 50 years of Independence: The Impact, Challenges and Future Prospects, *9th Engineers Day*, September, Mlimani city Conference Hall, Dar es Salaam

Shem, M. N., (2010) Impacts of Government Policies on Pastoralist Livelihoods in the Semi-arid Areas of Tanzania. In: *Proceedings of the International Congress on Infections Diseases (ICID) 16 – 20 August*, 2010, Fortaleza-Ceara, Brazil

Shin, N., and Jemella, D. F., (2002) Business process reengineering and performance improvement, "the case of Chase Mahattan Bank", *Business process management journal*, vol. 8, No. 4, Pp. 351 – 363

Sidwell, A. C., Kennedy, R. J., and Chan, A. P. C., (2002) Reengineering the Construction Delivery Process, *Report and Case Studies, Construction Industry Institute Australia*, www.ciia.qut.com

Sikazwe, H, C., (1999) Information Technology in the European Construction Industry; *The Application of Workflow Management and Business Process Reengineering*, Forum, Research Paper

Singh, Y. K., (2006) *Fundamental of Research Methodology and Statistics*, New Age International Publishers, New Delhi.

Smith, J. A., and Albaum, J., (2012) BIM – A Contractor Perspective, *International Federation of Surveyors,* Article of the Month – June 2012

Soares, R., (2013) Reengineering Management of Construction Projects, *International Journal of Business and Social Sciences,* Vol. 4, No. 7, www.ijbssnet.com

Sobek, D. K., and Jimmerson, L., (2003) *Applying the Toyota production System to a Hospital Pharmacy*, Montana State University, Bozeman

Sommerville, J., and Craig. N., (2006) Implementing IT in Construction, T*aylor and Francis*, Tylor and Fransis Group, London

Stamatiadis, N., Goodrum, P., Shocklee, E., Sturgill, R., and Wang, C., (2012) Tools for Applying Constructability Concepts to Project Development (Design), *Kentucky Transportation Canter, Kentucky University*, Research Report

Stoica, M., Chawat, N., and Shin, N., (2004) *An Investigation of the Methodologies of Business Process Reengineering*, ISECON, San Diego

Strandhagen J. O., and SkarloT., (1995) *A Manufacturing Business Process Reengineering Method: Design and Redesign of a Production Control Model*, http://citeserx.ist.psu.eduviewdoc/summary?doi=10.1.1.116.4276 (Accessed, October, 2010)

Straub, D. W., Boudreau, M. C., and Gefen, D., (2004) 'Validation Guidelines for IS Positivist Research', *Communications of the Association for Information Systems*, Vol. 13,

Suermann., P. C., Usaf M. P. E., and Issa, R. R. A., (2006) Evaluating the Impact of Building Information Modelling (BIM) on Construction, *7th International Conference on Construction Applications of Virtual Reality*, October 22-23, The University of Florida,

Susan, P., (2010) *The Power of Business Process Improvement, 10 Simple Steps to Increase Effectiveness, Efficiency and Adaptability*, Library of Congress Cataloging, USA

Susan, R., (2015) *Case Study Research Design, Management Research*, Applying the Principles, Nigel Spinks and Ana Isabel, Canhoto

Takie S., (2005) *Research Methods and Writing Research Proposals*, Centre for Advancement of Postgraduate Studies and Research in Engineering Science, Cairo University.

Takim, R., and Akintoye, A., (2002) *Performance indicators for Successful Construction Project Performance:* in Greenwood (Ed.), 18th Annual ARCOM conference, 2 - 4 September, University of Northumria, Vol. 2, Pp. 545 -545

The Construction Users' Roundtable (CURT)., 2005) Construction Measures: Key Performance Indicators, 4100 Executive Park Drive, Cincinnati, www.CURT.org Accessed 8th September, 2009.

The US Department of American Department of the Interior., (2006) *Conducting Business Process Reengineering Enterprises*, Architecture, USA

Tookey, J. H., (1998) *Re-engineering the Building Procurement Decision Making Process*, Cobra '98, Glasgow Caledonian University, The Royal Institution of Chartered Surveyors

Torbett, R. Saltar, A. J., Gann, D. M., and Hobday, M., (2001) Design Performance Measurement in the Construction Sector: *A Pilot Study, Electronic*

Working Paper, Number 16, IEEE Transactions of Engineering Management, University of Sussex, Brighton, UK.

Towers, S., (1994) Business Process Reengineering, *A Practical Handbook for Executives,* Stanley Thomas Ltd, Chaltenham

Transportation Research Board of the National Academies (TRBNA)., (2009) A Guide for the Evaluation of Project Delivery Methods, *Transit Cooperative Research Progress Report 131, Washington, D.C.,* www.TRB.org, Accessed on January 2015

Tsalgatidou, A., (2008) *Methodologies for BPR Modelling,* http://www.google.co.tz/search?hl=sw&q=bpr+methodologies&start=30&sa=N, Accessed on 4th June 2009

Tupa, J., (2010) *Process Performance Measurement as Part of Business Process Management in Manufacturing Area*, University of West Bohemia in Pilsen, Czech Republic

Tzortzopoulas, P., and Cooper, R., (2007) Design Management from a Contractor's Perspective, The Clarity, in Emmitt (ed.) *Architectural Engineering and Design Management, aspects of Building design Management*, ebooksclub.org

Tzortzopoulas, P., and Formoso, C. T., (1999) *Construction on Application of Lean Construction Principles to Design Management*, Proceedings 1 GLC-7, University of California, Berkeley CA, USA, 26 -28th July

Udo-Akang, D., (2012) Theoretical Constructs, Concepts, and Applications, *American International Journal of Contemporary Research*, Vol. 9 (2), Pp. 89 - 96

Ulrsic, D., Mulej, M., and Telic, B., (2005) *The steps towards successful Reengineering in Slovenian Companies*, University of Maribor, Slovenia

Ulrwick, A. W., (1999) *Business Strategy Formulation, Theory, Process and Intellectual Revolution*, Westport, Connecticut, London

UNESCO., (2010) *Construction: A Vibrant Industry*, www.natcomreport.com/Tanzania/pdf-new/construction.pdf (accessed, 24, April, 2014)

University of Kentucky., (1997) Toyota Production System, 'One by one Confirmation', *Lean Manufacturing Conference*, http://www.mfg.Eng.com accessed in January, 2013

Vakola, M., and Rezqui, Y., (2000) Critique of Existing Business Process Reengineering Methodologies: The Development and Implementation of a New Methodology, *Business Process Management Journal*, vol. 6., No. 3., Pp. 238 – 250.

Wardani, M. A., (2004) *Comparing Procurement Methods for Design-Build Project*, *Computer Integrated Construction Research Program*, Technical Report No. 45, Penn state The Pennsylvania State University

Wu, S., Fleming, A., Aouad, G. and Cooper, R., (2000) *The Development of the Process Protocol Mapping Methodology and Tool*,– http://www.processprotocol.com/processprotocol%20Methodology%20and%20tool.pdf Accessed 12/06 2009

Wyssusek, B., Schwatz, M., Kremberg, B., and Baier, F., (2001) Business Process Modelling as an Element of Knowledge Management – A Model Theory Approach, *Conference on Managing Knowledge*, 10 - 11, April, Leicester University, UK

Yin, R. K., (1993) *Applications of Case Study Research, Applied Social Research Methods*, Series, Volume 34, Sage Publications, Inc., California

Yin, R. K., (2003) Case Study Design: D*esign and Methods*, Sage Publications Inc., California

Yin, R. K., (1989) Case Study Research: *Design and Methods*, London, Sage Publications

Zahoor, A., Ijaz, S., and Muzammil, T., (2015) Effective Management System: A Key to BPR Success*, European Journal of Business Management*, Vol. 7, No. 25

Zaied, R. M. B., Louati, H., and Affes, H., (2015) *International Journal of Value and Supply Chains (IJMVSC), Vol. 6, No. 1, FSEGS University*, Sfax, Tunisia

Zairi, M., (2005) Benchmarking for Best Practice: The Power of its Adoption and the Perils of Ignoring its use in a Modern Business Environment; *Pakistan's 9th International Convention on Quality Improvement, November 14 -15*, Karachi, Pakistan

Zairi, M., and Sinclair, D., (1995) 'Business Process re-engineering and process Management' *a Survey of Current Practice and Future Trends in Integrated Management'*, Management Decision, Vol. 33, No 3, Pp 3 - 16

Zigiaris, S., (2000) *Business Process Re-engineering (BPR) Report for the EC Funded Project*, INNOREGIO, Hellassa

APPENDICES

Appendix A

List of Firms Involved in the Interviews and Questionnaire Surveys

Date and time	Firm	Category in business	Participants per seat	Total participants
25.7.2016, 12.03 – 2.42 pm and 29.07.2016 at 02.00-03.25pm	Holtan	Contractor	2	2
26.07.2015 12.00-3.02pm and 30.07.2016 at 08.30-9.38am	Skol	Contractor	2	2
28.07.2016 2.00 - 3.15pm	Advert	Contractor	1	1
28.07/20169.12-1205pm	NHC	(2 Consultants, 1 contractor, 1 developer and 1 Client)	5	5
28.07.201609.55-10.51am	Hari and Sons	contractor	1	1
29.07.2016 at 3.33-5.52pm	Multi-struct	Contractor	1	1
1.08.2016, 11.34-01.53 pm	Group 6	Contractor	3	3
2.08.2016, at 10.02am-1.45pm	Wella architects and planners	consultant	1	1
2.08.2016, 08.12-9.40am	Engg consult	consultant	1	1
2.08.2018, 2.10-4.05pm	Tanesco	Client	2	2
3.08.2016; 9.35am – 11.40am	Watumishi Housing Company	Client and Developers	2	2
3.08.2016, 12 – 2.05pm	PPRA	Regulator/client	1	1
4.08.2016, 12.00-1.45pm	Howard Humphreys	consultant	2	2
4.08.2016,8.50-10.09 am	Cost Data	consultant	1	1
4.08.2016, 10.20-1.03pm	TBA	3 consultants and 1 client	4	4
5.08.2016, 8.05-9.32 am	Cowi Tanzania,	Consultant	2	2
5.08.2016, 12.05 - 2.34pm	Estim	Contractor	2	2
-	-	-	17 seating conducted	33 participants

Appendix B

Introduction Letter to the Firms During Questionnaire Survey

UNIVERSITY OF DAR - ES - SALAAM
COLLEGE OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF STRUCTURAL AND CONSTRUCTION ENGINEERING
P. O. BOX 35131 - DAR ES SALAAM – TANZANIA

Tel: 255-22-2410752 (Direct)
2410500/9 Ext. 2833 (General)
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HEKIMA NI UHURU

E-Mail:
head_sce@.udsm.ac.tz
Website:
http://www.ce.udsm.ac.tz

Date: **19th July, 2016**

Our Ref:
Your Ref:

The Managing Direct,

To whom it may concern

RE: Introduction Letter to Mr. Yazidi H. B. Mwishwa

The above heading refers.

Mr. Yazidi H. Mwishwa with Number 2008-0700010 is a PhD student in our Department, Structural and Construction Engineering (SCE), University of Dar es Salaam. Currently, he is collecting data to validate the model he developed in his study. On behalf of the Department and the University, I request you to support Mr. Mwishwa with the data that he may require.

In short, the nature of data required is conducting conversation discussion with either **three** or **four** engineering practitioners (expertise) from your firm. If an idea under discussion would need access into documentation, a request for accessibility is also kindly requested. This is also to appreciate your support, and, assuring you that the information would be used confidentially and for academic purposes only.

Yours Sincerely,

Dr. Ing. J.K. Makunza
Head
Department Structural and Construction Engineering.

Head
Department of Structural and
Construction Engineering

Appendix C

Guide to the Interviews and the Questionnaire Survey

This guide was prepared to help researcher present the needed information so as to maintain consistence among the involved participants.

It helped the researcher to present the needed material as required (this helped to serve time and deal with necessary items accurately).

- Briefing information on why the model is developed and the tasks on each step of the model is explained by the researcher ;
- Brief description on three processes categories and mapping out the flow of the project information is also presented (show the three Mapping graphics of Design, procurement and construction management and the model as a whole);
- Information in the protocol (questionnaire instrument) was also checked;
- The firm having understood the matters described, they filled in the cells provided by indicating extents of agreement to the statement using five point scale, from 1 – strongly disagreed to 5 – strongly agreed;
- In case there were any needing of further clarifications, this could be raised and clarification made by the researcher;

Appendix D
Data collection for a Questionnaire Survey and the Four Graphic Maps that Guided Interview Forums

This data collection tool is divided into two parts; Part One and Two.

Part One

Part one of data collection was aimed to obtain general information of the firm. In order to achieve this objective, please, fill in the cells or spaces provided by providing a tick.

General Information

1: Company name:…………………………………………

2: Firm's business classification, please tick as appropriate

Firm	Client	Consultant	Contractor	Developer	Others
Tick mark					

3: Category, if it is a Consultant, Client, Developer or Contractor indicate whether the firm is local or foreign ………..………..………………….

4: Respondent's position/title, please put a tick

Position/title	Manager	Director	Site agent (engineer)	Foreman	Others
Tick mark					

5: Respondent's profession, please put a tick

Career	Civil Engineer	Architect	Quantity surveyor	Mechanical engineer	Others
Tick mark					

6: General experience

Years	Below 2 yrs	2 -5 yrs	6 – 10 yrs	11 – 15 yrs	16 – 20 yrs	Above 20 yrs
How long have you been with the firm?, Please tick as appropriate						
How long have you been in the construction industry?, Please tick						

Part two

The second part of data collection is divided into four sections. Section One investigates the attributes of 'build BPR foundation' to help prepare and guide in BPR implementation, Section Two used developed indicators to identify weaknesses, Section Three investigates the usability of the radical change processes improvement, Section Four investigates the facts of 'strategies of improvement' towards BPR implementation initiatives and Section Five investigates the facts on the usability and functionality of the developed model.

Section One: 'Build BPR Foundation'

Model Step one	Attributes	Questions/Statements	Likert Scale Rating and Responses				
			1	2	3	4	5
Built BPR foundation	Leadership and team	Appoint a person to lead and manage the changes					
		Appoint appropriate team to champion and enable the changes to happen					
	Resources	Avails adequate resources to support change process					
		Institute programmes to change culture of employees					
		Uses a consultant (where necessary) to lead revolutionary change					
	Policies deployment	Formulate and adequately communicate appropriate change policies					
		Establishes programmes to train Employees					
		Ensures all employees are aware and ready of the planned changes					

DESIGN PROCESS WEAKNESSES						
Indicators	Use likert scale translating: 1 –strongly disagree, 2 – disagree, 3 agree, 4 – agree and 5 strongly agree to respond into the following statements	1	2	3	4	5
Critical Design Inputs						
Users' requirements	Client's and users' requirements inadequately evaluated by the consultants create more chances of reworking					
Designers ideas and design needs	If designers' ideas and design needs are not well identified and evaluated, they contribute to poor design results					
Financial requirement	Inability to evaluate project financial need by the client contribute to project delays, or even disputes					
Qualification and experience	In experienced design expertise contributes to inadequate design documentation					
Expertise availability	Un-availability or absence of the designers expertise contributes into inaccuracies design documentation(s)					
Design requirements	If design requirements (e.g. codes, rules etc.) are not adhered to during design process, this increases chances of reworks					
Critical Activities of Design Process						
Preliminary design-focuses on achieving functional brief	If design activities are not well described, a common goal will be missed by all design team members					
	If user groups and their needs are not identified and recorded, poor functional brief					

	would prevail					
Schematic design Checks production of option sketches status	If work sketches are not prepared and deployed, one sketch option of use enlarges the chances for reworks					
	If a single sketch option is adopted, it would limit client on available options, causing dissatisfaction					
Detail design	If the outputs of the detail design is not forecasted early-on, e.g. inaccurate design or non constructible documents, would be produced					
	If collaborative effort is inappropriate during design, lack of sharing views between designers impact the overall design results					
Critical Design Interfaces						
Reviewed activities issues	If review/constructability process is not effected during design stage, errors, mistakes in documentations would be generated					
	If interfaces between design activities are not well identified and linked, this may create delays in later design activities					
	If design milestones are not prepared, new design phase would be hardly be prepared and commenced					
	If client approves fault designs, this would result into reworking during actual construction					

Section Two: "Indicators established to identify weaknesses'

PROCUREMENT PROCESS WEAKNESSES						
Critical Inputs of Procurement						
Indicators	Description/Statement	1	2	3	4	5
Conversant client	Client who is not conversant with the project is likely interfere project decision making					
Project objectives	If project objectives (e.g. of budget needs, speed needs are not well evaluated, project progresses and results would be impacted, negatively					
Project characteristics	If project characteristics, e.g. uniqueness of project, complexity etc. are not well evaluated incompetent builder, or poor contract can be prepared					
Procurement risks	If procurement risk is not well evaluated, project delay is likely to occur					
Critical Activities of Procurement						
Elements: Project delivery option	If clients fail to evaluate: project characteristics, his changes needs, speed needs of the project, budget issues etc. this impact his selection of appropriate project delivery method					
Contract type	If clients fail to evaluate and categorize works in the itemized form, in a schedule of rate, lump sum, etc. appropriate contract type will be missed					
Procurement method	If clients fail to evaluate work contract works right procurement option would be missed					
Procurement activities	If procurement activities are not be well evaluated by a client, this contributes to obtaining incompetent builder					
Critical Interfaces of Procurement						

Interface	If either of the procurement activities is not checked for completeness, accuracies, the end product dissatisfies the owner					
CONSTRUCTION MANAGEMENT PROCESS WEAKNESSES						
Critical Inputs of Construction Management						
Competent contractor	Incompetent contractor contribute enormously in creating fault product					
Design documents	Incomplete design documents have wider chances to contribute into work delays or even disputes					
Contractual	If fairness in the contract is not established, disputes would be created					
Expertise availability	un-availability of a qualified contractor contributes into inaccurate construction work					
Work records	Inappropriate actual site records create chances of disputes					
Information flows	In effective information flows in the site lower productivity levels					
Critical Activities of Construction Management						
Site layout	*Site space needs* not well planned create chances of accident					
	Resources not well *organized* in the work site create chances of lowering site productivity					
	Temporary structures not well secured may slow down site work operative					
R**esources** planning	Unavailability of a checklist of resources in type categories impacts productivity					
	Unavailability or, not using the schedule that explore resources requirements: type, category and number has affects in site productivity					
Resources mobilization	Lacking of the resources utilization plan, appropriate resources would not be acquired					
	Missing a checklist of resources in numbers, their effective acquisition would not be realized					
Implementation	Lacking of decomposition work impact clarity of the works					
	If resources, e.g. material, equipments are not properly checked for: deliveries use, recorded, etc. actual work would not happen					
	job site security problem can be impacted by unorganized temporary site buildings or insufficient number of watchmen available					
Work control	Lacking evaluation of the work budgets, schedules, safety and quality conformity, impact productivity, negatively					
Project closeout	If punch lists/minor works are not identified and effected timely, the damaged portions would dissatisfy the client					
	If substantial completion is not effected it becomes hard to earmark works for rectification					
	If commissioning is not well conducted, completed building components may exhibit malfunctioning					
	Lacking of the final project documentation creates gaps of the knowledge on the next project(s)					

	If warranting is not stated in the contract, contractor may escape from its obligatory role of effecting failed components of the finished structure					
	Lack of conducting project evaluation limits involved parties to understand their benefits or losses					
Critical Interfaces of Construction Management						
Interface	If either of the construction management activities is not checked for completeness, accuracies, the end product dissatisfies the owner					

SECTION THREE:

Indicators are Put in the Italic Form

Table a: Measures to Create Desired (**To-Be**) Design Process

Process categories	Measures	A five point Likert scale was used that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 - agree and 5 – strongly agree to respond to the given statements that defines indicators by putting a tick at a respective cell of	1	2	3	4	5
Critical Inputs							
Critical Inputs	Design team competency	Provide appropriate *design process planning*					
		Provide appropriate *schedule and cost estimate*					
		provide *advice on material selection, availability* and use					
		identify, quantify and *manage risks* in design process performance					
		*share experiences, intellectu*als amongst others, between design specialists					
Critical Design Flows (Activities and Interfaces)							
Design activities and innovativeness	Design value created through design map out	*identify and meet all users requirements*					
		concentrate in *doing each design activity at a time*, thereby, avoiding mistakes or errors					
		ensure a *balanced deployment of resources*					
		conduct *error proofing and conducting self inspection*					
		standardize methods and avoid variations					
	Adoption of IT and BIM technologies	*recording, storing, processing, manipulating and updating* design information					
		applying *database services* to quickly track information or items					
		accessing *Internet* that accelerates design collaboration					

		providing *platform for visualization of the graphics* that facilitate decision making					
		Effecting changes in an *automated way*; thus, creating accuracies in design documentations					
	Constructability	incorporating *constructible ideas* during *design stage* and avoids reworks					
		creating strict restriction on fault work to *progress* to the next phase					
	Design management	*all design participants are well identified* subject to their engagements					
		c*ollaboration* is enhanced by ICT facilities to bring in the dynamic teams					
		designer is responsible to *appoint other consultants* with the *required expertise*					
		design team leader is appointed who *deals with planning, coordinating* etc.					
		design *team adopts process control* that focus on overseeing the completeness of activities					

Table b: Measures to Create Desired (**To-Be**) Procurement Process

Processes categories	Measures	A five point scale was used that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree to respond to the given statements that defined indicators by putting a tick at a respective cell	1	2	3	4	5
Critical Inputs							
Critical Inputs	A conversant and, or, a public client sharing views	gain ideas, or *experience of similar projects* to help understand the current project characteristics					
		gain *knowledge base to discuss and, or share* about *project delivery methods, contract types and procurement methods* to aid decision making					
Critical process flows	**Procurement Activities and their Flows**						
	Project delivery option (DBB, DB or CM)	a broad definition of *uniqueness of the project: complexities*, sizes, location etc.					
		evaluates and deploys his *funds requirements*, and have know how on the trends of his cash – flows					
		knows *speed needs* of his project					
		knows his *pace of needing changes* onto a project					
		is aware of the project impacts caused by *external factors:* politics, social, economy etc.					
		Owner decides on, or not taki*ng risk of employing project manager* to guide him on the project					
		Owners critically evaluate the impacts of the *team communication and collaboration*					

		Owners defines the critically the *work roles of the parties into the project*					
		Owners critically evaluate the *occurrence and avoidance of the adversarial situations*					
		Owners defines and evaluates their i*nvolvemen*t into the project					
	Specific contract type	all work items been well *defined and priced*, this defined a BOQ contract					
		a single total contract sum quoted, either a *BOQ or lump sum contract* may be adopted					
		Know how of the work items is limited, or the work is needed urgently, we usually adopt *schedule of rate contract*					
		On the case where the *cost target is reimbursable*, target cost contract is adopted					
	Specific procurement option	many bidders are allowed to participate, a need is placed to adopt *competition method*					
		When the job is urgent, and competent builder is *known, direct contact approach is useful*					
		Either, a *competition*, *direct*, *negotiation* is adopted					
	IT and BIM technology	*recording, storing, processing, manipulating and updating* information					
		applying d*atabase* to track information quickly					
		accessing *Internet* services, and, for an intended purpose					
		providing a *platform/interface where work processes are visualized*, by all, at the same time					
		Effecting *changes in an automated* way, thus, increasing accuracies and speeding up the work					

Table c: Desired (**To-Be**) Construction Management Process

Processes categories	Measures	A five point scale was used that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree to respond to the given statements that defines indicators by putting a tick at a respective cell	1	2	3	4	5
		Critical Inputs					
Critical Inputs	Contractor competence	provide *site work plans, organize resources* etc. to maximize site productivity					
		manage work *site productivity*					
		accomplish *jobs as per specifications*					
		Enhance work progresses all the time					
		provide ti*mely and accurate services on any emergent event* at the work site(s)					
Critical construction process	Value created through Construction	Contractor's engaging with *each project activity at a time* helps in creating value					
		Using of *resources schedules* help to balance the resource gap against resources needed					
		Site meetings, work records, use of planning techniques help to track work progresses					

flows	activities mapped out	Conducting daily recording in the firms help in curbing claims, thus avoiding chances of disputes					
		Conducting work studies on all works operatives creates work site productivity					
	IT and BIM technologies	*recording, storing, processing and updating information*					
		tracking information or items quickly through the use of *database*					
		accessing *Interne*t, and used meaningfully					
		Effecting changes in an *automated* way, thus, increasing accuracies and speeding up the work					

SECTION FOUR

Strategies for Improvement

Use five point scale that translate: 5 - strongly Agree, 4 – agree, 3 – average, 2 – disagree, 1 – strongly disagree to provide ideas about the attributes of 'strategies of improvement' towards implementation of the BPR/radical change initiatives. Fill in the cells given as may be necessary.

Table 5.6a: Responses on the Attributes of Strategies of Improvement

S/N	The following are strategies to handle weak Identified processes:	1	2	3	4	5
1	Institute continuous learning and benchmarking from best practice firms					
2	Train employees on: on-job training, formal training and allow them participate seminars, etc.					
3	Plan and set funds to manage changes in the firm					
4	Plan to invest, or expand IT and BIM application in the firm					
5	Recruit, retain and recognize manpower competencies					
6	Seek and adopt appropriate emerged management techniques					
7	Conduct in-house training and adopt any major changes in stages to build capability (CMM)					
8	Conduct continuous learning plans					

SECTION FIVE

Facts about usability and functionality of the model

The add-up question was provided, that seeks information on the usability of the developed model.

In your own view, do you think the model improves design, procurement and construction management processes? Give reasons

....
....

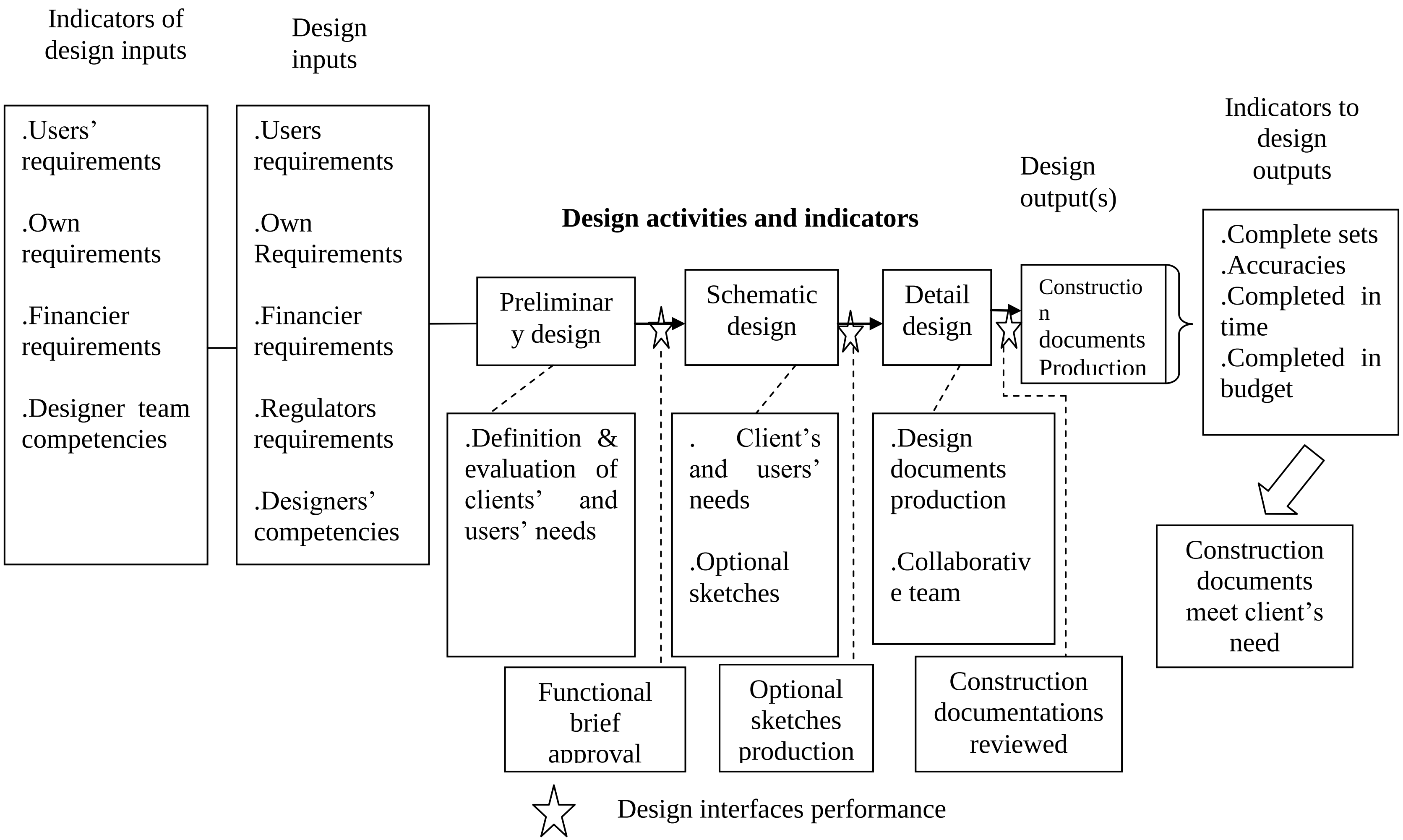


Figure 6A: Mapping out of Design Process Performance

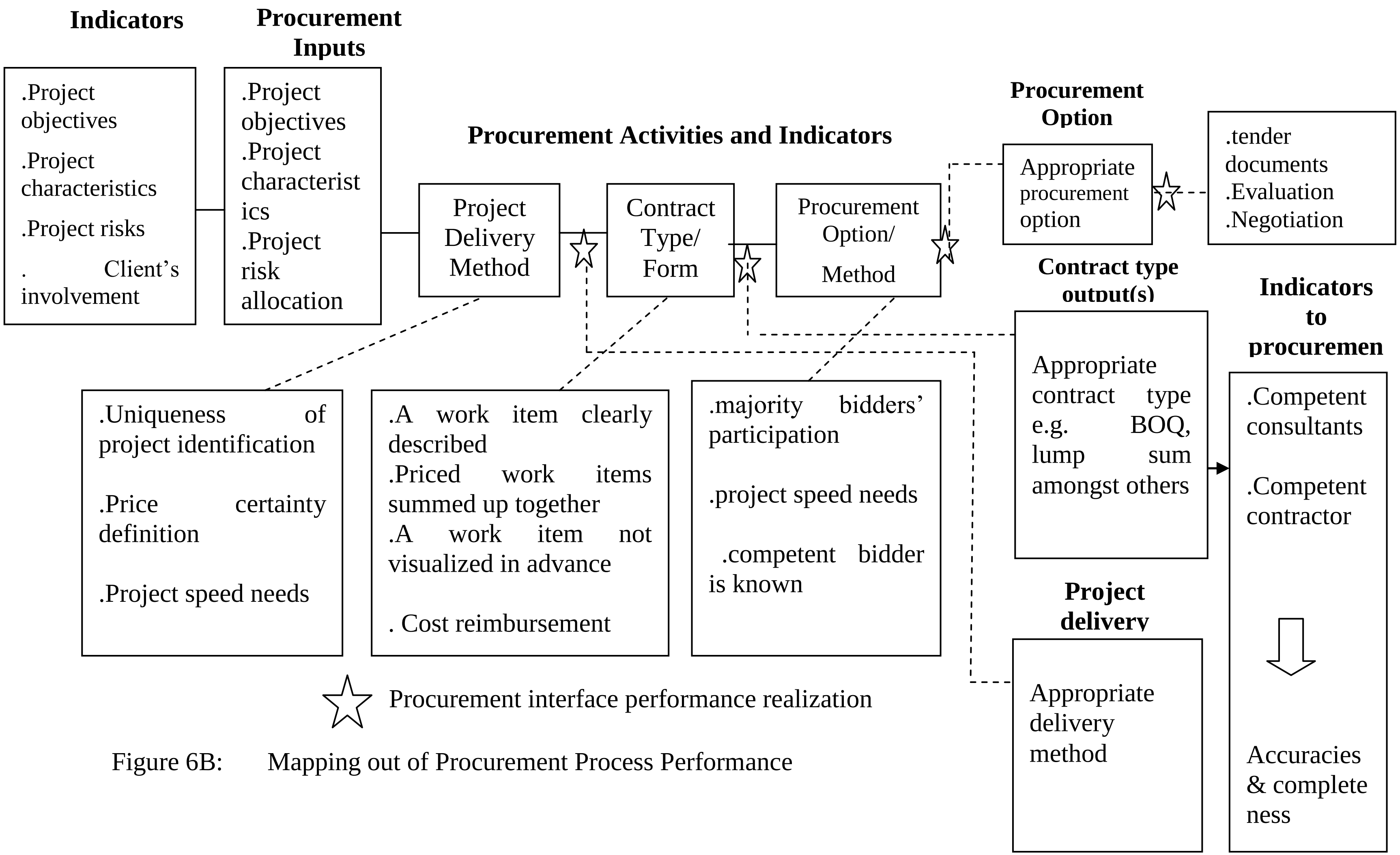


Figure 6B: Mapping out of Procurement Process Performance

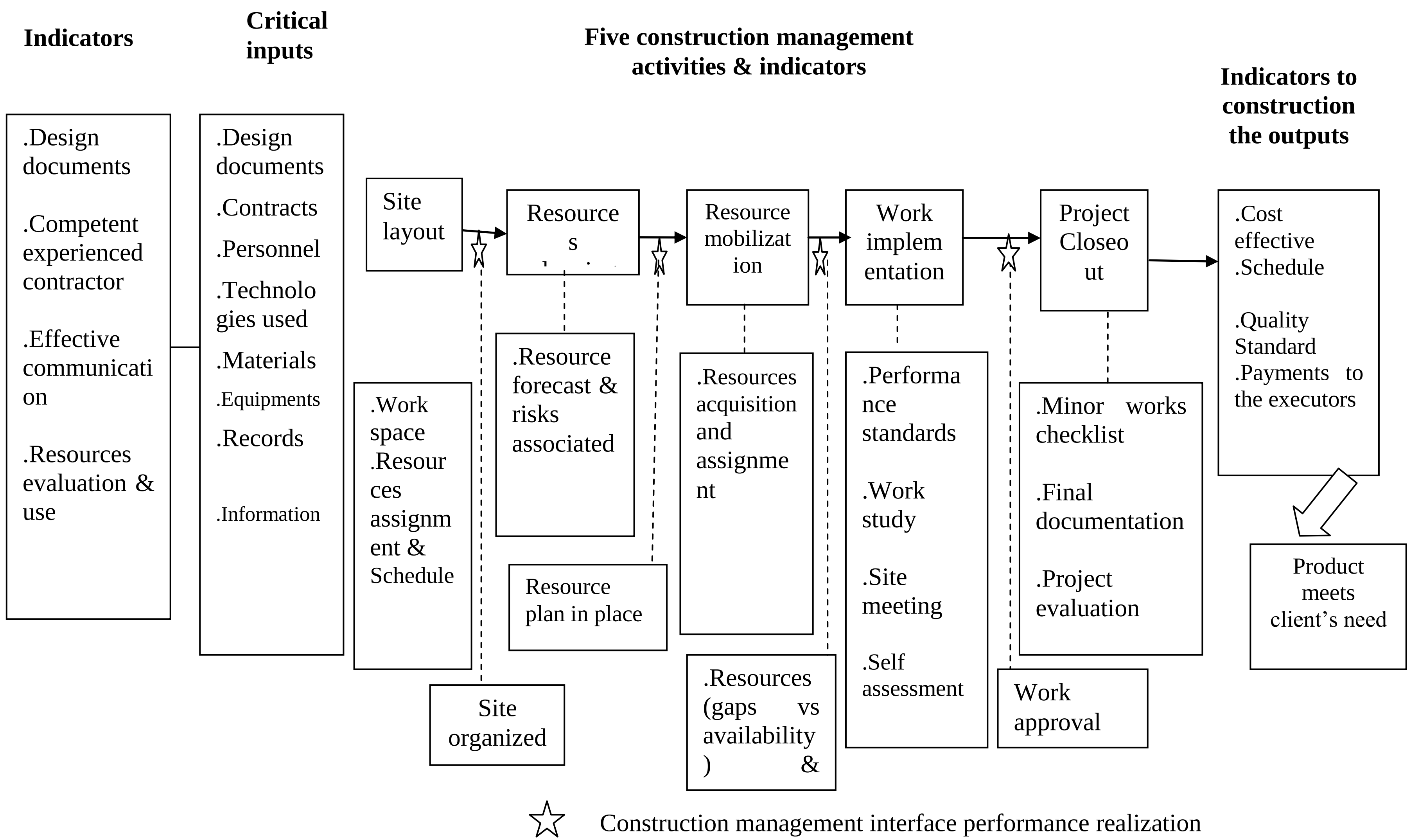


Figure 6C: Mapping out of Construction Management Process Performance

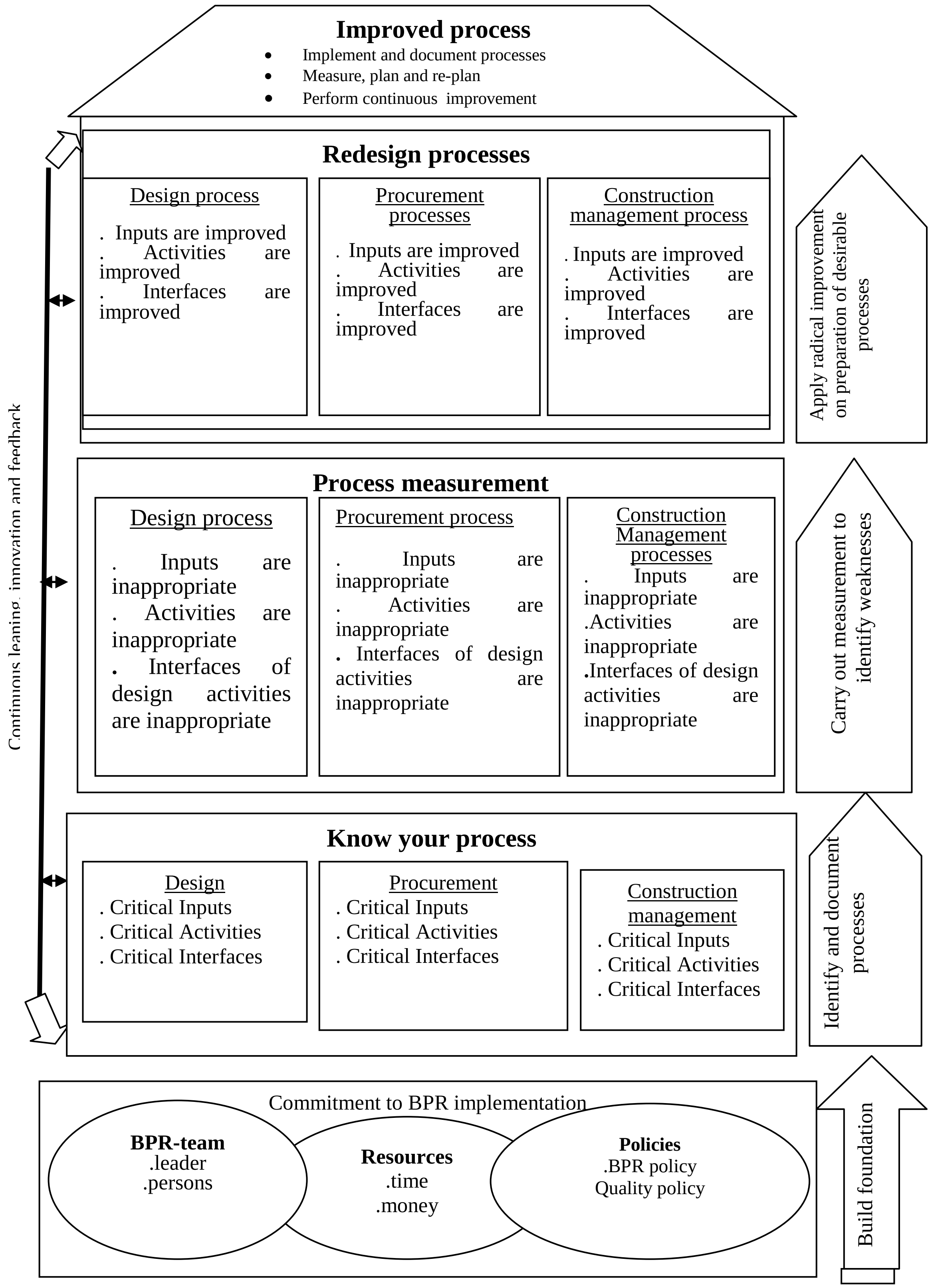


Figure 3.6a: Conceptual BPR Model to Improve Performance of Project

Appendix E

Table 4.1: Computation of Reliability using Pearson-Brown Formula

s/n	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Total X	Total Y	$X-\overline{X}$	$Y-\overline{Y}$	$(X-\overline{X})(Y-\overline{Y})$	$(X-\overline{X})^2$	$(Y-\overline{Y})^2$
1	3	5	5	3	5	3	3	4	4	5	5	4	5	5	3	3	31	33	-5	-4.05	20.25	25	16.4
2	5	5	5	4	5	5	4	5	3	5	5	5	5	3	4	4	36	36	0	-0.05	0	0	0.0025
3	5	3	5	5	5	5	5	5	4	5	5	5	4	5	5	5	38	38	2	1.95	3.9	4	3.8
4	5	5	5	5	4	5	4	4	3	5	5	4	5	5	5	4	34	37	-2	0.95	-1.9	4	0.903
5	5	4	5	5	5	5	5	4	5	3	4	3	5	5	4	4	38	33	2	-3.05	6.1	4	9.3
6	4	5	5	5	5	3	5	4	5	5	5	5	4	5	5	5	38	37	2	0.95	1.9	4	0.903
7	5	3	5	5	5	5	5	5	3	5	5	5	5	5	4	4	37	37	1	0.95	0.95	1	0.903
8	5	5	5	4	5	5	4	3	5	5	4	5	5	5	5	5	38	37	2	0.95	1.9	4	0.903
9	5	5	5	5	4	5	5	4	3	5	3	4	5	5	3	3	38	36	2	-0.05	-0.1	4	0.0025
10	4	4	2	5	4	3	4	4	5	4	5	5	4	3	5	4	34	32	-2	-4.05	8.1	4	16.4
11	5	5	5	5	5	5	4	5	5	5	5	3	3	5	5	4	37	37	1	2.95	0.95	1	0.903
12	5	5	5	5	5	4	4	4	4	5	4	5	5	5	4	3	36	36	0	-0.05	-0.05	0	0.0025
13	5	3	4	4	5	5	4	4	4	5	5	4	5	4	3	4	33	33	-3	-3.05	9.15	9	9.3
14	4	5	5	3	3	3	4	4	4	3	3	5	5	5	4	5	34	33	-2	-3.05	6.1	4	9.3
15	5	5	5	5	5	5	4	5	5	3	5	4	4	5	4	4	37	36	1	-0.05	-0.05	1	0.0025
15	5	4	5	5	5	5	5	4	4	5	4	4	5	4	5	5	37	36	1	-0.05	-0.05	1	0.0025
17	5	5	5	5	5	4	4	5	4	4	5	5	3	5	4	5	33	37	-3	0.95	-2.85	9	0.903
18	5	5	5	5	3	5	4	4	4	3	3	5	5	5	5	4	35	36	-1	-0.05	0.05	1	0.0025
19	4	5	5	4	5	3	5	4	4	5	5	5	5	5	5	4	38	35	2	-1.05	-2.1	4	1.1025
20	5	5	2	3	5	5	4	5	3	4	3	4	5	5	5	5	33	36	-3	-0.05	0.15	9	0.025
21	5	5	5	5	3	5	5	4	4	4	4	5	3	5	4	4	34	37	-2	0.95	-1.9	4	0.903
22	5	5	5	5	5	5	4	4	4	3	5	5	5	5	5	5	37	37	1	0.95	0.95	1	0.903
23	5	5	4	5	5	4	5	5	4	5	5	4	5	5	4	4	37	37	1	0.95	0.95	1	0.903
24	5	5	5	4	4	5	4	4	5	4	4	5	5	5	5	5	38	38	2	1.95	3.9	4	3.8
25	5	5	5	5	5	5	4	5	4	5	5	5	5	5	4	4	37	39	1	2.95	2.95	1	8.703
26	5	5	5	5	5	5	5	4	4	5	4	5	5	5	5	5	38	39	2	2.95	5.9	4	8.703
																	$\overline{X}$ **=36**	$\overline{Y}$ - **36.05**	-	-	**68.15**	**108**	**94.98**

$$r = \frac{2r_i}{1+r_i}$$ ……………………………………………………………Equation 4.1

Where: r_i = is correlation between the half tests, further calculated with Equation 4.2, and r = is the reliability projected for the test/scale,

$$r_i = \frac{\sum\left(x-\bar{x}\right)\left(y-\bar{y}\right)}{\sqrt{\sum\left(x-\bar{x}\right)^2\left(y-\bar{y}\right)^2}}$$ ……………….……………………………….....Equation 4.2

$\overline{X}$ = mean for values of odd items; $\overline{Y}$ = mean for values of even items; X =sum for each odd values and Y = sums of each even values.

r_i = 68.15/101.20; r = 2 X 0.674/1+0.674 = 0.8061; therefore, Reliability correlation equal = **0.81**

Appendix F

Introduction Letter and a Data collection Protocol For a Case Study (for Model Validation)

Introduction letter to the firms during case study of a road project in Mbeya city

Yazidi H. B. Mwishwa,
Mbeya University of Science and Technology,
Box 131, MUST,
Date: 27st January, 2014.
MOB. 0655-789425/0757-432581.

Managing Director,
Tanzania Roads Agency (TANROADS),
P. O. BOX.......**Mbeya.**

U.f.s,
The Head of Civil Engineering Department,
Mbeya University of Science and Technology,
P.O. Box 131, **Mbeya.**

Forwarded. Your assistance is appreciated
HoD CIVIL DEPT

THE HEAD
DEPARTMENT OF CIVIL ENGINEERING
MBEYA INSTITUTE OF SCIENCE
AND TECHNOLOGY
P. O. Box 131, MBEYA

RE: REQUEST OF INFORMATION ABOUT AN ONGOING CONSTRUCTION PROJECT WITHIN YOUR CONSTRUCTION SITE, AND, INTRODUCING ME TO THE PRATIES INVOLVED IN THE SAME PROJECT (CONRACTOR & CONSULTANT) IN ORDER TO AID IN MY THESIS STUDIES AT THE UNIVERSITY OF DAR ES SALAAM

The above heading refers.

I am a PhD student at the University of Dar es salaam and an employee of Mbeya University of Science and Technology. This is the time, proximity to finalize my studies at the UDSM, on which case; I am seeking construction project information to justify the developed model of my study. With the time I continue with this task, I am also engaging with my employee's responsibilities; that is why I sought/used his authority that introduces me to your good office.

The study's aim seeks information from stakeholders of three parties to a project, and, for an ongoing construction project. With this aim, I request that you allow me to participate on site, observing the work processes and discussing with the employees and the site agent. Seeking information in that way, I also request that you introduce me to a contractor and a consultant that engage with the same project because the aim is get full ideas of an overall project.

I feel that a Mbeya - Chunya road work project can be appropriate.

I hope my request will be considered favourably,

Thank you,

YHBmwishwa
....
Yazidi H. B. Mwishwa.

Case Study Data Collection Protocol, Divided into Four Sections; Section One - Four

Section One

Use indicators to measure critical inputs, critical activities, and critical interfaces of construction management process to identify weaknesses.

Table 1.1: Guidance to using indicators that measure critical inputs, critical activities, and critical interfaces of construction management process to identify weaknesses

Indicators and descriptions	wea knes ses
Inputs	
-design documents: -contract: -technology used: users' needs not classified and identified -manpower involved: qualified, overloaded, do not follow specification etc.	
Activities	
Selected activity was studied if it is unclear/poor recording of the work, non-on-time study delivery and non-on-budget study delivery	
Interfaces	
Work task's relationships and approval – not related tasks, approval problems	

Section two: Risk Management

Table 1.2: Risk Management Adoption

Risk management template – availability, firm's awareness, necessities and impacts	
Risk management – firms awareness	
Risk management adoption – two selected activities and studied if identify weaknesses or improvement	

Section three: Adoption of IT Technology

IT facilities were studied on their use by the firm when accomplishing construction management process to identify weaknesses and desired (To Be) processes

Table 1.4: IT Protocol used on the Study

s/n	Measuring IT use	Search questions of use of IT	Methods employed
1	Using computers to: record, store, update and present information	The extents of using IT	-Narrative -Interview -Documentary review -observation
2	Printing and photocopying services		
3	Using database		
4	Using Email and Internet		

Appendix G

Holistic list of Indicators that Improve Project Processes

Three terms, input, activity and interface are defined to guide understand their practices on processes of the project.

Input: is anything required to influence process performance
Activity: is act of doing something
Interface: is a point that link information between two tasks or activities

Table 1: Indicators that Improve Design Inputs, Activities and Interfaces

Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure design inputs. NS is put to indicate not sure		√	X	Not sure
Proposed indicators	Client's and users' needs			
	Designers ideas and design needs			
	Financial requirement			
	Qualification and experience			
	Expertise availability			
	Design requirements			
Put either, a tick (√) to accept or, a cross (x) to disagree on whether the proposed indicators measure design activities. NS is put to indicate not sure				
Preliminary design- focuses on achieving functional brief	Describing design ***activities***			
	Identifying the u***ser groups and specific needs***			
Schematic design	Preparation of ***work sketches***			
	Designers ***solicit more information on client and users*** needs			
Detail design	Designers ***evaluating the outputs of detail design***			
	Designers studying the ***collaborative efforts***			
	Designers teams involvement			NS
Put either, a tick (√) to accept or, a cross (x) to disagree on whether the proposed indicators measure design interfaces. NS is put to indicate not sure				
Reviewed activities issues	Engaging with ***reviewing processes***			
	Establishes of the ***design milestones***			
	C***lient conducting approves***			
	Restricting fault jobs to proceed to the next levels			
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure procurement inputs. NS is put to indicate not sure				

Conversant client	Use conversant client			
Project objectives	Project objectives e.g. of budget needs, speed needs etc.			
Project characteristics	Project characteristics, e.g. uniqueness, complexity etc.			
Procurement risks	Procurement risk, e.g. what aspects create project delays?			
Project participants	Project participants' involvement		X	
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure procurement activities. NS is put to indicate not sure				
Activities: Project delivery option	Identifying and defining the project delivery options			
Contract type	Identifying and defining the contract types			
Procurement method	Identifying and defining the procurement methods			
Tender processes	Identifying and defining tender advertisement, evaluation and negotiation			
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure procurement interfaces. NS is put to indicate not sure				
Procurement activities, options and contract types	Procurement activities, options and contract types are evaluated and defined			
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure construction management inputs. NS is put to indicate not sure				
Qualified/competent contractor	Competent contractor			
Design documents	Design documents			
Contractual	Meeting Contractual needs			
Expertise availability	Expertise availability			
	Client availability			NS
Work loads	workloads			
Work records	site records lower			
Information flows	Information flows			
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure construction management activities. NS is put to indicate not sure				

Site layout	*Site space needs*			NS
	Resources organization			NS
	Temporary structures			NS
R**esources** planning	*resources types, categories and numbers*			
	schedule			NS
Resources mobilization	*resources utilization plan*			
	resource requirements			
Implementation	W*ork decomposition*			
	Resources deliveries and use			
	Work in teams			NS
	S*ite security*			
Project closeout	P*unch list/minor work*		X	
	S*ubstantial completion*			NS
	C*ommissioning*			
	Final documentation			NS
	Warranting – rectify failed components of the structure			NS
	P***roject evaluation***			
Work control	B***udget, schedule, safety and quality conformity***			
	Working environment		x	
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure construction management interfaces. NS is put to indicate not sure				
Construction management interface	Construction management activities are checked for completeness, accuracies, etc.			
Total indicators of use to identify weaknesses			55	

** Fifty five indicators prepared from review works

Table 2: Indicators that improve Critical Inputs, Critical Activities and Critical Interfaces of Project Processes

Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators improve design inputs. NS is put to indicate not sure		Results	Number	Total
Proposed indicators	Client's and users' needs	√		
	Designers ideas and design needs	√		
	Financial requirement	√	6	
	Qualification and experience	√		
	Expertise availability	√		
	Design requirements	√		
Put either, a tick (√) to accept or, a cross (x) to disagree on whether the proposed indicators measure design activities. NS is put to indicate not sure				
Preliminary design- focuses on achieving functional brief	Describing design ***activities***	√		
	Identifying the u***ser groups and specific needs***	√		
Schematic design	Preparation of ***work sketches***	√	6	16
	Designers ***solicit more information on client and users*** needs	√		
Detail design	Designers ***evaluating the outputs of detail design***	√		
	Designers studying the ***collaborative efforts***	√		
Put either, a tick (√) to accept or, a cross (x) to disagree on whether the proposed indicators measure design interfaces. NS is put to indicate not sure				
Reviewed activities issues	Engaging with ***reviewing processes***	√		
	Establishes of the ***design milestones***	√	4	
	C***lient conducting approves***	√		
	Restricting fault jobs to proceed to the next levels	√		
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure procurement inputs. NS is put to indicate not sure				
Conversant client	Use conversant client	√		
Project objectives	Project objectives e.g. of budget needs, speed needs etc.	√		
Project characteristics	Project characteristics, e.g. uniqueness, complexity etc.	√	4	
Procurement risks	Procurement risk, e.g. why a project may delay?	√		
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure procurement activities. NS is put to indicate not sure				
Activities: Project delivery option	Identifying and defining the project delivery options	√		
Contract type	Identifying and defining the contract types	√	4	
Procurement method	Identifying and defining the procurement methods	√		9
Tender processes	Identifying and defining tender advertisement, evaluation and negotiation	√		
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure procurement interfaces. NS is put to indicate not sure				
Procurement activities, options and contract types	Procurement activities, options and contract types are evaluated and defined	√	1	

Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure construction management inputs. NS is put to indicate not sure				15
Qualified/competent contractor	Competent contractor	√	6	
Design documents	design documents	√		
Contractual	Meeting Contractual needs	√		
Expertise availability	Expertise availability	√		
Work records	site records adoption	√		
Information flows	Information flows	√		
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure construction management activities. NS is put to indicate not sure				
Site layout	***Site space needs***	√	8	
	Resources organization	√		
	Temporary structures	√		
R**esources** planning	***resources types, categories and numbers***	√		
	schedule	√		
Resources mobilization	***resources utilization plan***	√		
	resource requirements	√		
Implementation	W***ork decomposition***	√		
	Resources deliveries and use	√		
	S***ite security***	√		
Project closeout	P***unch list/minor work***	√		
	S***ubstantial completion***	√		
	C***ommissioning***	√		
	Final documentation	√		
	Warranting –continuing effecting rectifying failed components of the structure	√		
	P***roject evaluation***	√		
Work control	Checking for ***budget, schedule, safety and quality conformity***	√		
Put either, a tick (√) to agree or, a cross (x) to disagree on whether the proposed indicators measure construction management interfaces. NS is put to indicate not sure				
Interface of construction management	Construction management activities are checked for completeness, accuracies, etc.	√	1	
Total indicators of use to identify weaknesses				**40**

Three indicators were responded on X remark, twelve indicators were NS, not sure). Total of fifteen indicators were not considered in the study.

Appendix H

Findings from Interview and Questionnaire Survey

Table 5.3a: Responses on the Attributes 'BPR Foundation'

Model Step one	Attributes	Questions/statements	Likert Scale Rating and Responses					∑(S*F)/N	Average ratings
			1	2	3	4	5		
Built BPR foundation	Leadership and team	Appoint a person to lead and manage the changes	0.0	0.0	0.0	3	30	4.9	4.85
		Appoint appropriate team to champion and enable the changes to happen	0.0	0.0	1	3	29	4.8	
	Resources	Avails adequate resources to support change process	0.0	0.0	2	6	25	4.7	4.7
		Institute programmes to change culture of employees	0.0	0.0	0.0	7	26	4.7	
		Uses a consultant (where necessary) to lead revolutionary change	0.0	0.0	4	5	24	4.6	
	Policies deployment	Formulate and adequately communicate appropriate change policies	0.0	0.0	1	6	26	4.7	4.7
		Establishes programmes to train employees	0.0	0.0	**0.0**	4	29	4.8	
		Ensures all employees are aware and ready of the planned changes	0.0	0.0	4	7	22	4.5	
	Average BPR Foundation Elements ratings		**-**	**-**	**-**	**-**	**-**	**-**	**4.75**

Indicator to Identify Weakness

DESIGN PROCESS WEAKNESSES							
Indicators	Use likert scale translating: 1 –strongly disagree, 2 – disagree, 3 agree, 4 – agree and 5 strongly agree to respond into the following statements	1	2	3	4	5	∑(S*F)/N
Critical Design Inputs							
Users' requirements	Client's and users' requirements inadequately evaluated by the consultants create more chances of reworking	0	0	1	4	21	**4.76**
Designers ideas and design needs	If designers' ideas and design needs are not well identified and evaluated, they contribute to poor design results	0	0	3	3	20	4.65
Financial requirement	Inability to evaluate project financial need by the client contribute to project delays, or even disputes	0	0	2	2	22	4.76
Qualification and experience	In experienced design expertise contributes to inadequate design documentation	0	0	3	5	18	4.57
Expertise availability	Un-availability or absence of the designers expertise contributes into inaccuracies design documentation(s)	0	0	3	4	19	4.61
Design requirements	If design requirements (e.g. codes, rules etc.) are not adhered to during design process, this increases chances of reworks	0	0	5	3	18	4.61
Total		-	-				
Total Average scores of 4 and 5		**0.91**					
Critical Activities of Design Process							
Preliminary design- focuses on achieving functional brief	If design activities are not well described, a common goal will be missed by all design team members	0	0	1	17	8	4.52
	If user groups and their needs are not identified and recorded, poor functional brief would prevail	0	0	1	16	9	4.30
Schematic design Checks production of option sketches status	If work sketches are not prepared and deployed, one sketch option of use enlarges the chances for reworks	0	0	4	16	6	**4.07**
		0	0	4	6	16	4.46
	If a single sketch option is adopted, it would limit client on available options, causing dissatisfaction	0	0	4	6	16	4.46
Detail design	If the outputs of the detail design is not forecasted early-on, e.g. inaccurate design or non constructible documents, would be produced	0	0	2	8	16	4.53
	If collaborative effort is inappropriate during design, lack of sharing views between designers impact the overall design results	0	0	3	4	19	**4.61**
Total Average scores of 4 and 5							
Critical Design Interfaces							
	If review/constructability process is not effected during design stage, errors, mistakes in documentations would be	0	0	1	6	19	4.69

Reviewed activities issues	generated						
	If interfaces between design activities are not well identified and linked, this may create delays in later design activities	0	0	2	2	22	**4.77**
	If design milestones are not prepared, new design phase would be hardly be prepared and commenced	0	0	3	10	13	4.38
	If client approves fault designs, this would result into reworking during actual construction	0	0	3	13	10	**4.26**

PROCUREMENT PROCESS WEAKNESSES							
Critical Inputs of Procurement							
Indicators	Description/statement	1	2	3	4	5	
Conversant client	Client who is not conversant with the project is likely interfere project decision making	0	0	5	18	10	4.15
Project objectives	If project objectives (e.g. of budget needs, speed needs are not well evaluated, project progresses and results would be impacted, negatively	0	0	2	25	6	**4.12**
Project characteristics	If project characteristics, e.g. uniqueness of project, complexity etc. are not well evaluated incompetent builder, or poor contract can be prepared	0	0	2	26	5	4.15
Procurement risks	If procurement risk is not well evaluated, project delay is likely to occur	0	0	6	12	15	**4.27**
Critical Activities of Procurement							
Elements: Project delivery option	If clients fail to evaluate: project characteristics, his changes needs, speed needs of the project, budget issues etc. this impact his selection of appropriate project delivery method	0	0	17	13	3	**3.57**
Contract type	If clients fail to evaluate and categorize works in the itemized form, in a schedule of rate, lump sum, etc. appropriate contract type will be missed	0	0	15	13	5	3.70
Procurement method	If clients fail to evaluate work contract works right procurement option would be missed	0	0	4	9	20	**4.48**
Procurement activities	If procurement activities are not be well evaluated by a client, this contributes to obtaining incompetent builder	0	0	6	9	18	4.36
Critical Interfaces of Procurement							
Interface	If either of the procurement activities is not checked for completeness, accuracies, the end product dissatisfies the owner	0	0	3	11	19	4.48
Total Average Scores of 4 and 5							
CONSTRUCTION MANAGEMENT PROCESS WEAKNESSES							
Critical Inputs of Construction Management							
Competent contractor	Incompetent contractor contribute enormously in creating fault product	0	0	3	16	14	4.33
Design documents	Incomplete design documents have wider chances to contribute into work delays or even disputes	0	0	3	15	15	4.27
Contractual	If fairness in the contract is not established, disputes would be created	0	0	2	15	16	**4.42**
Expertise availability	un-availability of a qualified contractor contributes into inaccurate construction work	0	0	7	9	17	4.30

Work records	Inappropriate actual site records create chances of disputes	0	0	9	7	17	4.24
Information flows	In effective information flows in the site lower productivity levels	0	0	10	10	13	**4.09**
Critical Activities of Construction Management							
Site layout	*Site space needs* not well planned create chances of accident	0	0	5	8	20	4.45
	Resources not well *organized* in the work site create chances of lowering site productivity	0	0	8	8	17	4.27
	Temporary structures not well secured may slow down site work operative	0	0	7	5	21	4.42
R**esources** planning	Unavailability of a checklist of resources in type categories impacts productivity	0	0	3	10	20	4.51
	Unavailability or, not using the schedule that explore resources requirements: type, category and number has affects in site productivity	0	0	4	9	20	4.48
Resources mobilization	Lacking of the resources utilization plan, appropriate resources would not be acquired	0	0	2	8	23	**4.87**
	Missing a checklist of resources in numbers, their effective acquisition would not be realized	0	0	1	15	17	4.48
Implementation	Lacking of decomposition work impact clarity of the works	0	0	5	15	13	4.25
	If resources, e.g. material, equipments are not properly checked for: deliveries use, recorded, etc. actual work would not happen	0	0	0	13	18	4.30
	job site security problem can be impacted by unorganized temporary site buildings or insufficient number of watchmen available	0	0	9	7	17	**4.24**
Work control	Lacking evaluation of the work budgets, schedules, safety and quality conformity, impact productivity, negatively	0	0	3	13	16	4.27
Project closeout	If punch lists/minor works are not identified and effected timely, the damaged portions would dissatisfy the client	0	0	5	7	21	4.48
	If substantial completion is not effected it becomes hard to earmark works for rectification	0	0	3	5	25	4.67
	If commissioning is not well conducted, completed building components may exhibit malfunctioning	0	0	9	6	18	4.27
	Lacking of the final project documentation creates gaps of the knowledge on the next project(s)	0	0	5	6	22	4.51
	If warranting is not stated in the contract, contractor may escape from its obligatory role of effecting failed components of the finished structure	0	0	4	4	25	4.54
	Lack of conducting project evaluation limits involved parties to understand their benefits or losses	0	0	6	6	21	4.36
Critical Interfaces of Construction Management							
Interface	If either of the construction management activities is not checked for completeness, accuracies, the end product dissatisfies the owner	0	0	4	9	20	**4.48**

Section Three:

Table 1: Measures to identify Desired (To-Be) Design Process

Process categories	Measures	Five point scale on **measures** that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 - agree and 5 – strongly agree	1	2	3	4	5	Average ratings
Critical Inputs								
Critical Inputs	Design team competency	provide appropriate *design process planning*	0	0	5	15	6	4.04
		provide appropriate *schedule and cost estimate*	0	0	5	14	7	4.07
		provide *advice on material selection*, *availability* and use	0	0	5	16	5	4.00
		identify, quantify and *manage risks* in design process performance	0	0	0	13	7	**4.53**
		share experiences, *intellectu*als amongst others, between design specialists	0	0	8	13	5	3.88
Critical design Flows (activities and interfaces)								
Design activities and innovativeness	Design value created through design map out	*identify and meet all users requirements*	0	0	4	9	13	4.34
		concentrate in *doing each design activity at a time*, thereby, avoiding mistakes or errors	0	0	7	11	8	4.04
		ensure a *balanced deployment of resources*	0	0	4	13	9	4.19
		conduct *error proofing and conducting self inspection*	0	0	5	14	7	4.07
		standardize methods and avoid variations	0	0	0	13	11	4.34
	IT and BIM technology adoption	*recording, storing, processing, manipulating and updating* design information	0	0	7	9	10	4.11
		applying *database services* to quickly track information or items	0	0	6	13	7	4.08
		accessing *Internet* that accelerates design collaboration	0	0	4	11	11	4.27
		providing *platform for visualization of the graphics* that facilitate decision making	0	0	5	11	10	4.19
		Effecting changes in an *automated way*; thus, creating accuracies in design documentations	0	0	1	13	12	**4.42**
	Deploy constructability	incorporating *constructible ideas* during *design stage* and avoids reworks	0	0	2	8	15	4.34
		creating strict restriction on fault work to *progress* to the next phase	0	0	6	9	11	**3.74**
	Design management	*all design participants are well identified* subject to their engagements	0	0	3	10	13	3.85
		c*ollaboration* is enhanced by ICT facilities to bring in the dynamic teams	0	0	6	11	9	4.11
		designer is responsible to *appoint other consultants* with the *required expertise*	0	0	3	11	12	4.34

		design team leader is appointed who *deals with planning, coordinating* etc.	0	0	4	9	13	4.05
		design *team adopts process control* that focus on overseeing the completeness of activities			5	11	10	4.19

Table 2: Measures to identify Desired (To-Be) Procurement Process

Processes categories	Measures	Five point scale of measures that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree	1	2	3	4	5	Average ratings
Critical Inputs								
Critical Inputs	A conversant, and, or, public client shared views	offer *experience of similar projects* to help understanding the project components	0	0	5	13	15	4.30
		establish a *knowledge base to discuss and share* about *project delivery methods, contract types and procurement methods* to aid decision on their use	0	0	4	14	15	**3.88**
Critical process flows	**Procurement Activities and their Flows**							
	Project delivery option (DBB, DB or CM)	is acquainted with a broad definition of *uniqueness of the project: complexities,* sizes, location etc.	0	0	4	13	16	4.36
		evaluates and deploys his *funds requirements*, and have know how on the trends of his cash – flows	0	0	9	11	13	4.12
		knows *speed needs* of his project	0	0	5	10	18	4.39
		knows his *pace of needing changes* onto a project	0	0	9	11	13	4.12
		is aware of the project impacts caused by *external factors:* politics, social, economy etc.	0	0	5	8	20	4.45
		Owner decides on, or not taki*ng risk of employing project manager* to guide him on the project	0	0	4	7	22	4.36
		Owners critically evaluate the impacts of the *team communication and collaboration*	0	0	6	14	13	4.21
		Owners defines the critically the *work roles of the parties into the project*	0	0	5	13	15	4.30
		Owners critically evaluate the *occurrence and avoidance of the adversarial situations*	0	0	3	12	17	4.31
		Owners defines and evaluates their i*nvolvemen*t into the project	0	0	4	13	16	4.36
	Specific contract type	all work items been well *defined and priced*, this defined a BOQ contract	0	0	5	13	15	4.30
		a single total contract sum quoted, either a *BOQ or lump sum contract* may be adopted	0	0	4	12	17	4.39
		Know how of the work items is limited, or the work is needed urgently, we usually adopt *schedule of rate contract*	0	0	5	12	16	4.33
		On the case where the *cost target is reimbursable*, target cost contract is adopted	0	0	2	9	22	**4.60**
	Specific	many bidders are allowed to participate, a	0	0	3	1	16	4.51

	procurement option	need is placed to adopt *competition method*				5		
		When the job is urgent, and competent builder is *known, direct contact approach is useful*	0	0	4	15	14	4.30
		Either, a *competition, direct, negotiation* is adopted	0	0	3	14	16	4.6
	Adopting IT and BIM technology	*recording, storing, processing, manipulating and updating* information	0	0	6	14	13	4.21
		applying d*atabase* to track information quickly	0	0	5	14	14	4.27
		accessing *Internet* services, and, for an intended purpose	0	0	3	13	17	4.42
		providing a *platform/interface where work processes are visualized,* by all, at the same time	0	0	8	13	12	4.12
		Effecting *changes in an automated* way, thus, increasing accuracies and speeding up the work	0	0	3	15	15	4.36

Table 3: Measures to identify Desired (To-Be) Construction Management Process

Processes categories	Clustered Indicator	Five point scale of measures that translates: 1– strongly disagree, 2 – disagree, 3 – average, 4 – agree and 5 – strongly agree	1	2	3	4	5	Average rating
Critical inputs								
Critical Inputs	Contractor Competency	provide *site work plans, organize resources* etc. to maximize site productivity	0	0	7	18	8	**4.03**
		managing work *site productivity*	0	0	5	18	10	4.15
		accomplish *jobs as per specifications*	0	0	6	16	11	4.18
		Enhance work progresses all the time	0	0	6	16	11	4.09
		provide ti*mely and accurate services on any emergent event* at the work site(s) (S and H measures)	0	0	2	18	13	4.33
Construction Management Activities and Interfaces								
Critical construction process flows	Value created through construction management activities map out	Contractor's engaging with *each project activity at a time* helps in creating value	0	0	5	13	15	4.30
		Using of *resources schedules* help to balance the resource gap against resources needed	0	0	4	11	18	4.12
		Site meetings, work records, use of planning techniques help to track work progresses	0	0	6	14	13	4.39
		Conducting daily recording in the firms help in curbing claims, thus avoiding chances of disputes	0	0	5	15	13	4.23
		Conducting work studies on all works operatives creates work site productivity	0	0	4	15	14	4.3
	IT and BIM technology	*recording, storing, processing and updating information*	0	0	4	14	15	4.33
		tracking information or items quickly through the use of *database*	0	0	5	14	14	4.27

		accessing *Internet*, and used meaningfully	0	0	3	14	15	4.24
		Effecting changes in an *automated* way, thus, increasing accuracies and speeding up the work	0	0	6	11	16	**4.48**

Section Four

Table 5: Responses on the Attributes of Strategies of Improvement

S/N	The following are strategies to handle weak Identified processes:	1	2	3	4	5	Average ratings
1	Institute continuous learning and benchmarking from best practice firms	-	-	2	4	27	4.76
2	Train employees on: on-job training, formal training and allow them participate seminars, etc.	-	-	2	4	27	4.76
3	Plan and set funds to manage changes in the firm	-	-	2	6	25	4.73
4	Plan to invest, or expand IT and BIM application in the firm	-	-	1	3	29	4.84
5	Recruit, retain and recognize manpower competencies	-	-	2	6	25	4.73
6	Seek and adopt appropriate emerged management techniques	-	-	3	6	24	4.69
7	Conduct in-house training and adopt any major changes in stages to build capability (CMM)	-	-	2	2	29	4.82
8	Conduct continuous learning plans	-	-	2	3	28	4.78

Section Five

Facts About Usability and Functionality of the Model

The add-up question was provided, that seeks information on the usability of the developed model.

In your own view, do you think the model improves design, procurement and construction management processes? Give reasons…………………………………
....

Appendix I

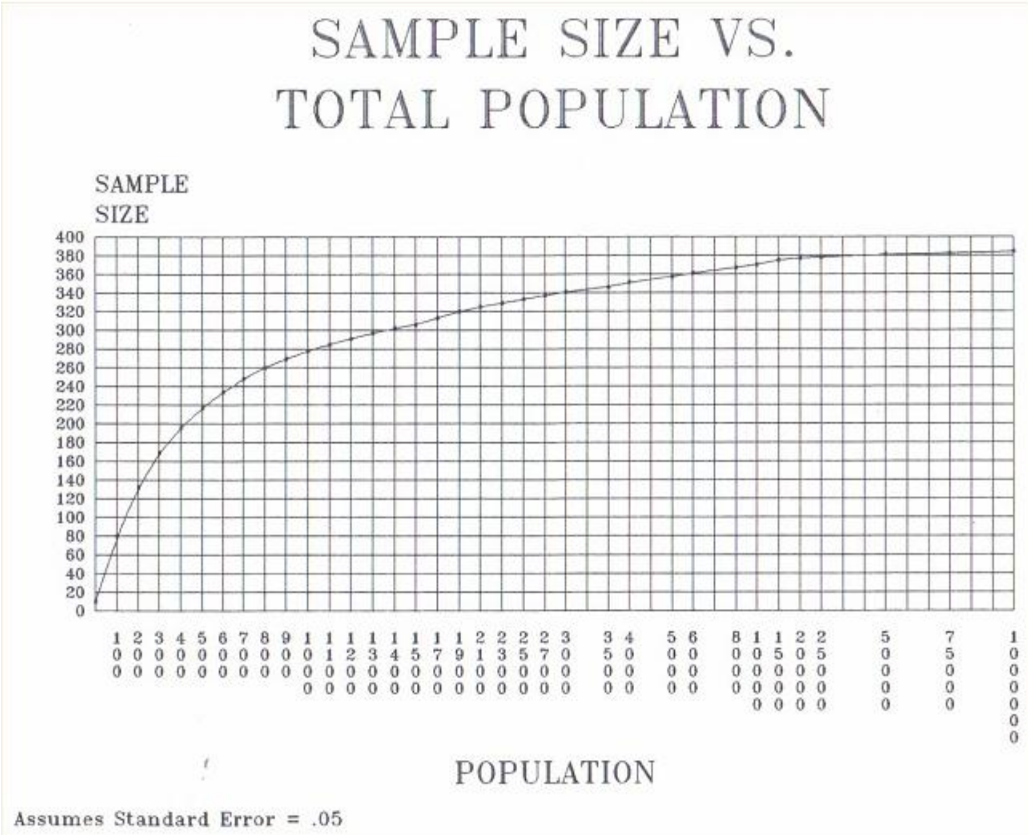
A Table and a Graph to Determine the Sample Sizes

TABLE 1

Table for Determining Sample Size from a Given Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size.
S is sample size.



[Sources: Krejciea and Morgan (1970)]

Appendix J

Yazidi H.B. Mwishwa
P.O.Box 131, MUST,
Mbeya.
27th October, 2018.

Regional Administrative Secretary (RAS),
Mbeya Region,
P.O. ……………
Mbeya.

u.f.s

HEAD OF DEPARTMENT
BUILT ENVIRONMENT ENGINEERING
COLLEGE OF ENGINEERING AND TECHNOLOGY
MBEYA UNIVERSITY OF SCIENCE AND TECHNOLOGY

Head of Department, – Forwarded for Consideration
Build Environment, – Mr. Yazidi is employ of MUST working
P.O Box 131, Mbeya University of Science and Technology (MUST),
Mbeya. as lecturer in Dept. of Built Environment.
19/11/2018

Re: **Introducing me to the Regional Administrative Secretary Office for Support of Research Data that helps to Finalize Model Validation of my PhD thesis at the UDSM**

Dear Sir/Madam:

Refer the above heading is concerned.

I am an employee of Mbeya University of Science and Technology working in the Department of Built Environment. I am also conducting my PhD studies at the University of Dar es salaam within the Department of Structural and Construction Engineering.

My PhD thesis is titled 'Development of Business Process Reengineering Model for Improving Project Performance in Tanzania'. The study has now reached the final stage, (Viva Voce examination already presented), and had demanded additional data to finalize validation of the model developed. The data relates to some project cycle phases such as: conception and briefing, designing, tendering, construction etc.

I wish to let you know that the 'the data obtained will be used strictly for academic purpose only. Therefore, your support is highly appreciated.

Thank you for your support,

YHB
……………………………………………
Yazidi. H. B. Mwishwa.
UDSM student/MUST staff

Yazidi H.B. Mwishwa
P.O.Box 131, MUST,
Mbeya.
27th October, 2018.

To whom it may concern (representative stakeholder in the construction industry),

u.f.s

Head of Department, – Forwarded for consideration. Mr. Yazidi is employ of MUST working as a lecturer in Dept. of built Environment
Build Environment,
P.O Box 131, MUST,
Mbeya.

HEAD OF DEPARTMENT
BUILT ENVIRONMENT
COLLEGE OF ENGINEERING AND TECHNOLOGY
MBEYA UNIVERSITY OF SCIENCE AND TECHNOLOGY

19/11/2018

Re: Introducing me to the Construction Organization Stakeholders for Support of Research Data to Finalize Model Validation of my PhD thesis at the UDSM

Dear Sir/Madam:

Refer the above heading is concerned.

My PhD study at the University of Dar es salaam has the title 'Development of Business Process Reengineering Model for Improving Project Performance in Tanzania'. The study has now reached to its final stage, where some data are still needed to finalize the model validation. The data relates to some stages of the project cycle that include: conception and briefing, designing, tendering, construction and commissioning.

This is to let you know that the 'the data will be strictly used for academic purposes and not otherwise. Therefore, your support is highly appreciated.

Thank you for your support,

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Yazidi. H. B. Mwishwa.
UDSM student/MUST staff

	DESCRIPTION	QTY	UN
	ELEMENT NO.2 – IMPROVEMENT OF WATER SUPPLY SYSTEM		
* (A)	Supply and install 1000 litres water storage tank complete with fittings.	1	No
(B)	Install none return valve at bottom of tank.	2	No
* (C)	Allow for additional pipe work and fittings to water supply pipe.	-	No.
(D)	Replace the worn-out cocks.	6	No.
* (E)	Replace the worn-out ~~cocks~~ taps.	5	NO Sum
(F)	Builder's work in connection with improvement of water supply system.	-	Sun
	TO COLLECTION		
	ELEMENT NO.2 – IMPROVEMENT OF WATER SUPPLY SYSTEM TOTAL CARRIED TO SUMMARY OF BILL NO.4.		

	DESCRIPTION	QTY	UNIT
	ELEMENT NO.5 – MISCELLANEOUS		
	Steel Grill.		
(A)	Supply and fix prefabricate steel grill made of 25mm wide flat bars spaced at 150mm both side, screwed and welded to existing frame.	3	No.
(B)	Ditto size 2000 x 1500mm.	3	No.
	Rescreeding Appron Floor:		
(C)	20mm thick cement and sand mortar (1;3) screed on apron floor.	70	M^2
	Vent Pipe		
(D)	Supply and install 100mm pvc vent pipe to pit latrine.	1	No.
	Mosquito Gauze Wire and Frame:		
(E)	Supply and fix steel mosquito gauze wire and frame size 1000 x 1200mm.	6	No.
(F)	**Ditto size 2000 x 1000mm:** Ditto size 2000 x 1500mm.	3	No.
(G)	Door Replacement:	3	No.
(H)	Replace new hardwood door at rear entrance, complete with all necessary iron mongeries.	1	No.
	TO COLLECTION		
	ELEMENT NO.5 – MISCELLANEOUS TOTAL CARRIED TO SUMMARY OF BILL NO.4.		