MODERATING ROLE OF PROJECT LEADERSHIP ON THE INFLUENCE OF COMPLEXITY ON SUCCESS OF PUBLIC INFRASTRUCTURAL MEGAPROJECTS IN KENYA

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DECLARATION

This research thesis is my original work and has not been presented for a degree in any other University

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DEDICATION

To the almighty God, maker of heaven and earth and giver of life, strength and ingenuity, I dedicate this work.

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LIST OF ABBREVIATIONS AND ACRONYMS

CAQ	Complexity Assessment Questionnaire
CAS	Complex Adaptive Systems
CLT	Complexity Leadership Theory
H_A	Alternative or Research Hypothesis
HIV/AIDS	Acquired immunodeficiency syndrome/human immunodeficiency virus
ICCPM	International Centre for Complex Project Management
ICT	Information Communication Technology
KNBS	Kenya National Bureau of Statistics
LAPSSET	Lamu Port-South Sudan-Ethiopia Transport
LBQ	Leadership Behavior Questionnaire
LDQ	Leadership Dimensions Questionnaire
LPI	Leadership Practices Inventory
MLDQ	Modified Leadership Dimensions Questionnaire
MODeST	Mission, Organization, Delivery, Stakeholders and Team
NASA	National Aeronautics and Space Administration
OLS	Ordinary Least Squares
PIP	Project Implementation Profile
PMI	Project Management Institute
PMM	Project Management Maturity
PMP	Project Management Profile
PPPs	Private-Public-Partnerships
PSQ	Project Success Questionnaire
SPSS	Statistical Package for Social Sciences

DEFINITION OF KEY TERMS

Adaptive Leadership:	Informal leadership process that occurs in intentional interactions of interdependent human agents (individuals or collectives) working to generate novel solutions to the adaptive needs of the organization (Marion & Uhl-Bien, 2007).
Administrative Leadership:	Managerial leadership that addresses the bureaucratic functions of the organization while not stifling the complex dynamics (Marion & Uhl-Bien, 2007).
Ambiguity:	The state of not knowing what to expect or how to comprehend a situation (PMI, 2014).
Anchoring:	Cognitive bias attaching great significance to information acquired early in programs or projects (PMI, 2014).
Complex Adaptive Systems:	Networks of interacting, interdependent agents bonded in a collective dynamic by common need (Marion, 1999).
Complexity Leadership:	Multi-level, processual, contextual and interactive leadership meant to enhance innovation, learning, adaptability and new organizational forms (Uhl-Bien & Marion, 2009).
Conceptual Framework:	System of concepts, assumptions, expectations, beliefs, and theories that supports and informs the research (Miles & Huberman, 1994).
Connectedness:	Number of connections among project components, stakeholders or team members (PMI, 2014).
Context:	Unplanned and uncontrolled mechanisms that emerge naturally in complex adaptive systems (Marion & Uhl-Bien, 2007).
Differentiation:	The number of components in a project (Baccarini, 1996).

Emergence: The anticipated change, spontaneous or gradual, that occurs within the context of a program or project (PMI, 2014).

Framing Effect: The manner in which an individual presents information (PMI, 2014).

Generative Leadership: Leadership style that acts in the interface between adaptive and administrative leadership to foster conditions conducive to the complex interactive dynamics of adaptive leadership and manages the administrative-to-adaptive and innovation-to-organization interfaces (Uhl-Bien, Marion, & Mckelvey, 2007).

Human behavior: The source of complexity that may arise from the interplay of conducts, demeanors and attitudes of people (PMI, 2014).

Interdependence: The degree of interrelatedness among components in a project (Baccarini, 1996).

Involving Leadership: A style that is based on a transitional organization that faces significant but not radical changes in its business model or “modus operandi” (Dulewicz & Higgs, 2005).

Iron Law: A phrase used to characterize delivery of megaprojects with budget overrun, behind schedule, with benefit shortfalls, over and over again (Flyvbjerg, 2014).

Leadership: The process whereby an individual influences a group of individuals to achieve a common goal (Northouse, 2016).

Leadership Style: The behavior pattern of a person who attempts to influence others (Northouse, 2016).

Loss Aversion: Reluctance to terminate a failing program or project despite clear indications that recovery may be impossible particularly when great deal of energy, emotion and resources have been invested (PMI, 2014).

Megaproject: A temporary multiparty organization established to create large scale, complex and multibillion dollar physical assets and services such as healthcare, transport, energy, water, waste and ICT systems (Altshuler & Luberoff, 2003; Flyvbjerg, 2014).

Misrepresentation: Deliberate overestimation of costs and schedules or knowingly conveying false information to achieve desired ends (PMI, 2014).

Optimism Bias: The natural tendency of individuals to believe that they are less likely than others to experience negative outcomes (PMI, 2014).

Planning Fallacy: The tendency to underestimate probable costs and time and overestimate probable benefits of efforts in which they or their organizations will be involved (PMI, 2014).

Postmodernism: A position that displays distaste for master-narratives and for a realist orientation (Bryman & Bell, 2007).

Project Complexity: A characteristic of a project that manifests in the interplay among human behavior, systems behavior and ambiguity (PMI, 2014).

Project Success: The criteria, both qualitative and quantitative, against which a project is judged to be successful (Turner, 2007).

Sublime: Rationale for implementing megaproject (Flyvbjerg, 2014).

System Behavior: The source of complexity that arises from interdependencies through connections among their parts or components (PMI, 2014).

System Dynamics: Connectedness and interdependency of many components that interact to cause change over time (PMI, 2014).

Theory: A body of knowledge, which may or may not be associated with particular explanatory models (Thomas, 2007).

ABSTRACT

The main objective of this study was to investigate the moderating role of project leadership on the influence of project complexity on success of public infrastructural megaprojects in Kenya. This was operationalized through a set of four specific objectives with human behavior, ambiguity, system behavior, project leadership and project success being the main variables. The need for this study arose from the thesis that complexity is the main cause of waste and failure that results in infrastructural megaprojects being delivered over budget, behind schedule, with benefit shortfalls; and that leadership skill is the most important for successful navigation of this complexity. The study was designed as multiple-method research, based on virtual constructionist ontology recognizing that complexity is the mid-point between order and disorder. A census survey of 124 respondents based on 31 completed public infrastructural megaprojects was conducted using three interlinked questionnaires. Quantitative data analysis was conducted using both descriptive and inferential statistics, while qualitative data analysis was done through scenario mapping and triangulation. Almost all the projects surveyed utilized some form of fixed price contract with a consequence that more of these projects were delivered within budget than within schedule. Whereas the context in which public infrastructural megaprojects are implemented reflects considerable uncertainty, emergence, dependency and rapid change, the current project leadership is largely goal-oriented. In fact, analysis of individual behaviors revealed a project culture characterized by internal focus and stability. The study showed that in practice, stakeholder satisfaction was not managed as a key project objective and in some cases it was considered as a front-end activity that was only important during project planning. Consistent with the developments in the success school of project management, the study showed that project management success had no significant relationship with product and organizational success. Inferentially, the study confirmed that complexity had significant influence on success of public infrastructural megaprojects (R^2=58.3% with P=0.000). Individually, all the dimensions of project complexity had significant negative influence on success of public infrastructural megaprojects, with human behavior having the greatest influence (R^2=0.463 with $P<0.025$). However, ambiguity dimension ceased to be significant when the complexity dimensions were combined into one model. Interestingly, when project leadership was introduced into the combined model, human behavior completely ceased to predict success but the interaction effect of project leadership with both system behavior and ambiguity remained significant (R^2=72.7% with P=0.000). On its own, project leadership had significant positive influence on project success (R^2=0.48 with P=0.000) in such a way that success rate increased as leadership style tended towards complexity leadership. In effect, the findings underscored the significance and application of complexity leadership theory, structural contingency theory and complex adaptive systems theory, in the delivery of public infrastructural megaprojects. Consequently, in order to navigate the complexity inherent in these projects, this study recommends adoption of a leadership style anchored on both complexity science and context. Such leadership is expected to be long on both generative and adaptive behaviors.

CHAPTER ONE

INTRODUCTION

1.0 Chapter Overview

This chapter introduces the background of the study in which main concepts of the study are presented. Each of these concepts is discussed briefly with their interrelationship being explained in the statement of the problem. This is followed by a list of the study objectives and research hypotheses. The rest of the chapter explains the justification of the study, its scope and limitations.

1.1 Background of the Study

The International Centre for Complex Project Management (ICCPM) describes complex projects as those characterized by uncertainty, ambiguity, with emergent dynamic interfaces, influenced by significant political or external change; are run over a period which exceeds the product life cycles of the technologies involved or where significant integration issues exist; are defined by effect (benefit and value) but not by solution (product) at inception (Hayes & Bennet, 2011). This definition is important in distinguishing complex systems from complicated ones, which have many moving parts but they operate in patterned ways. Organizational complicatedness is usually measured based on the number of procedures, vertical layers, interface structures, coordination bodies and decision approvals (Morieux, 2011).

Complex systems by contrast are imbued with features that may operate in patterned ways but whose interactions are continually changing. According to Sargut and McGrath (2011), three properties determine the complexity of the environment namely; multiplicity, interdependence and diversity. The inability to manage complexity has been recognized as a major factor in project failure for a number of years. However, complexity remains ambiguous and ill-defined in much of the project management literature (Geraldi, 2008) and there has not been sufficient attention paid to early studies of complex projects.

Based on a review of literature covering research results on project complexity from late 1960s to mid-1990s, Baccarini (1996) proposed two dimensions of complexity, namely; differentiation and interdependence, to help distinguish between organizational and technological complexity. Remington and Pollack (2011) classify project complexity into four categories namely; structural, technical, directional and temporal complexity. Cooke-Davies (2011) lists various causes of complexity in projects, namely; unhelpful behavior, failure to appreciate systemicity, use of abstract models, simplistic project management and over-ambitious strategic management.

In response to an identified gap in the literature for a grounded framework of managerial complexity, Maylor, Vidgen, and Carver (2008) carried out a multistage empirical study in order to determine what makes project or program complex to manage. The results established a grounded model of structural managerial complexity commonly referred to as the MODeST model in which Mission, Organization, Delivery, Stakeholders and Team evolved as high level headings for groups of characteristics. This study further indicated that there was an additional dimension of complexity, namely, dynamic complexity which resulted when the elements of structural complexity were not stable and changed over time (Carver & Maylor, 2011).

The MODeST framework was later reviewed to integrate elements of the literature based on a categorization framework defined by scale, uncertainty, pace, and socio-political (Geraldi, Maylor, & Williams, 2011). The result was a highly comprehensive instrument for assessing complexities which comprised 140 questions measuring both structural and dynamic complexity. In a comparative study of the Heathrow Terminal 5 and the London 2012 Olympics projects, Brady and Davies (2014) used this model to illustrate how structural and dynamic complexities were managed in both projects.

To underscore the importance of complexity in determining project outcomes, Project Management Institute (PMI) published a global practice standard on navigating complexity in 2014. According to this standard, the causes of complexity in projects and programs are grouped into human behavior, system behavior and ambiguity. The standard also includes a questionnaire that can be used to assess the causes of complexity in any given project. The questionnaire is based on a reduced number of items (cf. Geraldi, Maylor, & Williams, 2011; Maylor, Vidgen, & Carver, 2008) which makes it more usable.

Human behavior may be the result of factors such as changing power relationships, political influence, and individuals' experiences and perspectives. These factors may hinder the clear identification of project goals and objectives. The human behavior factors that cause project complexity are usually grouped into four categories namely; individual behavior, group behavior and organizational design and development.

Based on system behavior, project complexity can also occur as a result of component connections and when there are disconnects among these components. As a result of these connections, changes at the component level may create unintended consequences throughout the program or project thus affecting project success. Interdependence among the component tasks and stakeholder relationships (Loch, De Meyer, & Pich, 2006, p.52) is also a key factor explaining project complexity.

Unclear or misleading events, cause and effect confusion, emergent issues or situations open to more than one interpretation in programs and projects lead to ambiguity (PMI, 2014). As a result of this emergence, the whole is always greater than the sum of the parts leading to uncertainty in performance of the project metrics. Uncertainty increases with the number of interdependent actions, the existence of unknowable unknowns, conflicting perspectives of stakeholders regarding the project deliverables, inability to fix the scope of the project so as to derive an accurate estimate and the emergence of new untested technology.

1.1.1 Complexity and Success of Megaprojects

Project success has received considerable attention within project management research literature over the last decades (Ika, 2009; Pinto & Slevin, 1988b). This attention has enabled understanding of project success to evolve and reach maturity

(Jugdev & Muller, 2005). Project success is now regarded as a multidimensional construct, with interrelated technical, economic, behavioral, business and strategic dimensions (Bannerman, 2008; Cao & Hoffman, 2011; Ika, 2009; Jugdev & Muller, 2005; Jugdev, Thomas, & Delisle, 2001; Thomas & Fernandez, 2008).

Most of the researches on this subject often cite operational excellence (i.e. time, cost, quality) and product success as key measures of project success. However, there has been little attention given to contextual measures of project success. For instance, very few researchers (Shenhar & Dvir, 2007a; Hoegl & Gemuenden, 2001) consider the outcomes of complexity leadership in defining project success measures. As a result, project success measures are presented in a one-size-fits-all manner without considering the typology, type or size of the project.

Perhaps this lack of applying contextual measures of project success explains the "iron law" of megaprojects. Whereas the project landscape has consistently shifted from simple projects to major- to mega- and now to giga- and terra-projects, project success theory has not kept the pace. There is need for these measures to reflect the sublimes of megaprojects (Flyvbjerg, 2014). It is noted however that all the critical success factors and success measures for a project are aspects of project complexity (see Pinto & Slevin, 1988b). In their third global survey on the current state of project management, Price Waterhouse Coopers (2012) identified eleven factors that contribute to poor project performance. All these factors are explained by project complexity causes of human behavior, system behavior and ambiguity.

Megaprojects are usually large-scale, complex ventures that cost billions of money, take many years to develop and build, involve multiple public and private stakeholders, are transformational, and impact millions of people (Flyvbjerg, 2014). These projects are generally "greenfield" in nature as they often create new assets and utilize a variety of delivery models depending on their inherent complexity.

Accordingly, megaprojects are not just magnified versions of smaller projects but are a completely different breed of project in terms of their level of aspiration, lead times, complexity, and stakeholder involvement (Flyvbjerg, 2014); implying that they are also a very different type of project to manage. As noted by Brady and Davies (2014), megaprojects are among the most complex category of project.

Inherent complexity in megaprojects is the main source of contextual risk which is usually referred to as typological risk (Omonyo, 2015). The magnitude of this risk increases as we move from an environment of low complexity towards high complexity. The effectiveness of project control is usually affected by typological risk in such a way that as the value of the typological risk increases, exercising project control becomes more difficult. This explains why complex megaprojects are usually delivered over budget, behind schedule, with benefit shortfalls, over and over again. Flyvbjerg (2014) characterizes this phenomenon as the "iron law of megaprojects". Indeed, several studies linking complexity with project success have confirmed that complexity predominantly determines project success (Meyer, 2014; Hargen & Park, 2013; O'Donnell, 2010; Shermon, 2011, Flyvbjerg, Holm, & Buhl, 2004; Vanston & Vanston, 2004).

Projects such as the Boston Big Dig, Denver International Airport and the Sydney Opera House were delivered in conformity with the "iron law of megaprojects" (PMI, 2011). Flyvbjerg (2014) added to this calamitous list several projects with the Egyptian Suez Canal reporting the greatest cost overrun of 1900%, and noted that there was no end in sight for such overruns in megaprojects across the world.

Despite these data, the growth in the use of megaprojects to deliver public products, services and results has been phenomenal over the past few years. Using the words of Flyvbjerg (2014), what we are witnessing is a consistent movement from "megaprojects" such as the Thika Superhighway to "gigaprojects" such as the Konza Technology City and the Standard Gauge Railway, and finally to "teraprojects" such as the LAPSSET Corridor project. In the Government of Kenya (2013) Medium Term Plan, infrastructure was allocated Ksh. 7.5 trillion in project funding for a period of 5 years, more than twice the amount allocated to all the other foundations of national transformation. Therefore, the main challenge on organizations is to find enough talent with the right skills to manage the complexity in megaprojects so as to reverse this inherent trend (PMI, 2013b).

1.1.2 Interaction of Project Leadership and Complexity in Success of Megaprojects

Throughout history, the difference between success and failure, whether in a war, business, a protest movement, or a basketball game, has been attributed to leadership (Luthans, 2002). Project managers in early documented achievements such as the construction of monuments or biblical narratives had to think and practice their leadership systematically to be successful (Cooke-Davies, 2011). Therefore, in order to respond positively to complexity in megaprojects, there is need for transformational leadership (Cooke-Davies, 2011). This is based on the highlights of the 2009 ICCPM round table series on complex project management which recommended that in future, managers of complex projects need to be developed and selected based on a range of leadership skills that enables them to operate in uncertain and ambiguous environments (Hayes & Bennett, 2011).

Project managers and project leaders consider leadership as the dominant determinant of project success (Zimmerer & Yasin, 1998). A global survey of 697 project management practitioners indicated that 75 percent of organizations rank leadership skills as the most important for successful navigation of complexity (PMI, 2013a) in megaprojects. The Chaos reports by the Standish Group (2009) suggested that problems related to successful project outcomes and inevitably the solution to achieving project objectives that meet stakeholders' expectations, originates with people in leadership roles.

A research study by Cambridge University's School of Business and Economics concluded that 80% of projects failed because of poor leadership (Zhang & Faerman, 2007). As Hauschildt, Gesche, and Medcof (2000) reported, the success of a project depended more on human factors, such as project leadership, top management support, and project team, rather than on technical factors. They also found that the human factors increased in importance as projects increased in complexity, risk, and innovation. Further, the researchers found that the critical role of the project manager's leadership ability had a direct correlation to project outcomes.

A project manager is not necessarily a leader. Whereas project leaders conquer the context-the volatile, turbulent and ambiguous surroundings that sometimes seem to conspire against us, project managers surrender to the context (Warren, 1989). Leadership style consists of the behavior pattern of a person who attempts to influence others (Northouse 2016). The behavior pattern of leaders is in itself defined by a set of leadership competences (Dulewicz & Higgs, 2005).

All too often, (project) managers rely on common leadership styles that work well in one set of circumstances but fall short in others (Snowden & Boone, 2007). The reason why these approaches fail even when logic indicates they should prevail is based on a fundamental assumption of organizational theory and practice: that a certain level of predictability and order exists in the world. This assumption, grounded in the Newtonian science that underlies scientific management, encourages simplifications that are useful in ordered circumstances. Circumstances change, however, and as they become more complex, the simplifications can fail. According to Snowden and Boone (2007), time has come to broaden the traditional approach to leadership and decision making and form a new perspective based on complexity science with the main outcomes being innovation, learning, adaptability and new organizational forms (Uhl-Bien & Marion, 2009).

1.2 Statement of the Problem

Generally, fewer than two-thirds of all projects fail to meet their original goal and business intent which puts US$135 million at risk for every US$1 billion spent on a project (PMI, 2013a). The trend becomes more troubling for projects with added complexity such as public infrastructural megaprojects. In a study of 258 infrastructure projects, Flyvbjerg et al. (2004) found that nine out of ten such projects had cost overruns; overruns of up to 50 percent in real terms were common, over 50 percent were not uncommon. Despite these data, the growth in the use of infrastructural megaprojects in Kenya to deliver goods and services has been phenomenal. The complexity inherent in the megaproject environment is often cited as the main cause of this poor performance (Bain & Company, 2013; Cooke-Davies, Crawford, &

Stephens, 2011). Therefore, without a coherent research agenda to understand both its causes and navigation strategies, complexity continues to result in problems, waste, economic and social failure (Remington & Zolin, 2011).

A global survey of 697 project management practitioners indicated that 75 percent of organizations ranked leadership skill as the most important for successful navigation of complexity (PMI, 2013a) in megaprojects. Unfortunately, existing studies on project leadership cannot be generalized to complex megaprojects since these studies assume fairly orderly and stable organizational settings (Chen, Donahue, & Klimoski, 2004; Packendorff, 1995). Further, these studies have treated project leadership as the main determinant of project success rather than as a variable that becomes depending on the level of project complexity.

Using managers, team members and sponsors of completed public infrastructural megaprojects as respondents, this multiple-method research based on virtual constructionist ontology sought to address these gaps through a deeper understanding of the extent to which complexity influences success of public infrastructural megaprojects; and the role of project leadership in moderating that influence considering the context of megaprojects.

1.3 Objectives of the Study

1.3.1 General Objective

The main objective of this study was to investigate the moderating role of project leadership on the influence of project complexity on success of public infrastructural megaprojects in Kenya.

1.3.2 Specific Objectives

The specific objectives of this study were to:

i. Determine the influence of human behavior on success of public infrastructural megaprojects;

ii. Determine the influence of ambiguity on success of public infrastructural megaprojects;

iii. Determine the influence of system behavior on success of public infrastructural megaprojects;

iv. Explore the moderating role of project leadership on complexity and success of public infrastructural megaprojects;

1.4 Research Hypotheses

Hypotheses for this study were derived based on review of relevant literature. The explanation for the direction of each hypothesis is shown in section 2.3 of this thesis. This study tested the following research hypotheses:

i. $\mathbf{H_A}$**:** Human behavior has significant influence on success of public infrastructural megaprojects.

ii. $\mathbf{H_A}$**:** Ambiguity has significant influence on success of public infrastructural megaprojects.

iii. $\mathbf{H_A}$**:** System behavior has significant influence on success of public infrastructural megaprojects.

iv. $\mathbf{H_A}$**:** Project leadership has significant moderating effect on complexity and success of public infrastructural megaprojects

1.5 Justification of the Study

In the Project Management Talent Gap Report, PMI (2013b) reports that from 2010 through 2020, 1.57 million project management jobs will be created each year globally. Given that complex megaprojects are now the preferred model to deliver products, services and results across a range of businesses, sectors and major events, it is highly probable that most of these jobs will involve management of such projects. This study contributes to the raging contemporary debate on how this iron law of complex megaprojects can be reversed through project leadership.

As far as Kenya is concerned, this study is pioneering in nature and opens up this area for further research in order to ensure that the delivery capability of megaprojects is enhanced. The findings of this study are of benefit to megaproject managers, sponsors and donors, contextual stakeholders, policy makers and researchers focusing on megaproject success. In line with Turner, Huemann, Anbari, and Bredillet (2010) classification of project management research, this study contributes to the governance, behavior, success, contingency and decision schools of project management.

1.6 Scope of the Study

This study was carried out within the context of the postmodern social world which is characterized by discourse, rhetoric and reflexivity. For that matter, only infrastructural projects implemented within the complex context were included in this study. The choice of projects to include in this study was guided by the definition of complex projects as provided by the ICCPM. A further criterion that projects in this study satisfied related to their budget.

The population of projects in this study comprised completed complex infrastructural megaprojects implemented by the government of Kenya over the last 10 years with a minimum budget of approximately Ksh. 1 billion. Infrastructure was selected because of its huge actual and projected expenditure when compared to the other foundations of national transformation (Government of Kenya, 2013). This sector was allocated Ksh. 7.5 trillion in the Government of Kenya 2013 Medium Term Plan, more than twice the Ksh. 3.4 trillion allocated to all the other foundations of national transformation.

1.7 Limitation of the Study

Data collection for this study fell behind by about five months as a result of the busy schedule of project managers of the surveyed projects, as most of them were always away on other assignments. Patience finally paid off. Getting the project leadership questionnaire filled was particularly difficult because it involved project team members assessing the leadership behavior of their project managers and some of them did not feel at ease with this. The use of various organizational departmental heads to coordinate the study helped overcome this fear. In some instances, there was no team-the client organization had just a project manager overseeing the work by the contractors. Under such circumstances, employees within the same functional area as the project manager assisted in conducting this assessment. This study only considered the issue of benefits from a short run point of view because the project appraisal documents for these projects showed that the project benefits shall be realized gradually over a longer time horizon.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the theoretical and conceptual frameworks governing the study together with empirical review of literature relevant to the variables contained in the conceptual framework. A critical review of the existing literature is also presented followed by a summary of both theoretical and empirical literature review. The last section in this chapter identifies the research gaps that were addressed by this study.

2.2 Theoretical Framework

This study was operationalized through cognitive bias theory, structural contingency theory, complex adaptive systems theory, agency theory, *Cynefin Framework*, complexity leadership theory and project success theory. Project success theory was presented as a body of knowledge while cognitive bias, structural contingency, *Cynefin Framework*, agency, complex adaptive systems, and complexity leadership theories, were presented as prescriptive theories.

2.2.1 Human Behavior

Human behavior was studied at three levels namely; micro, meso and macro. The first level involved the study of individuals in organization, the second level involved the study of work groups and the third level involved the study of how organizations behave (Wagner & Hollenbeck, 2010). The study used the Cognitive Bias Theory was used to explain individual behavior and group behavior while Structural Contingency Theory was used to explain organizational design and development.

Cognitive Bias Theory

This theory stems from the broader family of Cognitive Psychology theories with its main proponents being Amos Tversky and Daniel Kahneman. The theory demonstrates several replicable ways in which human judgments and decisions differ from rational choice theory. Accordingly, individuals create their own subjective social reality from their perception of the input; and this construction of social reality, not the objective input, may dictate their behavior in the social world (Bless, Fiedler, & Strack, 2004).

According to this theory, a cognitive bias is a systematic pattern of deviation from norm or rationality in judgment (Haselton, Nettle, & Andrews, 2005). The notion of cognitive biases developed out of people's innumeracy, or inability to reason intuitively with the greater orders of magnitude. Thus, cognitive biases may sometimes lead to perceptual distortion, inaccurate judgment, illogical interpretation, or what is broadly called irrationality (Ariely, 2008). Not all cognitive biases are bad since some cognitive biases may lead to more effective actions in a given context. Psychologists believe that many of these biases serve an adaptive purpose by allowing us to reach decisions quickly, which can be vital if we are facing a dangerous or threatening situation. Furthermore, cognitive biases enable faster decisions when timeliness is more valuable than accuracy, as illustrated in heuristics (Tversky & Kahneman, 1974).

Following this theory, biases arise from various processes including: information-processing shortcuts, also referred to as heuristics which involves mental shortcuts that provide swift estimates about the possibility of uncertain occurrences (Baumeister & Bushman, 2010); distortions in the process of storage in and retrieval of information from memory; the brain's limited information processing capacity; emotional and moral motivations; and social influence.

Biases can be distinguished on a number of dimensions. For example, there are biases specific to groups (such as the risky shift, groupthink, groupshift) as well as biases at the individual level (such as optimism bias, anchoring, framing effect, misrepresentation); some biases affect decision-making, where the desirability of options has to be considered (e.g., sunk costs fallacy); others such as illusory correlation affect judgment of how likely something is, or of whether one thing is the cause of another; a distinctive class of biases affect memory such as consistency bias (remembering one's past attitudes and behavior as more similar to one's present attitudes); some biases reflect a subject's motivation, for example, the desire for a positive self-image leading to egocentric bias and the avoidance of unpleasant cognitive dissonance.

The postulations of this theory are significant in defining the constructs and measures of individual as well as group behavior.

Structural Contingency Theory

The main premise in structural contingency theory is that there is no one best organizational structure; rather, the appropriate organizational structure depends on the contingencies facing the organization (Burns & Stalker, 1961; Chandler, 1962). The theory posits that organizations will be effective if managers fit characteristics of the organization, such as its structure, with contingencies in their environment (Donaldson, 2001). One of the most important concepts in the theory is alignment. An organization whose characteristics align with the contingencies in its situation will perform more effectively compared to an organization whose characteristics do not fit with the contingencies in its situation. According to the theory, there are two main contingencies: organizational size and organizational task.

2.2.2 Ambiguity and System Behavior

Complex Adaptive Systems Theory

Complex Adaptive Systems (CAS) theory also referred to as Complexity theory, states that critically interacting components self-organize to form potentially evolving structures exhibiting a hierarchy of emergent system properties (Lucas, 2009). The rise of CAS as a school of thought is usually attributed to the mid-1980's formation of the Santa Fe Institute, a New Mexico think tank formed in part by the former members of the nearby Los Alamos National Laboratory. The scientists here claimed that through the study of complexity theory, one can see both laws of chaos and that of order; through which an explanation for how any collection of components will organize itself can be generated.

This theory takes the view that systems are best regarded as wholes, and studied as such, thus rejecting the traditional emphasis on simplification and reduction as inadequate techniques. Complexity theory is concerned with the study of how order, structure, pattern, and novelty arise from extremely complicated, apparently chaotic systems and conversely, how complex behavior and structure emerges from simple underlying rules. The theory attempts to discover how the many disparate elements of a system work with each other to shape the system and its outcomes, as well as how each component changes over time (PMI, 2014).

Insights from the study of complexity in the life sciences suggests that there is a natural tendency for all organisms (including human kind and social organisms such as project teams) to evolve complex responses to challenges that they encounter in their environment. This provides a compelling argument for why there is a pressing need for a coherent research agenda to understand both the causes of complexity, and what can be done to prevent it resulting in problems, waste, economic and social failure (Remington & Zolin, 2011).

Another important concept in complexity theory is that there is no master controller of any system. Rather, coherent system behavior is generated by the competition and cooperation between actors that is always present. The components of a system have different levels of organization-made up of divisions, which contain different departments, which in turn comprise different workers. But the important differentiation from this organization is that complex adaptive systems are constantly revising and rearranging their building blocks as they gain experience (Caldart & Joan, 2004).

In summary, CAS theory identifies key distinguishing characteristics of a complex system namely; context, emergence, uncertainty, connectedness, dependency and system dynamics. The first three characteristics define the ambiguity dimension of complexity while the last three define the system behavior dimension.

Agency Theory

Agency theory, also referred to as principal-agent problem or agency dilemma, has its roots in behavioral economics and has been used extensively in organization behavior (Eisenhardt, 1985; 1988). This theory relates to risk sharing among groups that are in a contractual relationship. According to this theory, agency problem occurs when cooperating parties have different goals and vision of labor (Jensen & Meckling, 1976).

Agency theory is concerned with resolving two problems that can occur in agency relationships. The first is the agency problem that arises when (a) the desires or goals of the principal and agent conflict and (b) it is difficult or expensive for the principal to verify what the agent is actually doing. The second is the problem of risk sharing that arises when the principal and agent have different attitudes toward risk. The problem here is that the principal and the agent may prefer different actions because of their different risk preferences (Eisenhardt, 1989). For instance, in a cost-plus percentage fee contract, a contractor may have no incentive to reduce costs since the higher the delivery cost, the higher their fee.

Using the contract as the unit of analysis that governs the relationship between the principal and the agent, this theory is concerned with determining the most efficient contract to be used in governing the agency relationship given the assumptions made about people, organizations and information. The fundamental concern of this theory is whether a behavior-oriented contract (e.g., salaries, hierarchical governance) is more efficient than an outcome-oriented contract (e.g., commissions, stock options, transfer of property rights, market governance) (Eisenhardt, 1989).

This theory provides key insight into how to structure the context of the project in order to align the interests of both the client and contractor so as to minimize the risk of cost overruns, schedule delays and benefit shortfalls.

2.2.3 Project Leadership

Cynefin Framework

This theory is attributed to Snowden and Boone. It stems from the philosophical positions held about what is a project and project management. According to this theory, the social world of projects can be divided into pre-modern, modern, postmodern and hypermodern/late modern (Gauthier & Ika, 2012). Snowden and Boone (2007) referred to these worlds respectively as; simple, complicated, complex and chaos.

Each of these social worlds of projects see project management and the project manager differently. For instance, the theory conceives the simple world to philosophize projects and project management before the onset of modernity. These projects are driven by the need to stimulate the economy and to serve the glory of a god or his representative, or a religion (Kozak-Holland, 2011). The project manager figure is a priest (Gauthier & Ika, 2012). Project management is relatively simple since best practices exist, and there is stability with clear cause-and-effect relationships. In this realm of known knowns, the approach to leadership is *sense, categorize and respond*. To do this, the leader ensures that proper processes are in place, delegates, uses best practices and communicates in clear, direct ways (Snowden & Boone, 2007).

The modern project management is closely linked to the scientific management approach (Joffre, Auregan, Chedotel, & Tellier, 2006). These projects have a core belief in progress, through knowledge and reason, thus challenging religion, myth, and tradition (Habermas, 1997). In this world, a project is a temporary endeavor undertaken to create a unique product, service or result, and project management is the application of skills, knowledge, tools and techniques to project activities to produce results (PMI, 2013c). The approach to leadership in this context is to *sense, analyze and respond*. The leader does this by using co-located and expert teams and by listening to conflicting advice (Snowden and Boone, 2007).

The postmodern and the hypermodern social worlds have evolved with the development of socio-technical objects such as the internet (Giddens, 1990) (see also. Beck, 1992; Beck, Giddens, & Lash, 1994; Charles, 2009). This world emphasizes constant redefinition as a means of avoiding the pitfalls experienced by modernity (Dery, 2009). In this world, reflexivity and rhetoric thrive over reason and the project is either a network of actors embedded in a social context and in constant transformation, or, a discourse of legitimation and an arena of social and power plays serving the interests of powerful stakeholders (George & Thomas, 2010; Hodgson & Cicmil, 2006).

Depending on whether the postmodern world is predominantly characterized by rapid change or by emergence, the approach to leadership is either to *act or probe* before *sensing and responding* (Snowden & Boone, 2007). The leader does this by either; looking for what works instead of searching for right answers, taking immediate action to reestablish order and providing clear direct communication, or by creating environments and experiments that allow patterns to emerge, increasing levels of interaction and communication, using methods that can help generate ideas, encouraging dissent and diversity and managing starting conditions and monitoring them for emergence.

This theory is important to this study as it spells out the contexts in which a leader can apply fact-based leadership (i.e., simple and complicated) and those in which mechanism-based or pattern-based leadership can be applied (i.e., complex and chaos). Of essence to this study is the theory's proposition that leadership is processual and becoming depending on the context of the project. Thus, the theory is key in explaining how leadership style interacts with the project context to determine desired outcomes.

Complexity Leadership Theory

Given the centrality of complexity in determining organizational outcomes, researchers have developed new approaches to leadership grounded in complexity theory (Lord, 2008; Uhl-Bien, Marion, & McKelvey, 2007; Surie & Hazy, 2006). These approaches are motivated by the desire to develop leadership models that more accurately reflect the complex nature of leadership as it occurs in practice (Uhl-Bien & Marion, 2009). They represent a growing concern that traditional models of leadership are insufficient for understanding the dynamic, distributed, and contextual nature of leadership in organizations (McKelvey, 2008; Johannessen & Stacey, 2005).

These approaches to leadership are consistent with the central assertion of the meso argument that leadership is multi-level, processual, contextual, and interactive (Uhl-Bien & Marion, 2009). One such approach is the Complexity Leadership Theory (CLT). CLT is a “framework for leadership that enables the learning, creative, and adaptive capacity of complex adaptive systems (CAS) in knowledge producing organizations or organizational units”. CLT entails the study of the interactive dynamics of complex adaptive systems embedded within contexts of larger organizing systems.

CLT is a contextual theory of leadership that describes leadership as necessarily embedded in context and to study it requires consideration and examination of context in both theorizing and operationalization (Uhl-Bien & Marion, 2009). Unlike other models of leadership such as Transformational Leadership Theory (TLT), CLT does not view change as only, or even primarily, top-down; it does not see change as being “led” in the traditional sense of the word. Rather, a core premise of CLT is that change is emergent, unpredictable, and essentially uncontrollable (Marion & Uhl-Bien, 2007).The main outcomes of Complexity Leadership Theory are innovation, learning, adaptability and new organizational forms.

CLT seems to combine three styles of leadership namely, adaptive, generative and administrative. The purpose of adaptive leadership based on behaviors such as stepping back, identifying adaptive challenges, regulating distress, maintaining disciplined attention, giving the work back to the people, protecting leadership voices from below (Heifetz, 1994).

The purpose of generative leadership is to embrace informal leadership that fuels entrepreneurial system within the organization. The leader behaviors that characterize this style include harnessing interaction experience, aligning interactions towards achievement of system goal, enhancing interaction speed, interaction partitioning to manage resource allocation and interfaces, interaction leveraging through documenting and communicating lessons and establishing centers of excellence (Surie & Hazy, 2006).

The purpose of administrative leadership is to loosen administrative systems in order to create an enabling environment for complexity leadership to thrive. The leader behaviors that characterize this style include: solving problems, understanding people and social systems, envisioning, managing resources, motivating, achieving, influencing, and adhering to rules and regulations (Katz, 1955; Mumford, Zaccaro, Harding, Jacobs, & Fleishman, 2000).

2.2.4 Megaproject Success

Project Success Theory

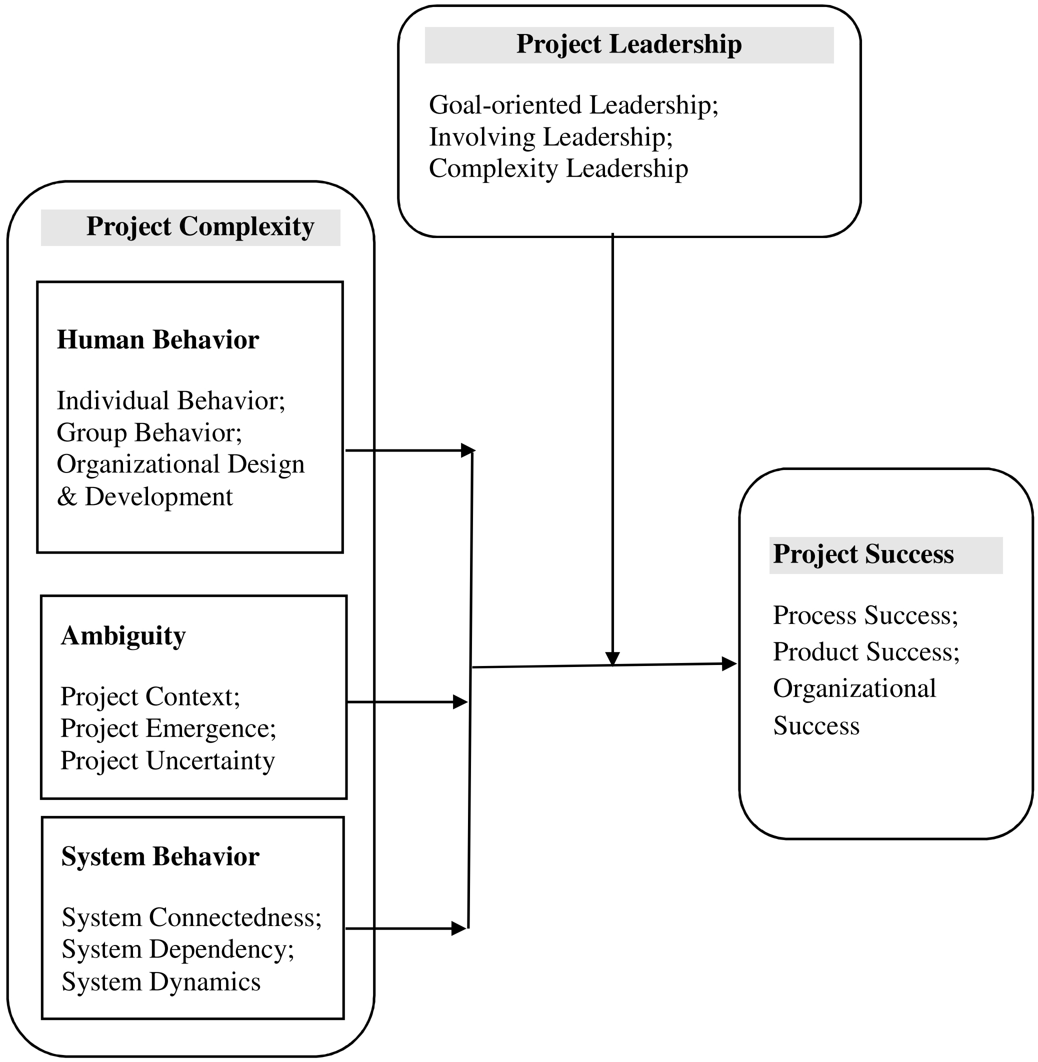
There have been various attempts over the history of project management to define suitable criteria against which to anchor and measure project success (McLeod, Doolin, & MacDonell, 2012). The most recognized of these measures is the long established and widely used "iron triangle" of time, cost and quality (Atkinson, 1999; Cooke-Davies, 2002; Ika, 2009; Jugdev, Thomas, & Delisle, 2001). However, the "iron triangle" dimensions are inherently limited in scope. As such, a project that satisfies these criteria may still be considered a failure; conversely a project that does not satisfy them may be considered successful (Ika, 2009). The "iron triangle" only focuses on the project management process and does not incorporate the views and objectives of all stakeholders (Bannerman, 2008; Jugdev & Muller, 2005).

Researchers have progressively widened the scope and constituency of what is meant by project success, recognizing that project success is more than project management success and that it needs to be measured against overall objectives of the project thus reflecting a distinction between the success of a project's process and that of its product (Markus & Mao, 2004). Product success involves such criteria as product use, client satisfaction and client benefits (McLeod et al., 2012).

Researchers are also increasingly advocating for project success criteria that incorporates achievement of broader set of organizational objectives involving benefits to the wider stakeholder base (Shenhar & Dvir, 2007b). This is plausible given that projects are a means of delivering the organization's strategic objectives. Proponents of this school of thought advocate for inclusion of success criteria such as business and strategic benefits. This study considered project success using this broader definition that includes process, product and organizational success.

2.3 Conceptual Framework

Based on the review of extant literature, complexity (caused by human behavior, ambiguity and system behavior) was identified as the independent variable that influences success of infrastructural megaprojects. Success of infrastructural megaprojects (defined as process, product and organizational) was identified as the dependent variable, while project leadership (defined by leader behaviors i.e., goal-oriented, involving and complexity) was identified as the moderating variable. The moderation model tests whether the prediction of a dependent variable from an independent variable differs across levels of a third variable (Aiken & West, 1991). Figure 2.1 presents the research conceptual model followed by this study.



Independent Variable **Moderating Variable** **Dependent Variable**

Figure 2.1: Conceptual Relationship among Project Complexity, Project Leadership and Success of Megaprojects

2.4 Empirical Literature Review

2.4.1 Human Behavior

In a grounded theory study of culture, communication and leadership for projects in dynamic environments, Collyer (2016) employed in-depth interviews and focus group discussions involving practitioners across 10 industries. The themes that emerged out of this study related to vision-led, egalitarian, goal-oriented culture supporting experimentation; timely and efficient communication; and flexible leadership with rapid decision making. These themes define critical human behaviors that are required to navigate complexity that abounds infrastructural megaprojects. In another study involving a critical review of extant literature, Olaniran, Love, Edwards, Olatunji, and Mathews (2015) conclude that complex interactions between project characteristics, people, technology, and structure and culture contribute to the occurrence of cost overruns in hydrocarbon megaprojects. This supports the thesis that human behavior (as identified by people, structure and culture) have an effect on the success of megaprojects.

In a study to establish the effect of optimism bias on the decision to terminate failing projects, Meyer (2014) used an experimental design in which a five-group, post-test-only, randomized experiment jointly varied invested amount and project progress and then read the scenario with regard to return on investment and salvage value. Using a combination of Chi-Square test of association and Correlation analysis, the results of the study indicated that decision makers believe that their own managerial efforts will affect the time and cost overruns on the project. Additionally, the findings led to the conclusion that the estimated business benefit from the project will exceed the calculated business benefit. According to this study, in-project optimism bias is a significant contributor to decision maker's motivation to continue with a failing project. For post-project optimism bias, the study showed that it is prevalent throughout the project and increases as the project approaches the end. The conclusions of this study are in line with the findings of Lovallo and Kahnemann (2003) whose research concluded that optimism and risk aversion were the main biases in forecasting and risk taking and that these two undermine executives' decision-making. Mackie and Preston (1998) also found optimism to be among the 21 sources of error and bias in appraisal of transport projects.

In exploring the role of project management maturity (PMM) and organizational culture in perceived performance, Yazici (2009) conducted a survey-based research with 86 project professionals from the manufacturing and service sectors in the United States of America. This study revealed that PMM is significantly related to business performance but not to project performance. According to this study, organizational culture change towards sharing, collaboration and empowerment, is required in order to deal with (overruns) in project time, cost and expectations.

In a study to identify systematic biases in project failures, Shore (2008) conducted research on 8 large projects and wrote case studies on each failure to demonstrate how organizational and project culture could contribute to those biases. The findings of the study confirmed that there are indeed systematic biases and culture in project failure that is worth exploring. The main premise of this study was the fact that systematic biases are common in the human decision-making process and this provides a fundamental reason why project failure should not be an unexpected result.

In a study of the causes of cost overruns in 258 transport infrastructure projects across 20 nations, Flyvbjerg, Holm, and Buhl (2004) used Regression Analysis and found a statistically significant relationship between cost escalation and schedule delay (implementation sluggishness). They also found a statistically significant relationship between cost escalation and project size. This study examined four kinds of explanation of cost underestimation: technical, economic, psychological, and political. The study concluded that underestimation cannot be explained by error and is best explained by strategic misrepresentation, that is, lying, which is an aspect of individual behavior. This is in line with the findings in Bruzelius, Flyvbjerg, and Rothengatter (2002) who in a study on improving accountability in megaprojects, argued that differences between forecasts and actual costs could only be explained by the strategic behavior of the project proponents. They identify lack of long-term commitment, rent seeking behavior for special interest groups and the tendency to underestimate in tenders to get proposals accepted, as the main strategic behaviors of project proponents that adversely affect project outcomes.

In a study of cost and time overruns in public sector projects, Morris (1990) identified bureaucratic indecision and a lack of coordination between enterprises to be among the main causes of cost and time overruns in large public sector projects. Both these factors map onto organizational design and development as an aspect of human behavior. In a similar study, Kaliba, Muya, and Mumba (2008) conducted a study on cost escalation and schedule delays in road construction projects in Zambia and found that administrative structures and inexperienced administrative personnel were among the factors that explained cost overruns.

The totality of this empirical review is to suggest that human behavior can have either positive or negative outcomes depending on the context. For instance, some positive psychologists postulate that optimism could be a very positive force at the workplace as it could motivate project teams to work harder, have high levels of inspiration and set stretch goals (Luthans, 2002). In the same veil, negative psychologists believe that optimism has a downside effect that could lead to dysfunctional outcomes. As Hauschildt, Gesche, and Medcof (2000) report, the success of a project depend more on human factors, such as project leadership, top management support, and project team, rather than on technical factors. They also found that the human factors increased in importance as projects increased in complexity, risk, and innovation. Further, the researchers found that the critical role of the project manager's leadership ability had a direct correlation to project outcomes. With this understanding, this study tested a non-directional research hypothesis that:

H_A1: *Human behavior has significant influence on success of public infrastructural megaprojects.*

2.4.2 Ambiguity

In a study on managing structural and dynamic complexity, Brady and Davis (2014) use a comparative study of two successful megaprojects to illustrate the importance of handling ambiguity in order to deliver such projects successfully. The study underscores the need for: integrated project teams which are expected to come up with innovative solutions in the face of uncertainty and emergence; prototyping and testing new technology offsite prior to introduction on site; and an integrated change control system to deal with progressive elaboration in scope and its consequences.

To determine the relationship between ambiguity acceptance and project outcomes, Hargen and Park (2013) conducted an online survey of 2 Fortune 100 and 2 Fortune 500 companies, all of which had implemented Six Sigma and used teams as the core deployment tool for improvement projects. The companies selected had annual sales in the range of US$ 4 billion-US$ 51 billion with the total number of employees ranging between 34,000-122,000. In total, 123 team leaders and 125 team members responded to the survey. Using a combination of Principal Component Analysis, Correlation Analysis and Regression Analysis, the study confirmed that there is a curvilinear relationship between open communication and customer outcomes of a Six Sigma project in the team leader group but found a linear relationship in the team member group. The study also established a significant positive relationship between ambiguity and both customer and organizational outcomes, underscoring the relationship between ambiguity as a dimension of complexity and outcomes.

In a study of the antecedents and impacts of ambidexterity in project teams, Liu and Leitner (2012) used an in-depth case study of a complex infrastructure project facing unique challenges and tight budget and schedule to demonstrate the need for simultaneous pursuit of innovation and efficiency in complex engineering projects. They argue that both exploration and exploitation are likely to be needed for complex engineering projects to succeed. The study found that ambidexterity at the project team level is a significant contributor to project performance; the effects of temporal separation and project context on project performance are mediated by the project team's degree of ambidexterity.

A key contribution of the study by Liu and Leitner (2012) is the characterization of contextual ambidexterity as that which utilizes behavioral and social means of integrating exploration and exploitation. Contextual ambidexterity is achieved through empowering individuals to decide on the time spent on exploration activities or exploitation activities. To achieve contextual ambidexterity, alignment and adaptability of organizational activities and capabilities must be ensured so as to meet changing demands. In the case of the present study, we utilize contractual arrangements as one way of ensuring contextual ambidexterity in infrastructural megaprojects. As Ghosh, Williams, Askew, and Mulgund (2012) rightly observe, contracting strategy of a project is a driving force that gives stimulus to project pace.

In a study to investigate the importance and usefulness of stability (i.e., ability of schedules to absorb emerging disruption) to project outcomes, Swartz (2008) conducted a survey with managers involved in aviation systems development. The study established that stability was perceived to be as important as the more common measures of project performance (time, cost, quality) and that perceptions differed depending on program size, scope (both could be used to explain complexity) and stage of completion and between managers based on their levels of experience and training.

In a study to examine the influence of product requirements ambiguity on new product development task structures, Duimering, Ran, Derbentseva, and Poile (2006) used interview data from new product development project managers in a large telecom firm to show that knowledge of how the task structures evolve (emergence) can lead to improved strategies for managing projects with ambiguous requirements. These strategies include decomposition of project tasks to reduce interdependence among tasks and flexible adaptation of the task structures. The study also underscores the role of communication, coordination, knowledge and problem solving in resolving ambiguity.

From the foregoing, it is clear that ambiguity plays a major role in success of projects. The direction of the relationship of ambiguity and success is not apparent as there are instances when it leads to negative consequences and others when it leads to positive consequences. It is on this basis that this study sought to test a non-directional hypothesis that:

H_A2*: Ambiguity has significant influence on success of public infrastructural megaprojects.*

2.4.3 System Behavior

In a study titled, "Toward a Systemic View to Cost Overrun Causation in Infrastructure Projects", Ahiaga-Dagbui, Love, Smith, and Ackermann (2017) posit that a poor understanding and treatment of project complexity and systemicity is the most common shortcoming of cost overrun research undertaken thus far. They further contend that a vast majority of infrastructure overrun studies utilizing systems thinking frame the overrun problem in a manner that ignores the typological context of the projects. Thus, singular and independent causes of overruns that are identified through techniques such as multiple regression and correlation do not reflect the becoming nature of the infrastructural megaproject environment. The study recommends understanding overruns through an understanding of the entire system in which the project is implemented by using techniques such as cognitive mapping, retrospective sense-making and systems dynamics.

In a comparative study of two successful megaprojects, Brady and Davies (2014) provide a conceptualization of project complexity and its management following literature review. They categorize complexity into two, namely; Structural and dynamic. Dynamic complexity has already been explored under ambiguity. Structural complexity involves arrangement of components and subsystems into an overall system architecture and is a key determinant of system behavior. In their study, Brady and Davies (2014) advise that decomposition of the project into more manageable components is critical in handling structural complexity arising from systems hierarchy and interdependence among components, using a systems integrator to manage technical and organizational interfaces is useful for systems integration while collaborative arrangements such as the use of integrated project teams, co-location, transparency and proactive stakeholder engagement, is important in managing structural complexity arising from stakeholder relationships.

Using a non-experimental, quantitative approach, O'Donnell (2010) conducted a study with the objective of providing insight into the relationships among project management leadership practices, project complexity, and measurements of project success within a variety of projects across six different organizations. The primary population for the study comprised 105 project managers and approximately 300 project stakeholders (management, team members, sponsors, customers) within the United USA. In this study, project success was measured from two perspectives:

internal metrics of cost and time actual versus plan and an external survey of project stakeholder perceptions of success. Using Structural Equation Modelling, this study found that increasing project complexity had a strong, negative correlation to internal success but no relationship to external success. Also, complexity was shown to moderate the relationship between leadership and internal success, but again, did not moderate the relationship between leadership and external success, which remained strong throughout all levels of project complexity.

In an attempt to understand the impact of complexity on cost and schedule estimates, Shermon (2011) asked the question, "how accurate is a parametric model?" To determine the relative accuracy of estimates for a complex project, a data set was employed containing more than 90 fighter aircraft. The approach was to normalize the cost and technical data. Costs were normalized against currency, economics, economics and quantity. The technical data were normalized for metric, imperial and other such anomalies. After normalization, the fighter aircraft data were subjected to the analysis process and a simple parametric model was created. The historical projects then had their costs predicted based on this parametric model. To assess the accuracy of this technique, the predictions were plotted against the historical data and the coefficient of determination (R^2) calculated through a series of the graphs. The system provided a poor model with R^2=0.23. However, there was an immediate increase in accuracy when the complexity of the systems, indicated by the time dependent residual was added to the Cost Estimating Relationship (R^2=0.87) (Shermon, 2011).

The empirical literature for the studies reviewed show that system behavior has a relationship with project success. However, the direction of that relationship is not apparent even though one study expressly states that it could have negative effect on internal success. The present study takes the apriori view that depending on the context, system behavior can provide an opportunity to innovate and enhance outcomes. It is thus hypothesized that:

H$_A$3: *System behavior has significant influence on success of public infrastructural megaprojects.*

2.4.4 Project Leadership

In a comparative study of two megaprojects, Brady and Davies (2014) demonstrated how complexity leadership was applied by the British Airports Authority and the Olympic Delivery Authority to manage both structural and dynamic complexity. The two projects are the over US$ 7 billion Terminal 5 project and the over US$ 13 billion London 2012 Olympic Park, respectively. Both these projects were system of systems (array projects) with very high levels of complexity. In both projects there was deliberate effort to create collaborative culture and integrated teams were used to come up with innovative solutions to emergent problems. In the case of the London Olympics project, the overall leadership approach was tight-loose. Loosening behaviors (exploration) involve enabling conditions for interaction, search, experimentation and information flows whereas tightening behaviors (exploitation) involve reducing variance through choice, execution, standardization, and restricting information flows (Uhl-Bien, 2012).

In order to identify a leadership style which can maximize the potential for project managers to achieve project success, Blaskovics (2014) used a mixture of library search (archiving) and field research (using qualitative interview of four project managers from one Information Technology company) to prove that project managers use a special combination of leadership style based on emotional intelligence and leadership style based on behavior. The study showed that the more democratic elements like communication, empowerment or creating an atmosphere which supports generating innovative ideas contribute to project success to a greater extent. The results of the study showed that classic elements are very important to achieve project success and cannot be neglected, but it should be enhanced by a more democratic leadership style. These results are more important for the project managers in an agile project environment.

In a study to examine leadership and adaptability in the healthcare industry using a complexity lens, Uhl-Bien (2012) conducted qualitative investigation in 6 hospitals to examine leadership processes in the context of a strategic initiative. In this research, each hospital was visited twice-first with the executive team to identify the strategic initiative and second to snowball the sample. A total of 195 interviews were conducted between April 2008-July 2009. The study found that Healthcare is “in” complexity, which is evidenced by increasing variety in (and pressures from) the environment and the traditional leadership is inadequate for operating in these contexts because it generates an “ordered” response that does not meet the needs of complexity (Uhl-Bien, 2012). Despite the importance of “complex” responses, the study found that only 2 of the 6 hospitals engaged in leadership styles appropriate to a complex response. The other 4 hospitals responded using traditional leadership approaches. Of the two who engaged in complex responses, one was reported to be thriving but the other overwhelmed the system resulting in the leadership team being ejected. Of the 4 who engaged in traditional responses, 2 used overpowering administrative leadership that stifled or suppressed adaptive dynamics. The leadership teams of these hospitals were either completely turned over or in leadership transition. The other 2 were either in status quo or steady state.

In exploring the question as to whether successful leaders of large-scale complex projects have an internal process leading to a display of administrative, adaptive, and enabling behaviors that foster adaptive processes and enabling behaviors within their teams and with external stakeholders, Pisarski et al. (2011) developed a model in which they proposed interactions of key attributes, namely cognitive flexibility, affect, and emotional intelligence. The result of these cognitive-affective attribute interactions is leadership leading to enhanced likelihood of complex project success. According to this model, a project leader’s cognitive flexibility; affect, and emotional intelligence determine a project leader’s adaptive and maladaptive behaviors that, in turn, create adaptive or maladaptive structures and processes at the project level. Ultimately, it is these structures and processes that determine project outputs, outcomes and impact (Pisarski et al., 2011).

In a study designed to determine to what extent servant leadership can contribute to project success, Thompson (2010) used a quantitative descriptive research approach involving electronic online survey of 308 members of the Project Management Institute. The study used Chi-square tests to determine the relationship between the dependent variable, successful project outcomes and the independent variable, servant leadership. The results of the tests led to the rejection of all ten null hypotheses, indicating a relationship between successful project outcomes and servant leadership.

Using a non-experimental, quantitative approach, O'Donnell (2010) conducted a study with the objective of providing insight into the relationships among project management leadership practices, project complexity, and measurements of project success within a variety of projects across six different organizations. The primary population for the study comprised 105 project managers and approximately 300 project stakeholders (management, team members, sponsors, customers) within the United USA. In this study, individual leadership practices were determined using Kouzes and Posners' (1988) 360º Leadership Practices Inventory (LPI) whereas demographic, project type, and internal success data were gathered through project leader surveys. The study found positive and medium to strong correlations between leadership and external and internal project success. A limitation of this study is that it failed to revise the leadership instrument to reflect the complex context of projects.
In a study to determine whether a project manager's leadership competences contribute to project success, Geoghegan and Dulewicz (2008) utilized the Leadership Dimensions Questionnaire (LDQ) (Dulewicz & Higgs, 2005) and the Project Success Questionnaire (PSQ) (Pinto & Slevin, 1988a, 1988b) to prove that there is a statistically significant relationship between a project manager's leadership competences and project success. Based on the survey results of 52 project managers and 52 sponsors working within the same company, the study correlated the scores from the LDQ survey with those of the PSQ survey and found a statistically significant relationship between leadership and project success at both 99 percent and 95 percent confidence levels.

In a study of project managers, Sunindijo, Hadikusumo, and Ogunlana (2007) found that Emotional Intelligence (EI) affected project leadership and organizational outcomes. According to this study, project managers with higher scores on an EI assessment tended to use open communication and proactive leadership styles. The study also found that these Project Managers exhibited greater tendencies towards delegating and were perceived as bringing more positive outcomes to projects and the organization.

In meta-study of project management leadership research, Turner and Muller (2005) summarized the literature observing that project manager competence is related to success, different project styles are appropriate at each stage of the project life-cycle, multi-cultural projects require specific leadership styles, project managers have an important role in creating an effective work environment for team members, project managers prefer task-oriented behavior to people-oriented, and leadership style influences perceptions of success.

In a landmark study to assess leadership styles and organizational context, Dulewicz and Higgs (2005) conducted a review of the literature covering different leader behaviors in differing contexts of change and identified three distinct leadership styles namely, engaging leadership (focused on producing radical change with high levels of engagement and commitment), involving leadership (based on a transitional organization which faces significant, but not necessarily radical changes in its business model) and goal-oriented leadership (a Leader-led style aligned to a stable organization delivering clearly understood results). They also developed the Leadership Dimensions Questionnaire (LDQ) containing 15 dimensions made up of 3 Intellectual Dimensions (IQ), 5 Managerial Dimensions (MQ) and 7 Emotional and Social Dimensions (EQ) using a combination of content and item analysis.

Further analyses on leadership style and organizational context using the final version of LDQ was conducted by Dulewicz and Higgs (2005) on data from the combined sample from two pilot studies. The sample consisted of 222 managers and officers. The profile for each style, based upon the range (high, medium, or low) of scores obtained on the 15 LDQ dimensions were then developed based on content analysis of the literature on leadership. Initially, this focused on the transformational and transactional behaviors which were context-based (Bass, Avolio, & Berson, 2003) and subsequently expanded to encompass the change leadership and broader change literature. The engaging style was informed by authors working in the transformational and change leadership fields (Higgs & Rowland, 2003; Kouznes & Posner, 1998). The traditional and the transactional leadership literature informed the development of the goal-oriented style (Bass, 1995). The involving style was again informed by both more traditional and change leadership literature (Higgs & Rowland, 2003).

Empirical literature reviewed thus far indicates that project leadership could impact outcomes and depending on the context, a leadership style may enhance or impede successful delivery of a project. It is on this basis that this study hypothesized that:

H$_A$4: *Project* l*eadership has significant moderating effect on complexity and success of public infrastructural megaprojects*

2.4.5 Project Success

Based on PMI (2013a) study, fewer than two-thirds of all projects fail to meet their original goal and business intent which puts US$135 million at risk for every US$1 billion spent on a project. The trend becomes more troubling for projects with added complexity (such as megaprojects), which, on average, have budgets nearly twice as large. In a survey of 1,208 executives around the world, Bain and Company (2013) found that 63 percent of global executives reported that excessive complexity is raising their costs and hindering their growth. Research conducted by Flyvbjerg, Holm, and Buhl (2002) pointed to the fact that transport infrastructure projects were reported to have an 86% probability of incurring cost overrun and the overruns could be as high as 70% and 183% more than the initial estimates (Love, Sing, Wang, Irani, & Thwala, 2012; Odeck, 2004).

In a study of 258 transport infrastructure projects, Flyvbjerg et al. (2004) found that nine out of ten such projects had cost overruns; overruns of up to 50 percent in real terms are common, over 50 percent are not uncommon. Flyvbjerg (2014) lists several megaprojects across the world that have been delivered in conformity with the Iron Law. In Africa, the Egyptian Suez Canal recorded the largest cost overrun at 1,900%; the Chad-Cameroon Oil Pipeline project which was originally estimated to cost US$ 3.7 billion but was delivered at US$ 4.2 billion with huge benefit shortfalls (Bank Information Center-BIC, 2008); the Basilica of Our Lady of Peace of

Yamoussoukro-Ivory Coast (which at the time of writing this thesis was the largest church in the world according to the *Guinness Book of World Records*) was originally estimated to cost US$ 300 million. This church was delivered at US$ 360 million. Ironically, today the church is hardly half full (Shiferaw & Klakegg, 2012); the Bujagali Falls 250 MW dam project in Uganda was originally estimated to cost US$ 530 million. It was delivered in July 2012 at a cost of US$ 900 million with huge benefit shortfalls. (International Rivers, 2012).

Based on a study conducted by the Standish Group (2001), over 30 percent of projects were considered failed by a 1994 survey of project managers. The same survey, having been repeated every 2 years since, found that the failure rate had improved to less than 25 percent by 2000 but a majority of projects (76 percent) continued to be considered either failed or challenged (Standish Group, 2001). A closer look at the statistics indicated that there was a clear inverse correlation between project success and the size of the project. The Standish Group survey showed that as project size increased from small projects (less than 6 team members, cost less than $750,000) to large projects (over 500 people and costs in excess of $10 million) the success rates of the projects falls dramatically. Small projects succeeded at almost a 60 percent rate while medium size projects success rate was about percent and the very largest projects rarely succeeded (Standish Group, 2001).

In a research study aimed at analyzing project success, highlighting those success criteria which the project managers have an impact on and identifying a leadership style which can maximize the potential for them to achieve project success, Blaskovics (2014) used a mixture of library search (archiving) and field research (using qualitative interview of four project managers from one company) to prove that managers directly have an impact on the project triangle and on the stakeholder satisfaction, while they have an indirect impact on the client satisfaction. So project managers could have an impact on all three layers of project success.

2.5 Critique of the Existing Literature

Available literature showed that project success had been researched extensively over the last three decades. Most of the authors on this subject agreed that project success is multidimensional often citing operational excellence (time, cost, quality) and product success as key measures of project success. However, there was little attention given to contextual measures of project success. For instance, very few researchers (Shenhar, Dvir, & Levy, 1997; Shenhar, Dvir, Levy, & Maltz, 2001; Shenhar & Dvir, 2007a; Hoegl & Gemuenden, 2001) considered the outcomes of complexity leadership in defining project success measures. As a result, project success measures were presented in a one size-fits-all manner without considering the typology, type or size of the project.

Project success should also be construed from the context in which the project is implemented. This means that when deciding whether a project has been successful or not, triangulation, cognitive mapping and retrospective sense making are required to ensure that the project context is considered. It is in this light that some studies have called for the use of chaos theory (and complex adaptive systems theory) in contextualizing megaproject performance. In other words, success criteria for complex megaprojects should take into account the main outcomes of complexity leadership namely; innovation, learning, adaptability and new organizational forms.

It is widely acknowledged in practice that project complexity affects performance. However, in most of the literature, this claim is made in passing. For instance, there appeared to be no study that had individually linked the causes of complexity (i.e., human behavior, system behavior, ambiguity) to project success. Instead, only aspects of these broader measures of complexity had been considered. Most of the complexity literature concentrated on characterizing complexity on projects. The result of this characterization was the identification of various categories and frameworks that can be used to analyze and classify the complexity that is inherent in projects. For instance, project complexity can now be classified as either structural or dynamic or being caused by human behavior, system behavior or ambiguity. This categorization is an important beginning point in determining how to manage complexity in projects. By understanding its root causes, appropriate management strategies can be pursued to ensure that complexity does not continue leading to project failure.

Leadership on projects and other temporary organizations has been extensively researched. However, like project success, leadership research on projects has not kept the pace in addressing emerging issues of project complexity. Leadership studies have generally been conducted assuming fairly stable organizational settings in which the concepts of “project” and “project management” are well defined. However, temporary complex organizations such as megaprojects require approaches that differ from those used in permanent organizations (Chen et al., 2004; Packendorff, 1995). Unlike in simple and complicated contexts where leadership of projects is fact-based, complex and chaotic contexts require pattern-based leadership (Snowden & Boone, 2007).

It is contended that traditional project managers oversimplify the processes involved in managing people and this oversimplification leads to project failure (Whitty & Schulz, 2007). A leader’s ability to cope with complexity and not to look for reductionist strategies should therefore aid project success and the emergence of adaptive systems. Uhl-Bien and Marion (2009) propose that adaptive leaders will be adept at recognizing and engaging with the complex interactive dynamics as they emerge; and that adaptive leadership should therefore produce a rich flow of information to stimulate and to enhance the effectiveness of leadership in a dynamically complex situation.

A deep understanding of context, the ability to embrace complexity and paradox, and a willingness to flexibly change leadership style is required for leaders who want to make things happen in a time of increasing uncertainty (Snowden & Boone, 2007), as is the case in megaprojects. There is need to deemphasize the “ontology of being” (Chia, 1995) on which the pre-modern and modern project management is based, in favor of the “virtual and process ontology” on which the postmodern and hypermodern project management is based. Such a view presupposes that leadership is emerging in social interaction, and that traditional leader-follower distinctions should be problematized (Packendorff, Crevani, & Lindgren, 2014).

A study similar to this was conducted by O'Donnell (2010). In seeking to establish the relationships among project management leadership practices, project complexity, and measurements of project success, the study identified leadership practices as the independent variable, project complexity as the moderating variable and project success as the dependent variable. Whereas this study had interesting findings, a fundamental question is whether project complexity should have been the independent variable. It is contended that in the context of process and virtual ontology, leadership style becomes depending on the context and not vice versa. A leader of a complex project exhibits exploitation or exploration behaviors depending on the level of complexity. As such, project complexity should be the independent variable and leadership style should be treated as a variable moderating the influence of complexity on megaproject success.

In a study to establish the relationship among leadership style, complexity and project success, O'Donnell (2010) neither reviewed the complexity theory nor the complexity leadership theory. Without a review of these theories, the study was not contextualized and anchored. To some extent, the study reviewed emergence and the growth of project management but this review did not extend beyond the projects of modernity. Thus, the study missed the opportunity to capture the real context in which contemporary projects fall.

2.6 Summary of the Existing Literature

Complexity is a characteristic of a program or a project or its environment that is difficult to manage due to human behavior, system behavior, and ambiguity. It is not directly proportional to the size of a program or a project as small programs and projects may contain substantial complexity. Programs and projects with complexity may fluctuate between conditions of relative stability and predictability to instability and uncertainty.

Megaprojects are some of the most complex type of projects. This complexity is the main cause of the iron law of megaprojects. The most important skills for the successful navigation of this inherent complexity in programs and projects is leadership. A megaproject leader should always use a flexible leadership style, which implies that the style changes with the context and the program or project team or individuals. The characteristics of the postmodern projects imply that the pre-modern and modern leadership approaches cannot be effectively applied to rid complex megaprojects of the iron law. The literature strongly suggests that context is highly relevant to leadership style.

Unlike other models of leadership such as transformational and situational leadership, complexity leadership does not view change as only, or even primarily, top-down; it does not see change as being led in the traditional sense of the word. Rather, a core premise of complexity leadership is that change is emergent, unpredictable, and essentially uncontrollable. The main outcomes of complexity leadership are innovation, learning, adaptability and new organizational forms.

2.7 Research Gaps

Prior studies have confirmed that complexity inherent in the context of infrastructural megaprojects is the main cause of their bizarre performance (Cooke-Davies, Crawford, & Stephens, 2011). However, none of these studies has included Kenya. This is despite the fact that Kenya continues to increasingly use complex infrastructural megaprojects to deliver goods and services to its citizenry. Further, existing studies on complexity have not established the causal relationship between its components and project success. Instead, complexity has been studied as a composite variable assuming that its causes are equally weighty. Without a coherent research agenda to understand both its causes and navigation strategies, complexity continues to result in problems, waste, economic and social failure (Remington & Zolin, 2011).

Several studies have singled out the project manager's leadership skill as the most important for successful navigation of complexity (PMI, 2013a). Unfortunately, existing studies on project leadership cannot be generalized to complex megaprojects since these studies have been based on the pre-modern and modern social worlds, both of which assume fairly orderly and stable organizational settings (Chen et al., 2004; Packendorff, 1995). On the contrary, megaprojects are implemented in an unstable and unorderly postmodern social world of emergence and rapid change, where the sum of the parts of a system are less than the whole (PMI, 2014); and project management is neither a practice nor a tool but a rallying rhetoric in the context of power play, domination and control (Gauthier & Ika, 2012).

Where studies on the relationship among project complexity, leadership and success have been conducted, leadership has been treated as an independent variable that causes project success while complexity has been treated as a moderating variable (O'Donnell, 2010). The present study contends that such conceptualization is flawed to the extent that project leadership is constantly in becoming depending on the context and therefore, complexity determines the project manager's leadership behavior.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter discusses the methodology followed by the study. The first section presents the research philosophy and design on which the study was anchored. The target population of the study is presented in the next section followed by a description of the sampling frame, sample and sampling technique. The remainder of the chapter describes the instruments of the study, data collection procedure followed by data processing, analysis and presentation. A table showing how the study variables were operationalized is also included in this chapter together with a description of the pilot study and diagnostic tests conducted on data.

3.1 Research Philosophy and Design

This study was operationalized through exploratory, descriptive and explanatory research goals based on Neuman (2003) classification of research goals. To achieve these goals, a post-positivist philosophy emphasizing virtual constructionist ontology (Gauthier & Ika, 2012) was assumed. This philosophy utilizes both interpretivist (Bryman & Bell, 2007) and pragmatist (Goldkuhl, 2012) epistemologies to generate knowledge based on a combination of deductive and inductive approaches. Given that complexity is the midpoint between order and disorder, the virtual constructionist ontology was deemed appropriate as it combines the characteristics of both the Heraclitean ontology of "becoming" and the Parmedean ontology of "being".

The choice of this philosophical perspective was guided by the social world of complex megaprojects. In this social world, a project is a discourse of legitimation and an arena of social and power plays; serving the interests of powerful stakeholders. As such, megaproject management is neither a practice nor a tool (as is the case with projects implemented in the modern social world) but a rallying rhetoric in a context of power play, domination and control (Gauthier & Ika, 2012).

This study was designed to be mixed-method research combining both quantitative and qualitative strategies (Burch & Carolyn, 2016). The mixed-method research provides an epistemological paradigm that occupies the conceptual space between positivism and interpretivism (Tashakkori & Creswell, 2007), the main epistemologies on which the virtual constructionist ontology thrives. Interpretivism was particularly important in mapping individual as well as group behavior, characterizing project culture and determining the leadership styles.

To generate data for this study, a cross-sectional survey design was used. This design entails the collection of data (predominantly by questionnaire or structured interview) on usually quite a lot more than one case and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables, which are then examined to detect patterns of association (Bryman & Bell, 2007). A variant of this research design involving qualitative interviews and archiving was used to build up a body of qualitative data.

3.2 Target Population

This study had as its primary population public sector infrastructural megaprojects implemented by the government of Kenya since 2005. Given the continual reorganizations within government and the several projects implemented by the government, it was unlikely that project records earlier than 2005 could be traced with ease. Following Flyvbjerg (2014), the minimum budget for megaprojects included in this study was approximately Ksh. 1 billion. A total of 31 projects were identified as having been completed from Vision 2030 Secretariat.

Managers, team members, sponsors and key stakeholders of these projects constituted the population of respondents from whom data was collected. These respondents were selected since they represent the three basic interest on any project namely; business interest, supplier interest and user interest (Axelos, 2017). The rationale for selecting infrastructure among other foundations of national transformation was based on its huge actual and projected expenditure in comparison to other sectors. Specifically, in the Government of Kenya (2013) Second Medium Term Plan, infrastructure was allocated over Ksh. 7.5 trillion with the second highest allocation of Ksh. 2.5 trillion going to the Information, Communication and Technology sector.

3.3 Sampling Frame

The sampling frame of this study comprised a listing of completed public sector infrastructural megaprojects implemented in Kenya since 2005 with a minimum budget of approximately Ksh. 1 billion. The list of these projects was obtained from the Vision 2030 Secretariat and counterchecked with key informants from government parastatals. A total of 31 such projects was identified as shown in Appendix 2. The Table below shows the distribution of those projects.

Table 3.1: Distribution of Completed Megaprojects

Government Agency	No. of Completed Megaprojects	Percentage of Total
Kenya Airports Authority	6	19.36%
Kenya Pipeline Company	2	6.45%
Kenya National Highways Authority	9	29.03%
Kenya Urban Roads Authority	6	19.36%
Kenya Ports Authority	2	6.45%
Kenya Power & Lighting Company	3	9.68%
Kenya Civil Aviation Authority	1	3.22%
Geothermal Development Company	1	3.22%
KENGEN	1	3.22%
Total	**31**	**100%**

3.4 Sample and Sampling Technique

Given the number of completed infrastructural megaprojects for the period under study as described by the sample frame, a census survey was found to be appropriate. Generally, when a sample frame is known, it can also be construed to mean that the population is known. In this case, collecting data on each member of the population becomes possible. The study used the completed public infrastructural megaprojects as the unit of analysis and a total of 31 such projects were sampled for study.

The unit of observation comprised project managers, project sponsors and project team members. These were purposively selected as respondents since they represent the three key interests on a project namely; business interest, supplier interest and user interest (Axelos, 2017). Following this approach, for each sampled project, a total of four respondents were selected comprising the project manager, two team members and one sponsor. In total, 124 respondents were selected to participate in this study composed of 31 project managers, 62 project team members and 31 sponsors. The project manager provided data on the overall complexity of the project while the project sponsor provided data on the overall success of the project. The team members provided responses to the leader-behavior questionnaire used to determine the manager's leadership style.

3.5 Instruments

The fieldwork for this study utilized three interlinked questionnaires namely, the Complexity Assessment Questionnaire (CAQ), the Leadership Behavior Questionnaire (LBQ); and the Project Success Questionnaire (PSQ). The CAQ was constructed based on the Practice Standard for Navigating Complexity (PMI, 2014) while the LBQ simulated the Leadership Dimensions Questionnaire (Dulewicz & Higgs, 2005). The PSQ was developed based on Shenhar and Dvir (2001) and McLeod et al. (2012). The questionnaire survey is hailed to be an efficient data collection mechanism when the researcher knows exactly what is required and how to measure the variables of interest (Neuman, 2003). All the 3 questionnaires utilized a mixture of Likert scale, open ended questions, checklists and probing questions including those soliciting for specific project metrics.

The Practice Standard for Navigating Complexity (PMI, 2014) was selected as an appropriate benchmark for the development of the CAQ given the rigor and wide stakeholder participation in its development. The Leadership Dimensions Questionnaire ((Dulewicz & Higgs, 2005) was used as a reference point to develop the LBQ given its validity and reliability. It is a proven questionnaire supported by previous research (Geoghegan & Dulewicz, 2008) and provides an indication of the respondent's leadership competences measured on 15 dimensions (Dulewicz & Higgs, 2005).

One important feature of the Leadership Dimensions Questionnaire is its ability to relate profiles of the scores across the 15 dimensions to three different leadership styles (viz., goal-oriented, involving and engaging). These styles are independent of four important variables namely; gender, sector, function, nationality and personality of the respondent (Dulewicz & Higgs, 2005).

The PSQ used in this study incorporates broader project success measures beyond the traditional critical dimensions of the "iron triangle". It incorporated the framework by Shenhar and Dvir (2004) which measures project success using efficiency, impact on team, impact on customer, business and direct organizational success, and preparing for the future. The PSQ also incorporated Pinto and Slevin's (1986) Project Implementation Profile (PIP) questionnaire that uses a model of project success composed of two key themes-the project and the client. Table 3.2 links the study variables to the instruments which are shown in Appendix 1.

Table 3.2: Operationalization of Study Variables

Variables	Indicators	Reference	Instrument Items
Human behavior	i. Individual behavior ii. Group behavior iii. Organizational design and development	PMI (2014), Cooke-Davies (2011), Maylor, Vidgen, and Carver (2008), Hauschildt, Gesche, and Medcof (2000)	**Complexity assessment Questionnaire:** Complexity Dimension 1
Ambiguity	i. Uncertainty ii. Emergence iii. Context	PMI (2014), Remington and Pollack (2011), Carver and Maylor (2011), Geraldi, Maylor, and Williams (2011)	**Complexity assessment Questionnaire:** Complexity Context: B1-B6 Complexity Dimension 2
System behavior	i. Connectedness ii. Dependency iii. System dynamics	PMI (2014), Baccarini (1996), Sargut and McGrath (2011), Loch, de Meyer, and Pich (2006)	**Complexity assessment Questionnaire:** Complexity Dimension 3

Project Leadership	i. Goal-oriented ii. Involving iii. Complexity	Northouse (2016), Dulewicz and Higgs (2005), Uhl-Bien, Marion, and Mckelvey (2007), Uhl-Bien and Marion (2009), Snowden and Boone (2007)	**Leadership Behavior Questionnaire** A1-A6: Intellectual Behavior (IQ) B1-B18: Managerial Behavior (MQ) C1-C13: Emotional and Social Behavior (EQ) D1-D16: Adaptive Behavior (AQ)
Project success	i. Process success ii. Product success iii. Organizational success	Turner (2007), Jugdev and Muller (2005), Shenhar, Dvir, Levy, and Maltz (2001); Thomas and Fernandez, (2008), Bannerman (2008), Shenhar and Dvir (2007), Pinto and Slevin (1988), McLeod et al. (2012)	**Project Success Questionnaire** Part A: Process Success Part B: Product Success Part C: Organizational Success

3.5.1 Validity and Reliability of Data Collection Instruments

Validity

Validity shows how well the concepts and constructs are defined by the measures (Hair, Anderson, Tatham, & Black, 1998). Concept validity was ensured through thorough review of both theoretical and empirical literature from which the research propositions were derived. On the other hand, construct validity was ensured partly through the use of existing theories and earlier research results for the definition of measurement dimensions and the development of questionnaire items. Using the results of the pilot test, item-to-item and item-to-total measures were further used to ensure construct validity.

External validity was ensured by including the user, supplier and business interests as respondents to the questionnaires. This ensured that the results of the study could be generalized to most megaprojects. Finally, internal validity to ascertain causality was ensured by conducting hypothesis tests on individual partial regression coefficients using *t*-test and through testing the overall significance of the estimated regression models.

Reliability

Reliability is concerned with the question of whether the results of a study are repeatable. It is concerned with whether or not the measures that are devised for concepts are consistent (Bryman & Bell, 2007). Cronbach's (1951) coefficient alpha (α) was used to measure the reliability of the scales. This is because the underlying assumption of the Likert scale is that it represents an underlying continuous latent scale, although the observations are ordinal (Likert, 1931), and a high score of Cronbach's coefficient alpha means high reliability, stability and accuracy (Papadopoulos, Ojiako, Chipulu, & Lee, 2012). Mathematically, if there are *p* sub-items used, the coefficient alpha is calculated as:

$$\alpha = \frac{p}{p-1}\left(\frac{s_t^2 - \sum s_i^2}{s_t^2}\right) \text{.. } (\textit{Equation 1})$$

where s_t^2 is the variance of the scores for the summation of the individual sub-items and $\sum s_i^2$ is the sum of the variance of individual items.

If the sub-items have high agreement and are highly correlated then α will be close to 1. Hair, Babin, Money, and Samouel (2003) asserted that an alpha coefficient between 0.8 and 0.9 shows very good strength of association. When α is ≥ 0.7, the scale is generally reliable (Nunnally, 1978). The reliability measures calculated were compared with these benchmarks.

3.6 Data Collection Procedure

The first phase of data collection involved a pilot study that tested both the feasibility of the data collection schedule and the reliability of the data collection instruments. This phase utilized questionnaires, expert judgment, archiving, content analysis and in-depth face to face interviews. Each of the questionnaires were reassessed based on the outcome of the pilot study and the data collection schedule was adjusted accordingly. The outputs of this phase were used to inform planning for the second phase which involved administering the CAQ, LBQ and the PSQ to the wider respondents.

The second phase entailed primary data collection using the three questionnaires. The first instrument to be administered was the CAQ. Given the technical nature of the CAQ, the researcher was mostly present when it was being filled by the project managers in order to make clarifications as required. The LBQ and PSQ were delivered to the team members and sponsors respectively and were collected after being completed. The researcher made follow-on clarifications on the data provided by the respondents on phone.

3.7 Data Processing, Analysis and Presentation

3.7.1 Data Processing

Raw data were collected from respondents using hard copy questionnaires. Each questionnaire was coded using the project title to avoid mixing up data for different projects. To aid in data input, processing and storage, this study utilized the Statistical Package for Social Sciences (SPSS) version 20, Microsoft Access 2010 and Microsoft Excel 2010. The original database was created in MS Access (due to its versatility) and then transferred to SPSS for ease of processing. MS Excel was used to complement SPSS in navigating through data sets during processing for analysis. The SPSS software was chosen for its analytical superiority, availability and ability to handle large amounts of data.

3.7.2 Data Analysis

Qualitative Data Analysis

Qualitative data analysis was conducted using cognitive and scenario mapping, and through triangulation. Both cognitive and scenario mapping allow for grouping together of like items so as to identify key categories and causes of a phenomenon. Triangulation on the other hand involves the use of three or more theories, sources or types of information, or types of analysis to verify and substantiate an assessment (Kusek & Rist, 2004). In this study, causes of cost and schedule overruns in projects, determination of typical project culture based on individual behaviors, and determination of typical project leadership behaviors and styles, were all done using mapping and triangulation. The Competitive Values Model (Livari & Huisman, 2007) was specifically used to map individual behaviors onto typical project/organizational cultures.

Quantitative Data Analysis

This was done using both descriptive and inferential statistics. SPSS version 20 was largely used in quantitative analysis. Descriptive statistics for quantitative data analysis were derived using frequencies and percentages, measures of central tendency (mainly the mean), measures of dispersion (mainly standard deviation coefficient of variation, skewness and kurtosis), Earned Value measures (mainly Cost Performance Index, CPI and Schedule Performance Index, SPI) and scoring (unweighted scores and Standard Ten Scores). Inferential statistics used were derived using parametric tests (i.e., regression and correlation analysis) and Analysis of Variance (ANOVA);

The overall model for this study assumed the form of a moderated regression model and was specified as:

$$\bar{P}S_i = \beta_1 + \beta_2 HB_i + \beta_3 AM_i + \beta_4 SB_i + \beta_5 L_i + \beta_6 HB_i L_i + \beta_7 AM_i L_i + \beta_8 SB_i L_i + \mu$$

(Equation 2)

where μ_i is the stochastic term and β_2, β_3, β_4 and β_5 *are* the slopes of the regression equation on account of human behavior, ambiguity, system behavior and leadership, and β_1 is the intercept. B_6, β_7, and β_8 are the slopes of the regression equation as a result of the interaction with leadership.

The regression coefficients were extracted using Ordinary Least Squares (OLS) method and tested for significance at the 95 percent confidence level using two-tailed *t*-test based on the hypothesis that:

$H_0 : b_i = 0$;

$H_A : b_i \neq 0$; where b_i are the values of individual betas in the estimated regression equation.

The significance of the individual models was tested using multiple coefficient of determination (R^2), the *F-test* and the *P*-Value. The overall significance of the moderation model was tested using $R^2 change$ which shows the increase in variation explained by the introduction of the interaction term.

Diagnostic Tests

The suitability of data for parametric tests (i.e., correlation and regression analysis) was conducted using diagnostic tests of normality, multicollinearity, autocorrelation and heteroscedasticity. Since parametric tests assume normal distribution of data sets, it was important to confirm that the distribution of collected data approximated a normal distribution. The normality test was conducted by calculating the measures of skewness and kurtosis and comparing them with the benchmark values. Skewness involves the symmetry of distribution of the variable about its mean, whereas kurtosis involves the peakedness of probability distribution of a variable (Hassan, Bashir, & Abbas, 2017). When the coefficient of skewness is within the -1 to +1 range and coefficient of kurtosis is within the range of -2.2 to +2.2, the data are assumed to be approximately normally distributed (Sposito, Hand, & Skarpness, 1983) and therefore pass the normality test.

Parametric tests also require that the regressors included in the regression model are not collinear. If the regressors are linearly related, then the problem of multicollinearity arises. To ensure that this was not the case for this study, Variance Inflating Factor (VIF) was determined. VIF measures the speed with which variances and covariances increase. It shows how the variance of an estimator is inflated by the presence of multicollinearity (Gujarati & Porter, 2009). For large samples, when VIF is greater than 10 then the problem of multicollinearity is said to be present. For smaller samples, a VIF greater than 4 implies presence of multicollinearity (O'Brien, 2007).

The problem of autocorrelation, also referred to as serial correlation arises when the error terms are correlated. The use of parametric tests requires that the error terms are not correlated. To check for autocorrelation, the Durbin-Watson statistic was calculated and its value compared with the benchmark which is usually a value of 2 (Gujarati & Porter, 2009). A value of less than 2 means than this problem is absent and therefore the data are fit for use.

One of the important assumptions of the classical linear regression model is that the variance of each disturbance term, conditional on the chosen values of the explanatory variables, is some constant number. Thus, the error terms are expected to exhibit equal spread (homoscedasticity). To ensure that this was the case for data in this study, residual statistics were plotted on a scatter diagram.

3.7.3 Data Presentation

Analyzed data was presented using tables, figures, charts, equations and text. Tables and figures were used to present descriptive data while equations were used to present inferential statistics. Explanations and discussions of both descriptive and inferential statistics was done using text.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

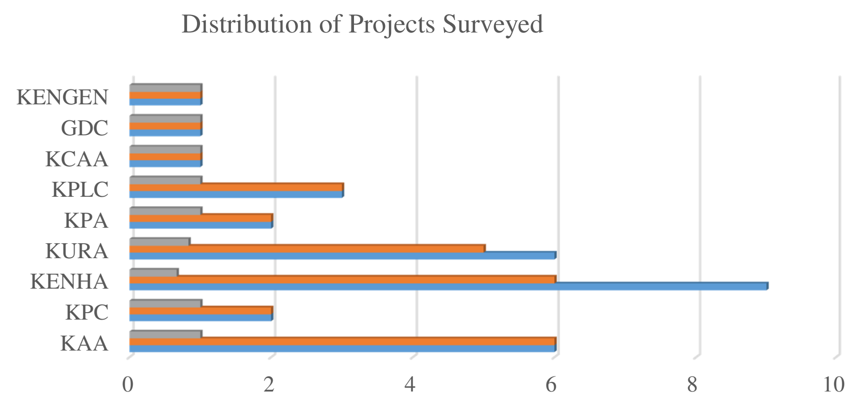
4.1 Introduction

This chapter presents the findings of the study together with a discussion of those findings in light of the literature reviewed. The first part of the chapter provides a brief description of the projects surveyed and the response rate. This is followed by the results of the pilot study. The findings of the main study are presented next starting with the dependent variable. Results for each of the independent variables are first presented descriptively followed by the tests of hypothesis and a discussion of the results. In the final section, the results of the moderated model are presented and discussed followed by a revised model. This revised model represents the optimal model of the study.

4.2 Projects Surveyed and Response Rate

The projects surveyed had a budget at appraisal ranging from approximately Ksh. 1 Billion to Ksh. 40 Billion with 8 of these projects (29.6%) having a budget at appraisal of over Ksh. 10 Billion. The scheduled duration for these projects ranged from 4 months to 72 months with most projects having a scheduled duration of above 20 months. The project locations were spread across several counties in Kenya. All the surveyed projects were turnkey, involving a variation of Engineer-Procure-Construct (EPC) and Design-Build-Transfer (DBT) delivery arrangements. The megaprojects studied fall into two main categories following the classification by Shenhar and Dvir (2007a). Most of the projects were system projects which produced a single outcome such as the KCAA Headquarter building, comprising a collection of assemblies, components and subsystems. Yet others, such as the Mombasa Port Modernization Project, were array projects (system of systems) that integrated a collection of systems functioning together to achieve a common goal.

Of the 124 respondents sampled for this study, a total of 108 participated in the study representing a response rate of 87.1%. Of these, 27 (25%) were project managers, 54 (50%) were project team members while 27 (25%) were project sponsors. 27 out of the 31 completed public infrastructural megaprojects were surveyed representing 87.1% of the entire population. Chart 4.1 shows the distribution of the projects surveyed.



	KAA	KPC	KENHA	KURA	KPA	KPLC	KCAA	GDC	KENGEN
Percentage Surveyed	100%	100%	66.70%	83.30%	100%	100%	100%	100%	100%
Surveyed Megaprojects	6	2	6	5	2	3	1	1	1
Completed Megaprojects	6	2	9	6	2	3	1	1	1

Chart 4.1: Distribution of Projects Surveyed

4.3 Results of Pilot Study

The pilot test involved validating data collection instruments and testing the feasibility of the data collection schedule. Through this study, the reliability and dimensionality of the measurement scales were tested to ensure that the items in the scales actually and reliably measured the intended variables. A total of four megaprojects (2 from Kenya Airports Authority and 2 from Kenya Urban Roads Authority) and 16 respondents were surveyed as part of the pilot study. This was well above the “10% of the sample projected for the larger parent study” rule (Connelly, 2008).

The results of the pilot study showed that the three data collection instruments were fairly reliable with each of them recording a Cronbach's alpha greater than the cut-off value of 0.7. The individual reliability measures are shown in Table 4.1.

Table 4.1: Reliability of Individual Scales

Scale	Number of Items in the Scale	Cronbach's Alpha Value
Overall Complexity	59	0.787
Human Behavior	22	0.879
Ambiguity	19	0.837
System Behavior	13	0.784
Project Leadership	53	0.980
Project Success	18	0.889

Pilot results were also used to test validity of the concepts and constructs used in this study. For the complexity scale, the results of the pilot study showed that communication and control which had been included in the research conceptual framework as a measure of ambiguity strongly mapped onto the measures of human behavior. Thus, the questionnaire was revised to include the measures of this construct under human behavior. Further, as a result of the pilot study, the research conceptual framework was revised to include context as a measure of ambiguity. Context had been included in the complexity questionnaire but not captured in the research conceptual framework.

4.4 Findings of the Main Study

The study sought to investigate the moderating role of project leadership on the influence of project complexity on success of public infrastructural megaprojects in Kenya. This was done through a set of four specific objectives namely;

i. To determine the influence of human behavior on success of public infrastructural megaprojects

ii. To determine the influence of ambiguity on success of public infrastructural megaprojects

iii. To determine the influence of system behavior on success of public infrastructural megaprojects

iv. To explore the moderating role of project leadership on complexity and success of public infrastructural megaprojects

The findings of this study are presented in the sections that follow based on the variables in each specific objective. For each variable, the findings are first presented for each indicator then a detailed discussion of those findings is presented. Findings on the dependent variable are presented first to provide a basis for relating with the findings for each of the independent variables.

4.4.1 Project Success

Infrastructural Megaproject success was measured along three constructs namely process, product and organizational success. The success scale comprised 18 items blending open and closed ended questions on one part and Likert-type questions on the other part. The first part involving closed and open ended questions was meant to assess process success while the Likert type questions assessed product and organizational success on a scale of 1 (strongly agree), 2 (agree), 3 (Neither agree nor disagree), 4 (disagree) and 5 (strongly disagree).

Process success

Process success incorporated the traditional measures of efficiency (delivery within budget and time schedule) and quality. Efficiency was measured using the cost and schedule performance indices with the weighted average of these indices calculated to denote the overall efficiency index for the project. Simple weighted averages of the CPI and SPI values were calculated to give the Weighted Project Efficiency (WPE) values for each project. The WPE measures for each of the 27 megaprojects were rated based on a predetermined scale in order to assign a score for project efficiency. The maximum score on this scale was 5 (WPE greater or equal to 1) and the lowest score was 1 (WPE is less or equal to 0.4). The quality score was based on the effect of changes (if any) to the scope baseline and was based on a scale of 1 (no or low impact) to 3 (high impact). The process success score was determined by adding a score for project quality to the score for project efficiency.

The CPI results showed that 14 projects (52%) were delivered over budget, 9 projects (33%) were delivered on budget with the remaining 4 (15%) being delivered under budget. SPI results showed that of the 27 megaprojects surveyed, 22 (81%) were delivered behind schedule, 3 (11%) were delivered on schedule while 2 (7%) were delivered ahead of schedule. The four sets of factors that were cited for budget overruns are: scope changes (37%); claims and penalties (22%); currency fluctuation and inflation (22%); and procurement issues (18.5%). Figure 4.1 summarizes these causes of cost overrun.

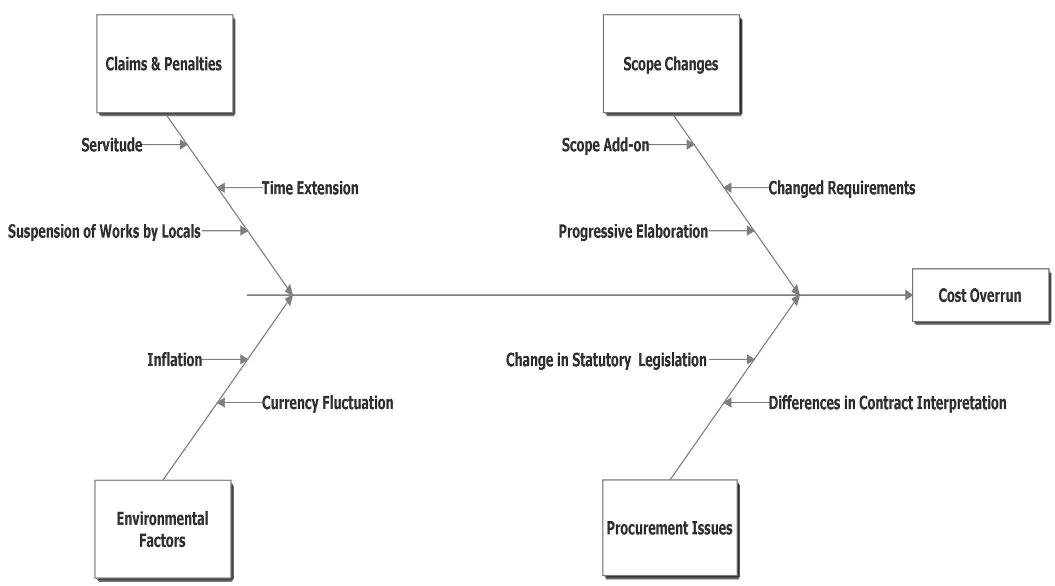


Figure 4.1: Major Causes of Cost Overrun

The four sets of factors that were cited for schedule overrun are: environmental factors (48%); stakeholder issues (36.8%); scope changes (33%); and procurement issues (33%). Figure 4.2 summarizes the causes of schedule delay.

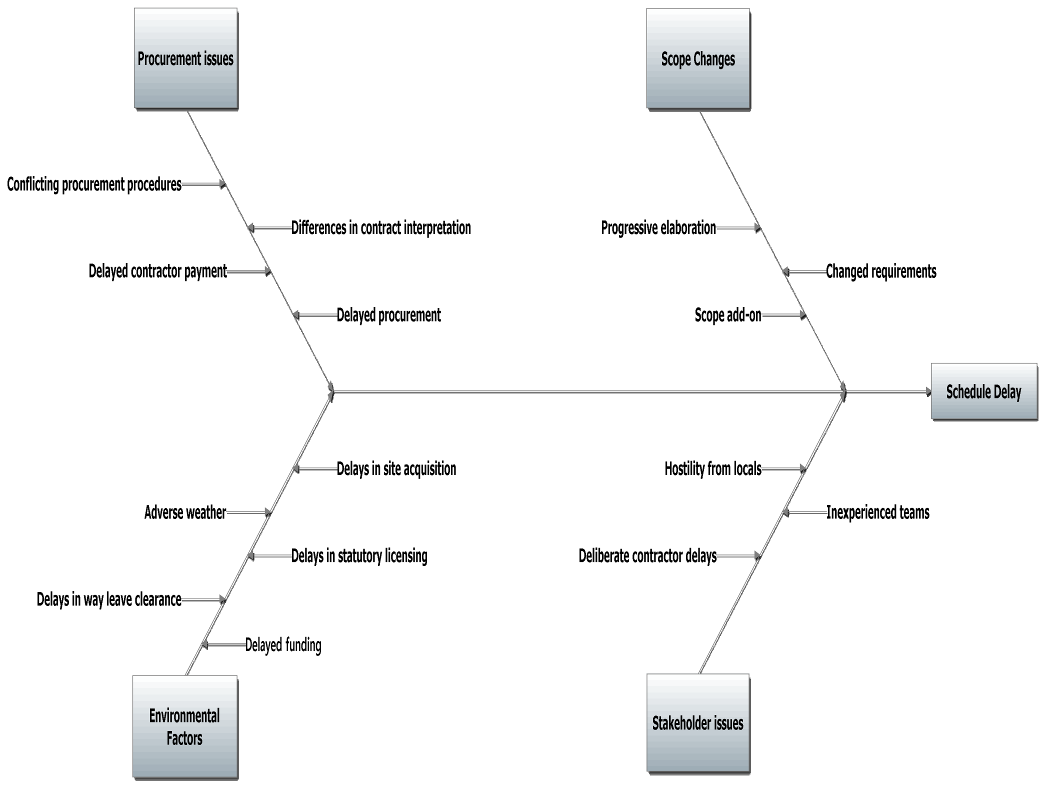


Figure 4.2: Major Causes of Schedule Delay

The main factors cited for delivery on and under budget were: competitive tendering (14.8%) and use of imposed budgets (7.4%). However, in all cases where imposed budgets were used, the project scope was narrowed to fit into the budget. The main factors that were cited for delivery on or ahead of schedule were: use of advanced technology (18%) and inclusion of late delivery penalties in the contract (7%).

The results of the Weighted Project Efficiency (WPE) values showed that a total of 4 megaprojects (15%) had efficiency levels greater or equal to 1 (100%). The rest (85%) of the megaprojects were delivered at efficiency levels lower than 100%. Further, these results showed that the 27 megaprojects had a mean of 0.91 in cost performance, 0.73 in schedule performance and 0.82 in overall efficiency.

Combining these means with their standard deviations, analysis of the Coefficients of Variation values indicated that the SPI had the highest relative variability (CV=0.35) compared to both CPI (CV=0.16) and overall efficiency index (CV=0.21). The results further showed that the energy sector projects had the lowest relative cost performance (CV=0.42) but had the highest schedule (CV=0.19) and overall efficiency (CV=0.14) performances. The roads sector scored highest on cost performance (CV=0.16) while ports (air and sea) projects scored lowest in both schedule performance (CV=0.47) and overall efficiency (CV=0.31). Table 4.2 provides a summary of project efficiency by sector.

Table 4.2: Project Efficiency by Sector

Sector	Descriptive Statistics for Efficiency Measures								
	CPI			*SPI*			*WPE*		
	MEAN	STDEV	CV	MEAN	STDEV	CV	MEAN	STDEV	CV
Ports $n=9$	0.85	0.17	0.20	0.79	0.37	0.47	0.80	0.25	0.31
Energy $n=7$	0.97	0.41	0.42	0.78	0.15	0.19	0.88	0.12	0.14
Roads $n=11$	0.91	0.15	0.16	0.66	0.19	0.28	0.79	0.12	0.15

The process success scores were determined and tabulated as showed in Table 4.3.

Table 4.3: Process Success Scores

Project	*CPI*	*SPI*	WPE	Efficiency Score	Quality Score	Process Success Score
1	1.00	1.50	1.25	5	3	8.00
2	0.84	1.00	0.92	4	3	7.00
3	1.00	0.80	0.90	4	2	6.00
4	0.98	0.78	0.88	4	2	6.00
5	0.81	0.69	0.59	2	1	3.00
6	0.58	0.50	0.54	2	2	4.00
7	1.06	1.09	1.08	5	3	8.00
8	0.60	0.75	0.68	3	3	6.00
9	0.86	0.24	0.55	2	2	4.00
10	1.00	0.56	0.78	3	2	5.00
11	0.82	0.50	0.66	3	2	5.00
12	1.17	0.75	0.96	4	3	7.00
13	1.00	0.80	0.90	4	2	6.00
14	1.05	1.00	1.03	5	2	7.00
15	1.00	0.55	0.78	3	3	6.00
16	1.00	1.00	1.00	5	2	7.00
17	0.92	0.90	0.91	4	3	7.00

18	0.90	0.54	0.72	3	3	6.00
19	1.00	0.67	0.84	4	1	5.00
20	0.88	0.75	0.82	4	3	7.00
21	1.00	0.50	0.75	3	2	5.00
22	1.00	0.71	0.86	4	2	6.00
23	0.91	0.77	0.84	4	3	7.00
24	1.04	0.46	0.75	3	1	4.00
25	0.60	0.78	0.69	3	1	4.00
26	0.65	0.42	0.54	2	2	4.00
27	0.80	0.80	0.80	2	2	4.00
Descriptive Statistics:						
Mean	0.91	0.73	0.82			
STDEV	0.15	0.25	0.17			
CV	0.16	0.35	0.21			

Product and Organizational Success

Product success measures the effectiveness of the project in delivering a product that meets the customer requirements, improves customer performance, and satisfies customer needs. To assess product success, project customers were asked to respond to a 5-item questionnaire of Likert-type scale. The product success scores were determined by averaging the responses with the highest score being 5 and the results interpreted based on a predetermined scale. The results indicated that the projects had a mean product success score of 4.09 with a standard deviation of 0.94.

Organizational success measures the interaction of process and product success to meet organizational objectives, maximize stakeholder value, and enhance organizational innovation capacity to deliver future projects. To assess organizational success, senior managers representing project sponsors were asked to respond to a 4-item questionnaire of Likert-type scale. The organizational success scores were determined by averaging the responses with the highest score being 5. The scores were then interpreted based on a predetermined scale. The results indicated that the projects had a mean organizational score of 4.39 with a standard deviation of 0.82.

Composite Success Scores

The composite success scores were obtained by taking the simple weighted average of the scores for process, product and organizational dimensions. With the highest score assigned to process, product and organizational dimensions being 8, 5, and 5 respectively, the highest possible mean composite score was therefore 6. The composite success scores are shown in Table 4.4.

Table 4.4: Project Success Scores

Project Code	Project Success Dimensional Scores			Composite Success Score
	Process	Product	Organizational	
1	8.00	4.40	3.80	5.40
2	7.00	4.40	4.00	5.13
3	6.00	5.00	5.00	5.33
4	6.00	5.00	5.00	5.33
5	3.00	5.00	5.00	4.33
6	4.00	4.00	4.00	4.00
7	8.00	5.00	5.00	6.00
8	6.00	3.60	3.80	4.47
9	4.00	3.40	4.00	3.80
10	5.00	3.80	4.00	4.27
11	5.00	4.00	4.50	4.50
12	7.00	1.20	2.50	3.57
13	6.00	5.00	5.00	5.33
14	7.00	5.00	4.80	5.60
15	6.00	4.60	4.80	5.13
16	7.00	4.00	5.00	5.33
17	7.00	4.00	3.00	4.67
18	6.00	2.00	2.00	3.33
19	5.00	5.00	5.00	5.00
20	7.00	3.00	5.00	5.00
21	5.00	4.40	4.80	4.73
22	6.00	4.00	4.80	4.93
23	7.00	4.20	5.00	5.40
24	4.00	3.00	5.00	4.00
25	4.00	4.60	5.00	4.53
26	4.00	4.80	4.80	4.53
27	4.00	4.00	4.00	4.00

Results of descriptive statistics for the scores of the three dimensions of project success showed that the composite success scores had the lowest variability with CV=0.14 while process and product success scores had the highest relative variability at CV=0.24 and CV=0.23, respectively. The success scores data was also tested for Skewness and Kurtosis to check whether the data met the assumption of normality for parametric tests. The results showed that despite moderate skewness in product and organizational success scores, and the moderate peakedness of the product success scores, the composite success scores satisfied the normality test. These descriptive statistics are summarized in Table 4.5.

Table 4.5: Descriptive Statistics for Project Success Scores

	N	Mean	STDEV	CV	Skewness		Kurtosis	
					Statistic	Std. Error	Statistic	Std. Error
Process Score	27	5.70	1.38	0.24	-.18	.448	-.98	.872
Product Score	27	4.09	.94	0.23	-1.50	.448	2.60	.872
Organizational Score	27	4.39	.82	0.19	-1.57	.448	2.04	.872
Composite Score	27	4.73	.67	0.14	-.29	.448	-.57	.872
Valid N (listwise)	27							

Project success results based on sector showed that the energy sector projects had relatively the highest process success variability (CV=0.11) but had the lowest product (CV=0.45), organizational (CV=0.40) and composite (CV=0.28) success variability. The ports sector had the lowest relative process success (CV=0.29) but the highest relative product (CV=0.20), organizational (CV=0.13) and composite (CV=0.12) success. Table 4.6 provides a summary of project performance by sector.

Table 4.6: Project Success by Sector

Sector	**Descriptive Statistics for Project Success Scores**								
	Process			Product			Organizational		
	mean	stdev	cv	mean	stdev	cv	mean	stdev	cv
Ports $n=9$	6.0	1.73	0.29	4.1	0.84	0.20	4.4	0.57	0.13
Energy $n=7$	6.1	0.69	0.11	3.8	1.71	0.45	3.9	1.53	0.40
Roads $n=11$	5.9	1.51	0.26	4.0	1.18	0.29	4.4	1.17	0.27

This study used developments in project success theory to identify the broader measures of project success. The findings agree in part with the trending view that megaprojects are always delivered over budget, behind schedule, with benefit shortfalls, over and over again (Flyvbjerg, 2014). With 52% of the projects having been delivered overbudget and 82% having been delivered behind schedule, the "iron law of megaprojects" is partly confirmed. Whereas existing positive literature indicates that one out of ten infrastructural megaprojects is delivered on budget and one out of ten megaprojects is delivered on schedule (Flyvbjerg, 2014), this study only confirms this to the extent that 11% of the projects were delivered on schedule.

This study found that more of the variability in overall project efficiency is attributed to schedule performance than to cost performance and most projects that were delivered on or under budget experienced schedule delay. This is a key finding that may be pointing to the fact that most emphasis in megaproject management is directed on the cost element rather than to an integrated trade-off among cost, time and quality. Schedule delay affects both the quality of benefits and the project delivery cost. The longer the duration of the project the larger the cost overrun (Flyvbjerg et al., 2004).

The findings of this study on the main factors leading to schedule delay corroborate with the findings of Yang, Chu, and Huang (2013). In their study, it was established that the most frequent cause of extended project duration is changed scope of work followed by weather, delayed inspection and acceptance from owner, and changed site conditions. On its part, this study identified way leave clearance and statutory requirements; scope add-on and changes in project requirements; procurement issues and delays in payment, project team inexperience, stakeholder hostility and deliberate contractor delays; and delays in site acquisition and adverse weather; in that order, to be the main factors leading to schedule overrun.

The findings of this study also add to the growing view that operational excellence or process success does not necessarily imply project success (Baccarini, 1999; Ika, 2009). For instance, when sectoral comparison was done, the ports sector had the lowest relative variability in process success (CV=0.29) but the highest relative variability in product (CV=0.20), organizational (CV=0.13) and composite (CV=0.12) success.

4.4.2 Human Behavior

The first objective of this study sought to determine the influence of human behavior on success of public infrastructural megaprojects. As part of this objective, three indicators of human behavior were studied. These are: individual behavior, group behavior, and organizational design and development. The findings of the study on each of these indicators are presented below followed.

Individual Behavior

Complexity due to individual behavior (IB) was measured based on a 7-item Likert type scale with the responses on each item rated on a 5-point mutually exclusive scale where a rating of 1 denoted a "strongly agree" response, 2 denoted "agree" response, 3 denoted "somewhat agree" response, 4 denoted "disagree" response, while 5 denoted a "strongly disagree" response. A choice of either 1 (strongly agree) or 2 (agree) implied low complexity while a choice of either 4 (disagree) or 5 (strongly disagree) implied high complexity. A choice of 3 (somewhat disagree) implied a neutral and borderline response which did not communicate much on the complexity of projects studied. As such, this neutral response was dropped from further analysis. The responses were analyzed and summarized as shown in Table 4.7.

Table 4.7: Individual Behavior Responses

Item in the Scale	% of respondents stating that they:				
	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
There was consistency between what the customer communicated and what the customer actually needed	40.8%	33.3%	25.9%	-	-
There was a high level of confidence that new information generated from progressive elaboration was captured appropriately in the project plan	33.3%	48.2%	11.1%	7.4%	-
There was a high degree of confidence in the Estimate to Complete (ETC) for the project	18.5%	33.3%	29.7%	14.8%	3.7%
Realistic expectations were set around project success criteria	22.2%	51.9%	18.5%	7.4%	-
Estimation of costs, time and benefits was free of any misrepresentation	37%	18.5%	29.7%	14.8%	-

There was support from the team whenever an approved change was implemented on the project	51.9%	33.3%	11.1%	3.7%	-
It was possible to terminate, suspend or cancel the project activity whenever there was evidence that achievement of the desired outcome was not possible	18.6%	22.2%	11.1%	22.2%	25.9%

To determine the typical individual behaviors on the studied projects, the items on the individual behavior scale were mapped onto common cognitive biases that have been linked to project failures by past researches and in extant literature. The first item on the scale mapped onto the "framing effect" bias, the second item mapped onto "anchoring" bias, the third and the fourth items mapped onto "optimism bias", the fifth item mapped onto "misrepresentation/noble lying", the sixth item mapped onto "resistance to change" bias while the seventh item mapped onto "loss aversion/sunk cost effect" bias.

The results showed that loss aversion (sunk cost effect) was the most cited individual behavior exhibited by the projects (48.1%) followed by optimism bias (25.9%), misrepresentation (14.8%), anchoring bias (7.4%) and resistance to change (3.7%). Both the projects exhibiting anchoring behavior were delivered behind schedule but one of these projects was delivered within budget. All the projects exhibiting optimism bias were delivered behind schedule with 42.9% of them being delivered within budget. In none of the projects was there framing effect, meaning that there was consistency across projects between what the customer communicated and what the customer actually wanted.

Of the projects that exhibited misrepresentation behavior, 1 was delivered within budget, 1 within schedule while the remaining 2 were delivered with schedule and cost overrun. The project that exhibited resistance to change was delivered within budget but behind schedule. Of the 13 projects that exhibited loss aversion behavior, 6 (46.2%) were delivered within budget, 2 (15.4%) were delivered within schedule while 6 (46.2%) were delivered with both cost overrun and schedule delay.

The results also indicated that the projects exhibiting misrepresentation bias had the lowest percentage of projects delivered within budget (25%). Projects exhibiting optimism bias had the highest percentage of projects delivered with cost overrun and schedule delay followed by projects exhibiting anchoring and misrepresentation behaviors. Projects exhibiting loss aversion behavior had 46.2% of them record delivery within budget but also had 46.2% of them delivered with both cost overrun and schedule delay. Table 4.8 summarizes cost and schedule performance for projects exhibiting the identified cognitive biases.

Table 4.8: Individual Behaviors and Performance

Individual Behavior	% of Projects Exhibiting Behavior	% Delivered Within Budget	% Delivered Within Schedule	% Delivered With Budget Overrun and Schedule Delay
Anchoring bias	7.4	50	0	50
Optimism bias	25.9	42.9	0	57.1
Misrepresentation	14.8	25	25	50
Resistance to change	3.7	100	0	0
Loss aversion (Sunk Cost effect)	48.1	46.2	15.4	46.2

The findings of this study agree with the postulation of both positive and normative literature that optimism bias and the other biases in individual behavior have negative implications throughout the life cycle of programs and projects (PMI, 2014; Shore, 2008). With the results of this study showing that projects exhibiting optimism bias had more incidences of delivery over budget and behind schedule compared to those exhibiting misrepresentation and loss aversion, this study is in consonance with the findings of Lovallo and Kahnemann (2003), Flyvbjerg et al. (2003), Mackie and Preston (1998), Kahnemann and Lovallo (1993), Wachs (1989:1987) and Meyer (2014), who posit that optimism bias is the main cause of delivery over budget and behind schedule.

The findings of this study also point to the fact that individual behaviors identified have more adverse effect on schedule performance compared to cost performance.

Indeed, the mean cost performance for the entire sample was higher and more stable compared to the mean schedule performance. This finding may be pointing to the fact that public infrastructural megaproject sponsors feel more pressure from the public when projects are delivered over budget compared to when they are delivered behind schedule and so they prioritize cost performance over schedule performance. Where this is the case, the overall essence of project management is lost as delivery on schedule is a core performance metric that must be monitored closely just as cost performance. Previous studies have shown that implementation sluggishness has a significant relationship with cost escalation in infrastructure projects (Flyvbjerg, Holm, & Buhl, 2004).

The findings of this study put misrepresentation bias in the second place among individual biases associated with cost overrun and schedule delay. Misrepresentation, which is sometimes referred to as “noble lying” has its support in Hirschman’s theory and a postulation that if people knew in advance the real challenges and costs involved in delivering megaprojects, they would probably never have touched them and nothing would get built (Flyvbjerg, 2014). Even though this theory is flawed in validity based on the small sample size on which it was construed, this study shows that it indeed explains under performance on infrastructural megaprojects. The surprising bit is that this misrepresentation comes from both in-project and corporate or programme management, as in the cases where project managers cited servitude to be the main reason for both cost and schedule underperformance.

In terms of occurrence on projects, this study found that loss aversion had almost twice the frequency of optimism bias and thrice the frequency of misrepresentation. These results corroborate with those of Shore (2008) who found twice as many incidences of sunk cost effect (loss aversion) in comparison with overconfidence (optimism). Continued exhibition of loss aversion bias on projects does not support the generally accepted project management principle of “continued business justification” (Axelos, 2017). According to this principle, a project can be canceled any time during its life cycle whenever it is found that its business case is not viable, desirable or achievable.

Group Behavior

Complexity arising from group behavior (GB) was measured based on a 7-item Likert type scale with the responses on each item rated on a 5-point mutually exclusive scale where a rating of 1 denoted a "strongly agree" response, 2 denoted "agree" response, 3 denoted "somewhat agree" response, 4 denoted "disagree" response, while 5 denoted a "strongly disagree" response. A choice of either 1 (strongly agree) or 2 (agree) implied low complexity while a choice of either 4 (disagree) or 5 (strongly disagree) implied high complexity. A choice of 3 (somewhat disagree) implied a neutral and borderline response. As such, this neutral response was dropped from further analysis. The responses were analyzed and summarized as shown in Table 4.9.

Table 4.9: Group Behavior Responses

Item in the Scale	% of respondents stating that they:				
	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
Senior management team and other key stakeholders were fully committed to the project	77.8%	22.2%	-	-	-
The project had the support, commitment and priority from the organization and functional groups	74.1%	18.5%	7.4%	-	-
The project team was cohesive and always worked towards common goals and objectives	63%	25.9%	11.1%	-	-
Contractual terms were well understood by all parties involved	48.2%	25.9%	22.2%	3.7%	-
The project team members were co-located, co-incentivized and co-responsible for the outputs of their projects	25.9%	40.8%	22.2%	11.1%	-
The project team members primarily worked face to face (rather than virtually) throughout the life of the project	29.6%	37%	18.5%	11.1%	-
Team members or stakeholders were able to accept the project information that may have been contrary to their beliefs, assumptions or perspectives	11.1%	55.6%	18.5%	14.8%	-

Analysis of project delivery was conducted based on the responses in the GB scale. The results showed that of the projects in which the respondents agreed that senior management team and other key stakeholders were fully committed to the project, 48.2% were delivered within budget while 18.5% were delivered within schedule. Top management support and support from other key stakeholders have long been recognized in extant literature as a key factor that contributes to project success (PMI, 2014; Hauschildt, Gesche, & Medcof, 2000). This is even more important for infrastructural megaprojects which are transformational in nature and whose budget may be more than the entire implementing organization's asset base in real terms. In some cases, the project may be the only activity the organization is involved in over several years. For the most part, senior management confuse this support for micromanagement and may get involved in the day to day management of the project denying the project manager and the team the flexibility they require to manage the project as per the project charter. This micromanagement comes with a lot of interests, including issues of servitude (as identified in this study) which could lead to poor project delivery capability. It is not surprising therefore, that despite the centrality of top management support in delivering successful projects, this study found that less than 50% of the projects where senior management teams were fully committed to their course were delivered within budget and a dismal 18.5% were delivered within schedule.

Of the projects in which respondents agreed that the project had the support, commitment and priority from the organization and functional groups, 52% were delivered within budget, with 20% being delivered within schedule. This is plausible particularly considering that nine out ten megaprojects have cost overruns (Flyvbjerg, 2014). Of the projects in which the respondents agreed that the project team was cohesive and always worked towards common goals and objectives, 54.2% were delivered within budget but only 20.8% were delivered within schedule. Again compared with the results in Flyvbjerg (2014), this is plausible. Normative literature recognizes that team working can improve efficiency (Green, 1997) but team work does not guarantee in itself good results (Belbin, 1993). Rather, what is important is how the individuals within the group work cohesively together (Mullins, 2005). The various behaviors of the team members must mesh together in order to achieve objectives (Crainer, 1998).

Of all projects in which respondents agreed that contractual terms were well understood by all parties involved, 55% were delivered within budget while 25% were delivered within schedule. All the projects in which the respondents disagreed with this statement were delivered both behind schedule and with cost overrun. In contemporary project management, the project manager has a role in ensuring that the project procurement function works well in support of project delivery. Ensuring that supplies of the right quality are delivered to the project at the right time is critical. Both ISO 21500:2012 and the *PMBOK® Guide* consider procurement as a key knowledge area for project management. It is also required of the project manager to ensure that contractual terms are well understood by all parties to the procurement contracts as any misunderstanding could lead to disputes and claims, which may affect project delivery capability. In practice however, procurement is usually a separate function from projects with its own structures.

For the projects in which the respondents agreed that project team members were co-located, co-incentivized and co-responsible for the outputs of their projects, 38.9% were delivered within budget while 16.7% were delivered within schedule. For the projects that disagreed with this statement, 33.3% were delivered within budget with none being delivered within schedule. This finding agrees with the postulations of normative literature that co-location is a factor in ensuring rapid and faster communication when managing projects in dynamic environments (Collyer, 2016) and it enhances the ability of team members to perform as a team (PMI, 2013c). The results showed that for the projects in which the respondents agreed that the project team members primarily worked face to face (rather than virtually) throughout the life of the project, 47.4% were delivered within budget with 10.5% being delivered on schedule. All the projects in which respondents disagreed with this statement were delivered with both cost overrun and schedule delay.

For the projects in which team members or stakeholders were able to accept the project information that may have been contrary to their beliefs, assumptions or perspectives, 50% were delivered within budget with 16.7% being delivered within schedule. For those that disagreed with this statement, only 25% were delivered within budget with none being delivered on schedule. Available normative literature on navigating complexity in projects reveals that groupthink can lead groups to ignore essential information that runs contrary to their beliefs, and that it can lead to reinforcement of tribal mindset (PMI, 2014) among project team members. When teams ignore project information that may be contrary to their beliefs, assumptions or perspectives, both rational decision making and project delivery capability are affected.

The findings of this study corroborate with the thinking in existing literature given that in projects where groupthink was not inferred, delivery was superior when compared to projects in which groupthink was inferred. Table 4.10 summarizes cost and schedule performance for the projects based on responses to the items in the group behavior scale.

Table 4.10: Cost and Schedule Performance Based on Group Behavior Responses

Item in the Scale	Responses			
	Strongly Agree/Agree		Strongly Disagree/Disagree	
	% of Projects Delivering Within		% of Projects Delivering Within	
	Budget	Schedule	Budget	Schedule
Senior management team and other key stakeholders were fully committed to the project	48.2	18.5	-	-
The project had the support, commitment and priority from the organization and functional groups	52.0	20.0	-	-
The project team was cohesive and always worked towards common goals and objectives	54.2	20.8	-	-
Contractual terms were well understood by all parties involved	55	25	0	0
The project team members were co-located, co-incentivized and co-responsible for the outputs of their projects	38.9	16.7	33.3	0
The project team members primarily worked face to face (rather than virtually) throughout the life of the project	47.4	10.5	0	0

Team members or stakeholders were able to accept the project information that may have been contrary to their beliefs, assumptions or perspectives	50.0	16.7	25.0	0

Organizational Design and Development

Complexity due to organizational design and development (OD & D) was measured using two sets of constructs namely: alignment, opacity and process maturity as one set, and organization structure, stakeholder engagement and culture as another. The results are presented below:

a. **Alignment, opacity and process maturity**

Complexity based on alignment, opacity and process maturity was measured based on a 8-item Likert type scale with the responses on each item rated on a 5-point mutually exclusive scale where a rating of 1 denoted a “strongly agree” response, 2 denoted “agree” response, 3 denoted “somewhat agree” response, 4 denoted “disagree” response, while 5 denoted a “strongly disagree” response. A choice of either 1 (strongly agree) or 2 (agree) implied low complexity while a choice of either 4 (disagree) or 5 (strongly disagree) implied high complexity. A choice of 3 (somewhat disagree) implied a neutral and borderline response which did not communicate much on the complexity of projects studied. As such, this neutral response was dropped from further analysis. The responses were analyzed and summarized in Table 4.11.

Table 4.11: Alignment, Opacity and Process Maturity Responses

Item in the Scale	% of respondents stating that they:				
	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
Alignment:					
The project had clearly defined boundaries with other projects and initiatives that were running in parallel	48.2%	37%	11.1%	3.7%	-
The organization had the right people with the necessary skills and competences as well as the	44.5%	37%	14.8%	3.7%	-

tools, techniques or resources to support the project					
There was an effective portfolio management process within the organization to facilitate strategic alignment and enable successful delivery of projects	25.9%	37%	29.7%	3.7%	3.7%
Opacity:					
The sponsor or project organization made decisions, determined strategies, and set priorities in a manner that promotes transparency and trust	33.3%	55.6%	7.4%	3.7%	-
There was open communication, collaboration and trust among the stakeholders and project team	37%	48.2%	11.1%	3.7%	-
Process Maturity:					
It was feasible to obtain accurate status reporting throughout the life of the project	44.4%	44.4%	7.4%	3.7%	-
The client created and ensured the use of common processes across all projects	29.7%	37%	22.2%	11.1%	-
The project manager had the authority to apply internal or external resources to project activities	18.5%	22.2%	22.2%	29.6%	7.4%

Cost and schedule performance was determined for the projects in which the respondents agreed or disagreed with the statements in the scale. The results showed that 47.8% of the projects in which respondents agreed that the project had clearly defined boundaries with other projects and initiatives that were running in parallel, were delivered on budget while 21.7% of those projects were delivered on schedule. The project in which the respondents disagreed with this statement was delivered on budget but behind schedule.

Of the projects in which respondents agreed with the statement that the organization had the right people with the necessary skills and competences as well as the tools, techniques or resources to support the project, 54.5% were delivered within budget whereas 22.7% of those projects were delivered on schedule. For the projects in which respondents disagreed with this statement, none was delivered on budget or on schedule.

For the projects in which the respondents agreed that there was an effective portfolio management process within the organization to facilitate strategic alignment and enable successful delivery of projects, 41.2% were delivered within budget while 17.6% were delivered within schedule. However, for the projects in which the respondents disagreed with this statement, 50% were delivered on budget but none was delivered within schedule. This finding agrees with the postulation in normative literature that misalignment may result in conflicting priorities and direction for the program or project team (PMI, 2014). For this study, the findings established that project misalignment adversely affected schedule delivery and to a considerable extent, budget delivery. The findings also support are reinforce the Structural Contingency Theory which posits that An organization whose characteristics align with the contingencies in its situation will perform more effectively compared to an organization whose characteristics do not fit with the contingencies in its situation ((Donaldson, 2001).

On average, 50% of the projects in which the respondents agreed that the sponsor or project organization made decisions, determined strategies, and set priorities in a manner that promotes transparency and trust, were delivered on budget with 20.8% of these projects being delivered on schedule. For the projects where this was not the case, none was delivered on budget or on schedule. A total of 47.8% of the projects in which there was open communication, collaboration and trust among the stakeholders and project team, were delivered within budget while only 13% of these projects were delivered on schedule. None of the projects in which the respondents disagreed with this statement was delivered on budget or on schedule. This finding agrees with the postulation of normative literature that in an environment that promotes open communication and where project decisions, priorities and strategies are made transparently, organization design and development improves the organization's visioning, empowerment, learning and problem solving processes (Mullins, 2005), which are critical aspects of adaptive behavior that project managers require to successfully deliver complex megaprojects. It was noted that none of the projects in which decisions, strategies and priorities were not made in a transparent manner, was delivered within budget or schedule.

The results of this study agree with the postulation in extant literature that effective communication has an impact on project execution and/or outcome (PMI, 2013c; Doloi, 2013; Rostand, 2013; Olaniran, Love, Edwards, Olatunji, & Matthews, 2015). It is also widely recognized in literature that trust within the project team and among team members has a positive effect on transfer of knowledge (Holste & Fields, 2010; Maurer, 2010), which is critical for the team to explore and exploit decision choices in complex megaprojects. As noted from this study, in projects where there was no open communication, collaboration and trust among the stakeholders and project team, the probability of delivery within cost and schedule dropped from 47.8% and 13% respectively, to 0%. Perhaps this finding provides a first level reply to Olaniran et al. (2015) who postulated that there is need for further empirical research to examine how communication influences megaproject performance.

Of the projects in which it was feasible to obtain accurate status reporting throughout the life of the project, 52.2% were delivered on budget while 21.7% were delivered on schedule. Where this was not the case, projects recorded 100% delivery within budget with 0% delivery within schedule. In projects where the client created and ensured the use of common processes across all projects, delivery within budget stood at 47.4% with delivery within schedule capping at 21.1%. However, where this was not the case, the probability of delivery within budget was 66.7% but none of those projects was delivered within schedule. There is evidence that project management maturity (PMM) is significantly related to business performance but not to project performance (Yazici, 2009). A critical aspect of PMM is process maturity which involves ensuring common processes are followed across all projects-of course with a considerable amount of tailoring. On whether PMM has a relationship with project performance, this study posts mixed findings-on one hand it is concluded that lack of process maturity had negative relationship with schedule delivery while the results are mixed on the relationship between lack of process maturity and cost performance. Thus, the results of this study only partly disagree with the findings of Yazici (2009).

For the projects in which the project manager had the authority to apply internal or external resources to project activities, 45.5% were delivered within budget and 18.2% were delivered within schedule. Where the project manager did not have authority to apply resources, the chance of delivery within budget went down to 40% while that of delivery on schedule diminished to 10%.

Table 4.12 summarizes cost and schedule performance based on the responses.

Table 4.12: Delivery Based on Alignment, Opacity and process Maturity

Item in the Scale	Responses			
	Strongly Agree/Agree		Strongly Disagree/Disagree	
	% of Projects Delivering Within		% of Projects Delivering Within	
	Budget	Schedule	Budget	Schedule
Alignment:				
The project had clearly defined boundaries with other projects and initiatives that were running in parallel	47.8	21.7	100	0
The organization had the right people with the necessary skills and competences as well as the tools, techniques or resources to support the project	54.5	22.7	0	0
There was an effective portfolio management process within the organization to facilitate strategic alignment and enable successful delivery of projects	41.2	17.6	50	0
Opacity:				
The sponsor or project organization made decisions, determined strategies, and set priorities in a manner that promotes transparency and trust	50.0	20.8	0	0
There was open communication, collaboration and trust among the stakeholders and project team	47.8	13	0	0

Process Maturity:				
It was feasible to obtain accurate status reporting throughout the life of the project	52.2	21.7	100	0
The client created and ensured the use of common processes across all projects	47.4	21.1	66.7	0
The project manager had the authority to apply internal or external resources to project activities	45.5	18.2	40	10

b. Organization Structure, Stakeholder Engagement and Culture

Data on organization structure and stakeholder engagement was collected using a checklist in which the respondents were required to select the statements that applied to their projects. Analysis of this checklist was done using mapping. Data on project culture was deduced from individual behaviors identified in Table 4.8.

Of the 27 megaprojects studied, 21 megaprojects representing 77.8% had less than 10 layers in their governance structure with 2 megaprojects (7.5%) having up to 20 layers in their governance structure. The remaining 4 megaprojects (14.8%) had over 20 layers in their governance structure. Of the projects that had less than 10 layers in their governance structure, 11 (52.4%) were delivered within budget, 3 (14.3%) were delivered within schedule while 9 (42.9%) were delivered both over budget and behind schedule. For the projects that had between 10 and 20 layers in their governance structure, 1 was delivered both within budget and schedule while 1 was delivered both over budget and behind schedule. Of the 4 projects that had over 20 layers in their governance structure, 1 was delivered both within budget and schedule while 3 (75%) were delivered both over budget and behind schedule. Table 4.13 summarizes project cost and schedule performance given the layers in their organograms.

Table 4.13: Performance Based on Layers in the Organogram

No. of layers (X)	No. of Projects	% Within Budget	% Within Schedule	% Budget & Schedule Slippage
X<10	21	52.4	14.3	42.9
10<X<20	2	50	50	50
X>20	4	25	25	75

All the 27 megaprojects studied were organized in a "one-size-fits-all" approach with 9 (33.3%) of these megaprojects being delivered through a pure functional structure, 5 megaprojects (18.5%) through a weak matrix structure, another 18.5% being delivered through a strong matrix structure and the remaining 8 megaprojects (29.6%) being delivered through a projectized structure. The projects that were organized through a weak matrix structure had the highest relative variability in their mean success (CV=0.29) followed by those that were organized through a pure functional structure (CV=0.18). Projects organized through a strong matrix structure recorded the lowest relative variability in mean success (CV=0.13) followed by those utilizing a projectized structure (CV=0.16) as illustrated in Table 4.14.

Table 4.14: Project Organization and Success

Organizational Form	Mean Success	STDEV	CV
Traditional Hierarchical	-	-	-
Pure Functional	4.78	0.87	0.18
Weak Matrix	4.46	1.28	0.29
Strong Matrix	4.98	0.63	0.13
Projectized	4.74	0.78	0.16
Composite	-	-	-

These results support and reinforce the Structural Contingency Theory whose main premise is that there is no one best organizational structure; rather, the appropriate organizational structure depends on the contingencies facing the organization (Burns & Stalker, 1961; Chandler, 1962). It is argued that a project organization structure cannot be bad but can be inappropriate given the complexity of the project and the overall level of organizational maturity. This argument is supported by existing empirical literature which shows that project organization based on a "one-size-fits-all" approach can deliver successful projects just as a "tight-loose" system of systems approach (Brady & Davis, 2014). The results of this study also support this view given that all projects studied were organized in a "one-size-fits-all" approach with 48.2% of these projects meeting their budget objective and 18.5% meeting the schedule objective.

However, consistent with the postulations of the project management theory, strong matrix and projectized organization structures usually give the project manager full authority to make project decisions, within the constraints of the project charter (PMI,2017). Project management success draws positive synergies from the authority of the project manager over project resources and it is highly likely that projects in which the project manager has near total authority over resources have more stable outcomes compared to those in which the project manager has weaker authority. The results of this study support this thesis, with the CV results in Table 4.14 showing more stable mean success results for projects utilizing strong matrix and projectized structures..

On stakeholder engagement, the main forms of engagement were through site meetings and progress reports, with some projects involving stakeholders only in preparatory stages. Stakeholder engagement was a formal role in only 4 projects (14.8%) with 6 projects (22.2%) having a clearly documented stakeholder engagement plan that was used to manage stakeholders. It is generally agreed that stakeholders can impact project outcomes and stakeholder satisfaction should be managed as a key project objective (PMI,2013c) just as time, cost, quality, risk, scope and benefits (Axelos, 2017). Both ISO 21500:2012 and the PMBOK® *Guide* place stakeholder management at the centre of project management theory. The findings of this study showed that there is an identifiable gap between the prescriptions of theory and actual practice. Indeed, the results showed a practice that is long on management for stakeholders and short on management of stakeholders. In the social world of complexity, a project is either a discourse of legitimation and an arena of social or power plays, serving the interests of powerful stakeholders, or, it is a network of actors embedded in a social context and in constant transformation, implying that the project is a work in progress.

The project manager figure in the complex contexts is either a rhetor or a reflexive agent (Gauthier & Ika, 2012). The implication here is that communication and stakeholder management are critical success factors for projects in complex contexts.

Since individual behavior can collectively define the culture of an organization, the individual behavior systematic biases identified in Table 4.8 were mapped onto four dimensions of organizational culture using the Competing Values Model (Livari & Huisman, 2007), in order to determine the culture of each project. The dimensions of the model are: internal focus, external focus, stability and change. The results showed that all projects mapped onto a project culture that can be characterized as having a preference for an internal focus and stability. As the results in Table 4.8 indicate, these biases were associated with escalation in cost and schedule overrun. In line with the findings of Shore (2008), who found that failed projects map onto a culture that can be characterized as having preference for internal focus and stability, this study affirmed that all the projects exhibiting those biases operated in a culture characterized with internal focus and stability. This type of culture is generally suitable for organizations that operate in more deterministic environments characterized with more stable outcomes. Table 4.15 shows the mapping of the individual behaviors on the competitive values model.

Table 4.15: Cognitive Biases Mapped onto Competing Values Model

Cognitive Bias	% of Projects Exhibiting Bias	Dimensions of Competing Values Model Implied			
		Internal Focus	External Focus	Stability	Change
Anchoring Bias	7.4	✓		✓	
Optimism Bias	25.9	✓		✓	
Misrepresentation	14.8	✓		✓	
Resistance to Change	3.7	✓		✓	
Loss Aversion (Sunk Cost Effect)	48.1	✓		✓	

Hypothesis Testing

Human Behavior has Significant Influence on Success of Public Infrastructural Megaprojects

In order to test the hypothesis that human behavior has a significant influence on success of public infrastructural megaprojects, the constructs of human behavior were scored to determine their complexity scores, based on the responses from the field. Based on the scale, the lowest score was 1 (implying low complexity) and the highest score was 5 (implying high complexity).

The results showed that individual behavior returned a mean complexity score of 2.21 with a standard deviation of 0.62, while group behavior had a mean complexity score of 3.29 with a standard deviation of 1.02. Organizational design and development recorded a mean complexity score of 1.97 with 0.60 standard deviation while the overall weighted complexity score had a mean of 1.87 with a standard deviation of 0.50. These scores are summarized in Table 4.16.

Table 4.16: Human Behavior Complexity Scores

Project Code	Human Behavior (HB) Constructs			Weighted Score
	IB	GB	OD & D	
1	1.70	2.98	1.22	1.97
2	2.60	2.79	1.28	2.22
3	2.60	2.88	1.40	2.29
4	2.60	2.88	1.57	2.35
5	2.80	3.85	1.65	2.77
6	2.80	4.95	2.47	3.41
7	1.00	1.78	1.22	1.33
8	2.78	3.31	2.19	2.76
9	3.43	5.96	3.15	4.18
10	3.30	4.85	3.15	3.77
11	2.40	3.06	2.44	2.63
12	2.00	3.29	2.61	2.63
13	1.43	1.98	1.39	1.60
14	1.57	3.18	2.24	2.33
15	2.57	3.06	2.03	2.55
16	2.20	3.49	2.09	2.59
17	2.00	2.83	1.89	2.24
18	2.57	3.49	2.11	2.72
19	2.00	3.06	2.19	2.42

20	1.78	1.00	1.22	1.33
21	2.00	3.21	1.69	2.30
22	2.00	3.18	1.72	2.30
23	1.86	2.49	1.61	1.99
24	3.00	4.49	2.26	3.25
25	1.29	3.53	1.40	2.07
26	1.29	2.82	1.69	1.93
27	2.00	4.56	3.19	3.25

Descriptive statistics for the HB complexity scores were determined and presented as shown in Table 4.17. The results indicated that mean scores for individual behavior had the lowest relative variability (CV=0.28) compared to Group behavior (CV=0.31) and organizational design and development (CV=0.30). This implies that group behavior had a higher effect on complexity due to human behavior followed by organizational design and development, with individual behavior recording the lowest effect.

The main items that contributed to the relative variability in the HB complexity scores were: understanding of contractual terms by all parties involved; misrepresentation in the estimation of time, cost and benefits; support from team members when an approved change was implemented by the project; and clear definition of boundaries with other initiatives and projects that were running in parallel.

To enable use of these scores in parametric tests (such as correlation and regression analysis), their coefficients of skewness and kurtosis were determined to ensure that the data met the normality assumption of parametric tests. As the results in Table 4.17 show, coefficients of skewness were within the -1 to +1 range and coefficients of kurtosis were also within the recommended range of -2.2 to +2.2 (Sposito, Hand, & Skarpness, 1983).

Table 4.17: Descriptive Statistics for Human Behavior Complexity Scores

	HB Constructs			
Statistic	IB	GB	OD&D	Weighted
Mean	2.21	3.29	1.97	2.49
STDEV	0.62	1.02	0.60	0.67
CV	0.28	0.31	0.30	0.27
Skewness	0.04	0.48	0.67	0.60
Kurtosis	-0.57	1.34	-0.28	0.75

Results of the other diagnostic tests showed that there was no serial correlation in the data used to conduct regression analysis given a Durbin-Watson statistic less than 2. Data was also checked for collinearity using the Tolerance and VIF statistics. The results indicated a VIF value much lower than 4 which is used as the threshold to indicate multicollinearity particularly in small samples (O'Brien, 2007). The problem of heteroscedasticity was checked using residual statistics in a scatter plot. The results indicated that almost all the residuals had a mean of 0.000 and were approximately equally spread implying that the data was homoscedastic and was therefore good for OLS regression analysis.

As a first step in testing the hypothesis, the scores of HB constructs were first correlated with those of project success to determine if they had any association. The results are summarized in Table 4.18. The results showed that at 99% confidence level all the three dimensional measures of success had significant positive correlation with the overall composite success score but this correlation was much stronger between product dimension and overall composite score ($r = 0.710$). This was followed by the organizational success dimension ($r = 0.630$). The correlation between the process success dimension and the composite project success was the lowest $(r = 0.589)$.

Further, the results showed that there was a strong significant positive correlation between product success and organizational success ($r = 0.709$). At 99% confidence level, the results showed that: there was significant moderate positive correlation between individual and group behavior (r=0.674); the correlation between individual behavior and organizational design and development was moderately positive and significant (r=0.539); there was a significant strong positive correlation between group behavior and organizational design and development (r=0.783); and group behavior had the strongest significant positive correlation with the weighted HB complexity (r=0.995) followed by organizational design and development (r=0.866) and individual behavior (r=0.816).

On the relationship between human behavior and project success, the results indicated that at 99% confidence level, group behavior and overall human behavior had significant but negative correlation with process success (r=-.639, and r=-.575, respectively). At 95% confidence level, the results indicated that individual behavior and organizational design and development had significant but negative correlation with process success (r=-.387, and r=-.430, respectively) and that organizational design and development had a significant negative correlation with product success (r=-.415). It was indicated that at the 99% confidence level, all the three constructs of human behavior had significant, though negative correlation with the overall project success. Further, the results showed that human behavior had significant negative correlation with overall project success.

Table 4.18: Correlation between Human Behavior and Success Constructs

Correlations (N=27)								
	Project Success				Human Behavior Scores			
	Process	Product	Org.	Overall	IB	GB	OD&D	HB
Process	1	-.074	-.164	.589**	-.387*	-.639**	-.430*	-.575**
Product	-.074	1	.709**	.710**	-.289	-.222	-.415*	-.327
Org.	-.164	.709**	1	.630**	-.234	-.257	-.379	-.316
Overall	.589**	.710**	.630**	1	-.499**	-.651**	-.647**	-.681**
IB	-.387*	-.289	-.234	-.499**	1	.674**	.539**	.816**
GB	-.639**	-.222	-.257	-.651**	.674**	1	.783**	.955**
OD&D	-.430*	-.415*	-.379	-.647**	.539**	.783**	1	.866**
HB	-.575**	-.327	-.316	-.681**	.816**	.955**	.866**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Causal relationship between human behavior and megaproject success was tested using OLS linear regression at the 95% confidence level. The results indicated that the overall model had a 46.3% predictive power (R^2=0.463). ANOVA results showed that the overall model was significant with $F_{(1,25)}$ = 21.530 and P<0.025. The regression equation is presented below:

$$\bar{PS}_i = 6.421 - 0.681 HB_i$$

$$s(\hat{b}_i) = (0.377) \quad (0.147)$$

$$t = \ (17.05) \quad (-4.64) \qquad R^2 = 0.463$$

Generally, at 95% confidence level with a two-tailed test, if the $s(\hat{b}_i) < \left(\frac{\hat{b}_i}{2}\right)$, the null hypothesis that $b_0 = b_1 = 0$ is rejected and a conclusion is made that the betas are significant (Koutsoyiannis, 1992). In this study, the results showed that the slope of human behavior was significant, implying that a one unit increase in the complexity score for human behavior reduced project success score by 0.681. Thus, the research hypothesis that human behavior has a significant influence on success of public infrastructural megaprojects was accepted. The full regression results are shown in Appendix 3.

The findings of this study on correlation among the project success measures showed that a project that has high product success is also likely to have high organizational success. This finding is in line with the thinking behind the *Theory of Change* and supports the generally accepted project management principle of "focusing on products" as opposed to focusing on the activity (Axelos, 2017). Project product effectiveness was significantly positively correlated with sustainability of project benefits and therefore, organizational success.

The results pointed to an interesting finding, that the correlation between process success and product success is negative. Though this correlation was not significant as seen from this study, it could mean that emphasis on process success could reduce the chances of product and organizational success. The correlation results also showed that there was no significant correlation between process success and product or organizational success. Thus, project success is more than project management success. These findings support the argument of Baccarini (1999) and Ika (2009), who contend that a project that satisfies process criteria may still be considered a failure and a project that does not satisfy them may be considered successful.

Previous studies have concentrated on investigating the relationship between the measures of the constructs within human behavior and project outcomes. Specifically, these studies have focused on the role of trust, knowledge sharing, culture, communication, behavioral biases, maturity and team working on project performance

(Collyer, 2016; Maurer, 2010; Holste & Fields, 2010; Yazici, 2009; Shore, 2008; Livari & Huisman, 2007). The present study looked at these measures collectively in one variable called human behavior as an independent study variable. Thus, the findings of this study contribute to and reinforce the developments in the behavior school of thought in project management research (Turner et al., 2010).

4.4.3 Ambiguity

The second objective of this study was to investigate the influence of ambiguity on success of public infrastructural megaprojects. Complexity arising from ambiguity was measured on a scale comprising three constructs namely; project context, emergence and uncertainty. The findings are presented per construct in the sections that follow.

Project Context

Complexity due to project context was assessed using a checklist that contained several statements regarding various project contractual arrangements and risk handling. The respondents were required to choose all the statements in the checklist that applied to their individual projects. The results showed that of the 27 projects surveyed, 20 projects (74.1%) utilized Fixed Price Contracts with 9(45%) of these utilizing a Firm Fixed Price/Lump sum contract and 11 projects (55%) utilizing Fixed Price with Economic Price Adjustment contract. One project (3.7%) utilized a Cost Plus Fixed/Percentage Fee contract while 6 projects (22.2%) utilized some form of Cost Contracts that involved re-measurement and ad-measurement based on initial estimates and Bill of Quantities respectively.

Table 4.19 presents the mean performance statistics of the megaprojects studied based on their contract types. The results showed that with the exception of the 1 project that utilized a CPF/PF contract, the projects that utilized cost contracts involving re-/ad-measurement had the highest mean success score at 5.11 points out of the possible 6.00. These projects also recorded the lowest relative variability (CV=0.1174) in the individual mean success scores. Using the CV values as measures of riskiness in project success, projects using re-/ad-measurable contracts had less risk followed by those utilizing FP-EPA. The projects utilizing FFP recorded the highest risk in mean success.

Table 4.19: Project Success by Contract Types

Contract Type	No. of Projects	Mean Success	STDEV	CV
FP-EPA	11	4.86	0.79	0.162551
FFP	9	4.3	1.01	0.234884
Remeasurable	6	5.11	0.60	0.117417
CPF/PF	1	5.4	-	-

Since contractual arrangements are usually a means of allocating cost and schedule risks, this study established that of the 11 megaprojects that utilized FPEA contracts, 6 (54.5%) recorded cost overrun while 8 (72.7%) experienced schedule slippage. Of the 9 projects that utilized FFP contracts, 4 (44.4%) experience cost overruns while 8 (88.9%) experienced schedule delay. Of the 6 projects that utilized re-/ad-measurable contracts, 4 (66.7%) were delivered over budget with 5 (83.3%) being delivered behind schedule. This study noted that for projects utilizing FFP contracts, project scope ended up being narrowed to fit into the budget. The CPF/PF contract project was delivered on budget but behind schedule. Table 4.20 summarizes this information.

Barring the results of the project utilizing CPF/PF, the results in the table showed that projects utilizing FFP contracts recorded the highest cost performance (55.6%) but also recorded the lowest schedule performance (88.9%). Projects that utilized FP-EPA contracts exhibited the second highest cost performance (45.5%) but also the third lowest schedule performance (after 83.3% from re-/ad-measurable contract projects).

In 13 (48.1%) of the surveyed projects the risk of schedule delay and cost overrun was contractually shared between the client and contractor. Of these projects, 3 (11.1%) were delivered both on budget and on schedule, 5 (18.5%) were delivered on budget but behind schedule with the remaining 5 (18.5%) delivered both with cost overrun and schedule delay. In 3 projects (11.1%) the client assumed full responsibility for all the risks and insured against schedule delay and cost overrun. Of these, 1 (3.7%) was delivered within budget and ahead of schedule, 1 (3.7%) was delivered within budget but behind schedule with the remaining 1 (3.7%) project delivered over budget but within schedule.

In 8 projects (29.6%) the contractor assumed full responsibility for all the risks and provided guarantees. Of these projects, 3 (11.1%) were delivered on budget, while none was delivered on schedule. In 3 projects (11.1%) FIDIC conditions were used and schedule and cost risks were handled as they occurred. Of these projects, 1 (3.7%) was delivered within budget while none was delivered within schedule. In summary, these results show that of the 24 megaprojects that either transferred risk to the contractor or shared it between the client and the contractor, 13 megaprojects (54.2%) were delivered on budget while only 3 megaprojects (12.5%) were delivered within schedule.

Of the 3 megaprojects where the client assumed full responsibility for cost and schedule risk, 2 (66.7%) of these met both cost and schedule objectives. Generally, the results showed that megaprojects that either transferred risk to the contractor or shared risk between the contractor and client, had better cost performance but poor schedule performance.

Table 4.20: Project Efficiency by Contract Type

Contract Type	Percentage of Projects Delivered With:			
	$CPI \geq 1$	$CPI_{<1}$	$SPI \geq 1$	$SPI_{<1}$
FP-EPA	45.5%	54.5%	27.3%	72.7%
FFP	55.6%	44.4%	11.1%	88.9%
Remeasurable	33.3%	66.7%	16.7%	83.3%
CPF/PF	100%	-	-	100%

It is generally recognized in normative literature that the FFP is the most commonly used contract type (PMI, 2013c). However, this study established that most infrastructural megaprojects utilized FP-EPA and the FFP was utilized by just one third of the projects surveyed. Given the sample size of this study, it may be difficult to draw a conclusion against the postulation of normative literature. The use of FP-EPA contractual arrangements is backed by the long term nature of the projects studied with the implementation of some spanning up to 6 years. With such longer implementation periods, it is likely that factors outside the control of the client or contractor such as inflation and currency fluctuation may adversely affect cost performance.

The use of Fixed Price contracts is usually a tactic of transferring the risk of cost overrun to the contractor. In the case of FFP contracts, the entire risk of cost overrun is actually transferred from the client to the contractor. In such cases, the contractors are usually careful not to eat into their profit margins. The results of this study agree with this practice given that a larger proportion of projects that utilized FFP contracts recorded the highest cost performance. This was followed by projects that utilized FP-EPA, which is a variation of FP contracts. Despite having recorded superior cost performance, projects that utilized FFP recorded the highest schedule slippage. This could mean that utilizing FFP contracts could be a zero sum game-since project management success must take into account both cost and schedule performance. It was noted that projects whose contracts included late delivery penalties actually delivered on schedule. This means that the use of FFP should be adjusted to include late delivery penalties if the objectives of both cost and schedule are to be achieved simultaneously.

The results indicated that none of the projects utilized contractual arrangements with incentives for accelerated cost or schedule delivery. Such pain/gain contracts would include Fixed Price Incentive Fee, Cost-Plus Incentive Fee or Cost-Plus Award Fee. The use of these types of contracts incentivizes the contractor for superior delivery of the pre-agreed performance metrics such as schedule and cost performance (PMI, 2013c). As such, using these types of contracts is strongly associated with superior project performance (Brady & Davis, 2014) since the parties involved in the project may prefer different actions because of their different risk preferences (Eisenhardt, 1989). Thus, the pain/gain contractual arrangements can be critical in solving the agency problem that characterizes most employer-contractor relationships (Jensen & Meckling, 1976) on projects.

It is argued that transferring risk to the contractor (as in the use of Fixed Price contracts) offers no real protection for the client because the client is always accountable for cost, time, quality and safety (Brady & Davis, 2014). The results of this study agree with this argument given that 2 out of the 3 projects in which the client assumed full responsibility for risk of cost overrun and schedule delay met their cost and schedule objectives. Thus, even though numbers are still small, the findings of this study could be pointing to the fact that outcome-oriented contracts lead to better results than behavior-based contracts. Such contracts enhance ambidexterity (simultaneous pursuit of efficiency and innovation) on projects, which in effect has significant effect on project performance (Liu & Leitner, 2012).

Emergence

Project complexity arising from emergence was measured using a 6-item Likert type scale largely centred on assessing project stability. The responses on each item were rated on a 5-point mutually exclusive scale where a rating of 1 denoted a "strongly agree" response, 2 denoted "agree" response, 3 denoted "somewhat agree" response, 4 denoted "disagree" response, while 5 denoted a "strongly disagree" response. A choice of either 1 (strongly agree) or 2 (agree) implied low complexity while a choice of either 4 (disagree) or 5 (strongly disagree) implied high complexity. A choice of 3 (somewhat disagree) implied a neutral and borderline response which did not communicate much on the complexity of projects studied. As such, this neutral response was dropped from further analysis. The responses were analyzed and summarized in Table 4.21.

Table 4.21: Summary Emergence Item Responses

Item in the Scale	% of respondents stating that they:				
	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
The project assumptions, metrics and constraints remained stable throughout its life	18.5	29.6	29.6	18.5	3.7
The stakeholder requirements remained stable throughout the project life	14.8	25.9	29.6	18.5	11.1
The project was conducted in a politically and environmentally stable context	18.5	37.0	25.9	14.8	3.7

The actual rate and type or propensity for change was manageable	25.9	55.6	14.8	3.7	-
The project had a documented change control system with identifiable change authority	40.7	29.6	14.8	7.4	7.4
Contractual arrangements included incentives for the parties to assume responsibility for emerging project risks	0.0	7.4	25.9	44.4	22.2

To check the relationship between emergence and project success, the cost and schedule performance results were mapped onto the responses with one cluster containing projects that either strongly agreed or agreed with the statements and the other containing those that disagreed or strongly disagreed. The results showed that for the projects in which assumptions, metrics and constraints remained stable through the life of the project, 53.8% were delivered on budget while 15.4% of those projects were delivered on schedule. Where assumptions, metrics and constraints did not remain stable throughout the life of the project, the results indicated that 66.7% of such projects were delivered within budget with only 16.7% of them being delivered within schedule.

Of the 11 projects in which stakeholder requirements remained stable throughout their life cycle, 54.5% were delivered within budget while 18.2% of those projects were delivered within schedule. For the projects in which stakeholder requirements did not remain stable throughout their life cycle, 50% were delivered within budget with only 12.5% of those projects being delivered within schedule. Projects which were conducted in a politically and environmentally stable context recorded a 46.7% chance of delivery within budget but only 20% of those projects were delivered within schedule.

Of the projects which were conducted in a politically and environmentally unstable context, 40% were delivered within budget with none of those projects being delivered within schedule. For the projects in which the actual rate and type or propensity for change was not manageable, 45.5% were delivered on budget while only 13.6% were delivered on schedule. Where the actual rate and type or propensity for change was not manageable, the project was delivered with both cost overrun and schedule delay. For the projects that had a documented change control system with identifiable change authority, 57.9% were delivered within budget while 21.1% were delivered within schedule.

For projects in which there was no documented change control system with identifiable change authority, 50% were delivered within budget but none of them was delivered within schedule. None of the projects surveyed utilized contractual arrangements that included incentives for the parties to assume responsibility for emerging project risks. However, for the projects in which contractual arrangements did not include incentives for the parties to assume responsibility for emerging project risks, 48.2% were delivered within budget with 18.5% being delivered within schedule. Table 4.22 summarizes project performance based on emergence responses.

Table 4.22: Project Delivery Based on Emergence

Item in the Scale	Responses			
	Strongly Agree/Agree		Strongly Disagree/Disagree	
	% of Projects Delivering Within		% of Projects Delivering Within	
	Budget	Schedule	Budget	Schedule
The project assumptions, metrics and constraints remained stable throughout its life	53.8	15.4	66.7	16.7
The stakeholder requirements remained stable throughout the project life	54.5	18.2	50.0	12.5
The project was conducted in a politically and environmentally stable context	46.7	0.20	40.0	0.00
The actual rate and type or propensity for change was manageable	45.5	13.6	0.0	0.0
The project had a documented change control system with identifiable change authority	57.9	21.1	50.0	0.0
Contractual arrangements included incentives for the parties to assume responsibility for emerging project risks	-	-	48.2	18.5

The results of this study seem to agree with the postulation of normative literature that emergence can have both positive and negative effect on project outcomes. (PMI, 2014). Emergence may enhance the ability of a project to innovate which in turn could improve project delivery capability. As an illustration, projects in which assumptions, metrics and constraints did not remain stable throughout their life recorded much better cost and schedule performance compared to those in which assumptions, metrics and constraints remained stable. The implication of this is that contractual arrangements in projects should ensure collaborative efforts with appropriate incentives to encourage the parties to solve problems that emerge as a result of progress elaboration and during execution (Brady & Davis, 2014).

Stability of stakeholder requirements is a key aspect of complexity that affects the delivery capability of a project since emergence in stakeholder requirements implies emergence in scope. As the findings of this study attest, emergence in stakeholder requirements throughout the project's life cycle could lead to reduced cost and schedule performance thereby dimming chances of project management success. Likewise, stability in the political and physical environment of a project could affect project delivery capability. In this study, instability in the political and physical environment adversely affected chances of delivery within budget and schedule. This is plausible particularly given that public infrastructural projects are implemented in delivery of a "political manifesto" and so instability in the political system inevitably affects project management success.

As noted by Swartz (2008), emergence can disrupt a project schedule, and the ability of the schedule to absorb that disruption is critical for the delivery of project outcomes. In situations where the actual rate and type or propensity for change is not manageable, as is the case in complex infrastructural megaprojects, the apparent schedule disruption may also disrupt cost performance. Indeed, the results of this study attest to this to the extent that where the actual rate and type or propensity for change was not manageable, cost and schedule delivery slipped to zero. In most cases where the project context was not stable, schedule delivery was adversely affected.

Change management is known to create a superior culture that supports open communication, trust and cooperation (Kerzner, 2009) among various stakeholders on the project. It allows for documented changes within the project to be considered in an integrated fashion while reducing project risk (PMI, 2013c). A well-documented change control system helps to identify, assess and control any potential and approved changes to the project baselines (Axelos, 2017) in order to avoid scope creep. In support of this, the results of this study showed that projects that had a documented change control system with identifiable change authority returned a higher probability of delivery within budget and schedule.

Uncertainty

Complexity arising from uncertainty was measured using an 11-item Likert-type scale. The responses on each item were rated on a 5-point mutually exclusive scale where a rating of 1 denoted a "strongly agree" response, 2 denoted "agree" response, 3 denoted "somewhat agree" response, 4 denoted "disagree" response, while 5 denoted a "strongly disagree" response. A choice of either 1 (strongly agree) or 2 (agree) implied low complexity while a choice of either 4 (disagree) or 5 (strongly disagree) implied high complexity. A choice of 3 (somewhat disagree) implied a neutral and borderline response which did not communicate much on the complexity of projects studied. As such, this neutral response was dropped from further analysis. The responses were analyzed and summarized in Table 23.

Table 4.23: Summary Item Responses for Uncertainty

Item in the Scale	% of respondents stating that they:				
	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
The project was conducted over a relatively short period of time with a manageable number of stakeholder changes	22.2	18.5	18.5	37.0	3.7
The project requirements, scope and objectives were clearly developed	37.0	40.7	11.1	7.4	-
The success criteria for the project was defined,	37.0	37.0	18.5	7.4	-

documented and agreed upon by the stakeholders					
Funding for the project was obtained from a single source or sponsor	48.2	14.8	3.7	11.1	22.2
This type of project had been undertaken by the organization before	59.3	7.4	3.7	7.4	22.2
The project had a manageable number of issues, risks and uncertainties	25.9	55.6	7.4	11.1	-
Suppliers were able to meet commitments to the project	25.9	40.7	25.9	-	7.4
The project delivered to the committed deadlines	18.5	7.4	44.4	22.2	7.4
The client was prepared in advance to accept and sign off deliverables	29.6	40.7	18.5	11.1	-
The project documents and files were kept current in an accessible location by the team	51.9	33.3	11.1	3.7	-
There were a manageable number of critical paths in the project	33.3	40.7	22.2	3.7	-

To check the relationship between uncertainty and project success, the cost and schedule performance results for the projects were mapped onto the responses. Table 24 summarizes the findings. The results indicated that 54.5% of the projects in which respondents agreed that the project was conducted over a relatively short period of time with a manageable number of stakeholder changes were delivered within budget, with 27.3% of those projects being delivered within schedule. Of the 11 projects in which the respondents disagreed with this statement, 63.6% were delivered within budget while only 9.1% of those projects were delivered within schedule.

Of the projects in which requirements, scope and objectives were clearly developed, 54.5% were delivered within budget with only 22.7% of those projects being delivered within schedule. Both the two projects in which the project requirements, scope and objectives were not clearly defined, were delivered within budget but only 1 was delivered on schedule. For the projects in which the success criteria was defined, documented and agreed upon by the stakeholders, 55% were delivered within budget while 25% were delivered within schedule. Both the projects in which the success criteria was not defined, documented and agreed upon by the stakeholders, were delivered on budget with none being delivered on schedule.

An aggregate 46.7% of the projects whose funding was obtained from a single source or sponsor were delivered within budget with 26.7% of those projects being delivered within schedule. Where project funding came from multiple sources or sponsors, 55.6% were delivered within budget with none being delivered on schedule. For projects which had not been undertaken by the organization before, the chance of delivery within budget was 44.4% while that of delivery within schedule was 22.2%. Where that type of project was being delivered by the organization for the first time, the chance of delivery within budget went down to 37.5% while that of delivery on schedule dropped to 12.5%.

In circumstances where the project had a manageable number of issues, risks and uncertainties, delivery within budget was recorded in 45.5% of the projects while delivery within schedule was recorded in only 13.6% of the projects. Where there were unmanageable number of issues, risks and uncertainties, cost delivery went down to 33.3% while schedule delivery slipped to zero. In projects where suppliers were able to meet commitments, 44.4% were delivered within budget and 16.7% were delivered within schedule. For the 2 projects in which suppliers could not meet their commitments, one was delivered on budget while both were delivered behind schedule. Of the 7 projects that were delivered to the committed deadlines, only 1 was delivered within budget, none was delivered within schedule. Where the projects did not deliver to the committed deadlines, 25% were delivered within budget but none was delivered within schedule.

In circumstances where the client was prepared in advance to accept and sign off deliverables, the chance of delivery within schedule was 52.6% and that of delivery within budget was 26.3%. These went down to 33.3% and 0% in circumstances where the client was not prepared in advance to accept and sign off deliverables. The results also indicated that of the 26 projects in which project documents and files were kept current in an accessible location by the team, 43.5% of those projects were delivered within budget with 17.4% of those projects being delivered within schedule. The project in which this was not the case was delivered within budget but behind schedule. Of the 20 projects in which there were a manageable number of critical paths in the project, delivery within budget was recorded in 40% of the projects while delivery within schedule was recorded in 25% of the projects. The project in which there were many critical paths was delivered within budget but behind schedule.

Table 4.24: Project Delivery Based on Uncertainty

Item in the Scale	Responses			
	Strongly Agree/Agree % of Projects Delivering Within		Strongly Disagree/Disagree % of Projects Delivering Within	
	Budget	Schedule	Budget	Schedule
The project was conducted over a relatively short period of time with a manageable number of stakeholder changes	54.5	27.3	63.6	9.1
The project requirements, scope and objectives were clearly developed	54.5	22.7	100.0	50.0
The success criteria for the project was defined, documented and agreed upon by the stakeholders	55.0	25.0	100.0	0.0
Funding for the project was obtained from a single source or sponsor	46.7	26.7	55.6	0.0
This type of project had been undertaken by the organization before	44.4	22.2	37.5	12.5
The project had a manageable number of issues, risks and uncertainties	45.5	13.6	33.3	0.0
Suppliers were able to meet commitments to the project	44.4	16.7	50.0	0.0
The project delivered to the committed deadlines	14.3	0.0	25.0	0.0
The client was prepared in advance to accept and sign off deliverables	52.6	26.3	33.3	0.0
The project documents and files were kept current in an accessible location by the team	43.5	17.4	100.0	0.0
There were a manageable number of critical paths in the project	40.0	25.0	100.0	0.0

The findings of this study disagree with those of Flyvbjerg et al. (2004) which showed that the longer the duration of the project the larger its cost overrun. However, based on the findings of this study, longer schedule duration was associated with increased delivery of projects under budget. This finding appears to be in line with the thinking of economic theory that uncertainties are necessary conditions for the existence of opportunities and that without uncertainty entrepreneurial profits would be impossible (Knight, 1948). What is apparent from the findings of this study is that longer schedule duration was associated with reduced delivery within schedule.

The results also showed that delivery over budget and behind schedule was equally high where the project had a large number of issues, risks and uncertainties. The implication of this is that change and risk management planning are critical to avoid firefighting whenever the vagaries of uncertainty hit a project. The Practice Guide on Navigating Complexity (PMI, 2014) recognizes that adequate risk and change management procedures should be in place to enable proper actions during the times of uncertainty, and risk sharing and collaboration are key strategies to handle uncertainty. This study found that chances of delivery over budget and behind schedule were also high in circumstances where that type of project had not been undertaken by the organization before. This confirms that the principle of learning from experience could lead to better project outcomes (Axelos, 2017).

Hypothesis Testing

Ambiguity has Significant Influence on Success of Public Infrastructural Megaprojects

In order to test the hypothesis that ambiguity has a significant influence on success of public infrastructural megaprojects, the constructs of ambiguity were scored to determine their complexity scores. The results showed that the emergence construct had a mean complexity score of 2.49 with a standard deviation of 0.66 while the uncertainty construct recorded a mean complexity score of 2.17 with a standard deviation of 0.52. The weighted ambiguity complexity score had a mean of 2.33 with a standard deviation of 0.52.

The results indicated that the emergence scores had the highest relative variability (CV=0.26) compared to that of uncertainty (CV=0.24) and the weighted score

(CV=0.22). With the coefficients of skewness and kurtosis being within the acceptable range (-1 to +1 for skewness and -2.2 to +2.2 for kurtosis), the data was approximately normal and could therefore be used to conduct tests such as correlation and regression, which assume a normal distribution. The results are presented in Table 4.25.

Table 4.25: Ambiguity Complexity Scores

Project Code	Ambiguity		Weighted Score
	Emergence	Uncertainty	
1	1.00	1.33	1.17
2	2.20	2.08	2.14
3	2.00	1.58	1.79
4	2.00	1.92	1.96
5	2.00	2.20	2.10
6	2.33	3.33	2.83
7	2.00	1.25	1.63
8	2.67	2.50	2.59
9	3.67	2.83	3.25
10	3.00	2.00	2.50
11	2.00	2.00	2.00
12	2.33	2.17	2.25
13	2.33	2.42	2.38
14	2.00	1.83	1.92
15	3.33	2.17	2.75
16	3.33	2.17	2.75
17	1.83	1.83	1.83
18	2.67	2.08	2.38
19	3.00	2.00	2.50
20	2.00	1.67	1.84
21	2.33	2.33	2.33
22	2.33	2.33	2.33
23	2.33	1.58	1.96
24	3.33	3.08	3.21
25	4.00	2.25	3.13
26	3.00	2.25	2.63
27	2.33	3.33	2.83
Descriptive Statistics:			
Mean	2.49	2.17	2.33
STDEV	0.66	0.52	0.52
CV	0.26	0.24	0.22
Skewness	0.39	0.66	-0.05
Kurtosis	0.34	0.60	-0.17

Results of the other diagnostic tests indicated that: there was no serial correlation in the data given a Durbin-Watson statistic value less than 2; the predictors were not linearly related given VIF value much lower than the cut-off value of 4; the error terms had constant variance given that almost all the residuals had a mean of 0.000 and approximately equally spread around their mean.

As a first step in hypothesis testing, the scores of AM constructs were first correlated with those of project success to determine if they had any association. The results showed that at the 99% confidence level, emergence had significant negative correlation with process success (r=-0.495) and uncertainty had a strong significant negative correlation with process success (r=-0.706). Overall, the results showed that ambiguity had a significant negative correlation with process success (CV=-0.687). The results indicated that both emergence and uncertainty had no relationship with product and organizational success, but uncertainty had a -0.641 correlation with the overall project success. The correlations are shown in Table 4.26.

Table 4.26: Correlation Between Ambiguity and Project Success

	Correlations						
	Project Success Scores				Ambiguity Scores		
	Process	Product	Org.	Composite	Emergence	Uncertainty	Ambiguity score
Process	1	-.074	-.164	.589**	-.495**	-.706**	-.687**
Product	-.074	1	.709**	.710**	-.139	-.236	-.214
Org.	-.164	.709**	1	.630**	.133	-.101	.035
Composite	.589**	.710**	.630**	1	-.353	-.641**	-.561**
Emergence	-.495**	-.139	.133	-.353	1	.454*	.888**
Uncertainty	-.706**	-.236	-.101	-.641**	.454*	1	.813**
Ambiguity Score	-.687**	-.214	.035	-.561**	.888**	.813**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Causal relationship between ambiguity and megaproject success was tested using OLS linear regression at the 95% confidence level. The results indicated that the overall model had a 31.5% predictive power (R^2=0.315). ANOVA results showed that the overall model was significant with $F_{(1,25)}$=11.501 and P< $\frac{\alpha}{2}$. The regression equation is presented below:

$$\bar{PS}_i = 6.461 - 0.743AM_i$$
$$s(\hat{b}_i) = (0.522) \quad (0.219)$$
$$t = \ (12.368) \quad (-3.392) \qquad R^2 = 0.315$$

The results showed that at 95% confidence level, the $s(\hat{b}_i) < \left(\frac{\hat{b}_i}{2}\right)$ for both the intercept and the slope of the equation. Thus, the null hypothesis that $b_0 = b_1 = 0$ was rejected and a conclusion made that the betas were significant. The results showed that the slope of Ambiguity was significant, implying that a one unit increase in the complexity score for ambiguity reduced project success score by 0.743. Thus, the research hypothesis that ambiguity has significant influence on success of public infrastructural megaprojects was accepted. The full regression results are shown in appendix 3.

The results of this study indicated that ambiguity had only a significant relationship with process success. The implication of this is that accepting and dealing with ambiguity should be a key aspect of project management. Hagen and Park (2013) assert that acceptance of ambiguity is a key trait that differentiates between effective and ineffective leaders. The results of this study also indicated a significant positive relationship between emergence and uncertainty, implying that there is an overlap between these constructs and distinguishing their independent effects on project outcomes can be difficult.

It is recognized in normative literature that ambiguity can have either positive or negative effect on project outcomes (PMI, 2014). However, the findings of this study only established that ambiguity leads to negative project outcomes. In a study on the effects of ambiguity on project task structure in new product development, Duimering, Ran, Derbentseva, and Poile (2006) concluded that knowledge of how the task structures evolve (emergence) can lead to improved strategies for managing projects with ambiguous requirements.

4.4.4 System Behavior

The third objective of this study was to investigate the influence of system behavior on success of public infrastructural megaprojects. Complexity arising from system behavior was measured on a scale comprising three constructs namely; connectedness, dependency and system dynamics. The findings are presented per construct in the sections that follow.

Connectedness

Complexity arising from connectedness was measured using a Likert-type scale containing 4 items. Each of these items were scored on a scale of 1 to 3 with a score of 1 denoting low complexity and 3 denoting high complexity. Connectedness denotes a relationship that exists between two or more components of a project (PMI, 2014). This relationship was measured by checking the number of connections among stakeholders, subcontracts, project components, third party relationships and layers in the organogram. The number of connections was determined using the formula:

$$C = \frac{N(N-1)}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \textit{Equation 3}$$

where N is the number of components, stakeholders, layers or third party relations. The results are shown in Table 4.27.

The results showed that in 66.6% of the projects surveyed, there were more than 45 stakeholder connections. These projects had more than 10 stakeholders. There were over 45 subcontractor/component connections in 25.9% of the projects, also implying that these projects had more than 10 subcontracts/components. The results also showed that in 39.7% of the projects surveyed, there were more than 45 third party relation connections while there were more than 45 connections related to the layers in the organogram in 22.2% of the project surveyed.

Table 4.27: Aspects of Connectedness

Aspect of Connectedness	% of Projects with No. of Connections		
	Below 45	Between 45 & 90	Above 90
Stakeholders	33.3	22.2	44.4
Sub-contracts or components	74.1	14.8	11.1
Third party relations	59.3	14.8	25.9
Layers in the organogram	77.8	7.4	14.8

Comparison in performance based on the number of connections was made using the CPI and SPI values. The results indicated that as stakeholder connections increased from 45 to above 90, cost performance dropped from 0.95 to 0.84 and schedule performance also dropped from 0.77 to 0.70. There was higher relative variability in both cost and schedule performance for the projects that had over 90 stakeholder connections. The results seemed to indicate that as stakeholder connections increased, the level of risk in cost and schedule performance increased.

For the subcontract or component connectedness, the results indicated that as the number of connections increased, cost performance decreased from 0.92 (when the number of connections was below 45) to 0.82 (when the number of connections was above 90). However, schedule performance seemed to improve from 0.71 when the connections were below 45, to 0.76 when the number of connections was above 90.

The values of coefficients of variation showed that cost and schedule performance risk seemed to increase as the number of subcontract/component connections increased.
On connectedness arising from third party relationships, the results indicated that the mean cost performance dropped from a high of 0.9 when the connections were below 45 to a low of 0.88 when number of connections was more than 90. Schedule performance results also showed a decrease (albeit slight) from 0.74 when the number of connections was below 45 to 0.73 when the number was above 90. The relative cost performance risk was higher when number of connections went from below 45 to above 90. However, the results showed that the schedule performance risk decreased from a high of 0.38 when the number of connections was below 45 to a low of 0.28 when the number of connections was above 90.

The results also indicated that as the number of layers in the organogram increased, the mean cost performance decreased but the mean schedule performance improved. It was also shown that as the number of layers in the organogram increased, the risk of delivery within budget increased but the risk of delivery within schedule decreased. Table 4.28 summarizes project performance based on the aspects of connectedness.

Table 4.28: Mean Performance Based on Connectedness

Aspect of Connectedness	Descriptive Statistics	No. of Connections					
		Below 45		Between 45-90		Above 90	
		CPI	SPI	CPI	SPI	CPI	SPI
Stakeholders	Mean	0.95	0.77	0.98	0.75	0.84	0.70
	Std Dev.	0.16	0.29	0.08	0.25	0.16	0.24
	CV	0.17	0.38	0.08	0.33	0.19	0.34
Sub-contracts or components	Mean	0.92	0.71	0.91	0.82	0.82	0.76
	Std Dev.	0.15	0.26	0.10	0.24	0.24	0.30
	CV	0.16	0.36	0.12	0.29	0.29	0.40
Third party relationships	Mean	0.90	0.74	1.00	0.70	0.88	0.73
	Std Dev.	0.15	0.29	0.07	0.25	0.19	0.20
	CV	0.17	0.38	0.07	0.35	0.22	0.28
Layers in the organogram	Mean	0.92	0.71	0.93	0.90	0.84	0.76
	Std Dev.	0.15	0.26	0.18	0.14	0.20	0.25
	CV	0.16	0.37	0.19	0.16	0.24	0.32

The findings of this study agree with Remington and Zolin (2011) who argue that complexity can result in problems, waste, economic and social failures. The results showed that Connectedness has some association with project outcomes, mostly failure to meet cost and schedule objectives. Complexity theory stipulates that complex adaptive systems exist at many levels of organization and the agents at one level are the building blocks for the agents at the next level. The theory attempts to discover how the many disparate elements of a system work with each other to shape the system and its outcomes, as well as how each component changes over time (PMI, 2014).

The number of stakeholder connections can be an indicator of the potential number of communication channels on a project, an indicator of the complexity of communications (PMI, 2013c), which is generally associated with negative outcomes. The findings of this study agree with the propositions of normative theory on the effects of complexity on project outcomes. The study finds that projects with fewer channels of communication (given the stakeholder connections) have superior cost and schedule performance than those with many channels of communication.

Even though there have been several conceptual contributions on the study of structural complexity (Dvir & Shenhar, 2011; Shenhar & Dvir, 2007b) in projects, and even though the concept of connectedness is well researched in the fields of sociology and/or psychology, not much literature exists about the specific components of structural complexity such as connectedness. While contributing to the contingency school of project management thought (Turner et al., 2010), the findings of this study could be a baseline for future research.

Dependency

Dependency occurs when work and task packages are interdependent in such a way that one work package depends on another work package or one task package depends on another task package. Dependency was measured using a Likert-type scale containing 3 items. Each of these items were scored on a scale of 1 to 3 with a score of 1 denoting low complexity and 3 denoting high complexity. The results indicated that of the projects surveyed, 11.1% had one critical path, 37% had up to 5 critical paths while 51.9% of the projects had more than 5 critical paths. In 14.8% of the projects there was one dependency relationship among the project components while in 29.6% of the projects, there were up to 5 dependency relationships. A total of 55.6% of the projects surveyed reported having more than 5 dependency relationships among the project components.

An aggregate 44.4% of the projects were reported to have had one interphase between the project's products and those of other projects within the organization while 37% of the projects reported having had up to 5 interphases between the project's products and those of other projects within the organization. In 18.5% of the projects surveyed there were more than 5 interphases between the project's products and those of other projects within the organization. Table 4.29 summarizes the responses based on aspects of dependency.

Table 4.29: Aspects of Dependency

Dependency Item	% of Projects stating No. as:		
	1	Up to 5	>5
Critical paths in the project	11.1	37.0	51.9
Dependency relationships among the project's components	14.8	29.6	55.6
Interphases between the project's products and those of other projects within the organization	44.4	37.0	18.5

Comparison in performance based on dependencies was made using the CPI and SPI values. The results indicated that projects that had more than one critical path recorded superior cost performance but schedule performance seemed to be a decreasing function of the number of critical paths in the project. However, relative variability in both mean and schedule performance seemed to decrease as the number of critical paths in the project increased.

Both mean cost and schedule performance appeared to go down as the number of dependency relationships among the project's components increased from one to above 5. The relative variability in both the mean cost and schedule performance also appeared to decrease with the number of dependency relationships among the project's components. Both the mean cost and schedule performance appeared to increase as the number of interphases between the project's products and those of other projects within the organization increased. The relative riskiness in cost performance seemed to increase with the number of interphases but the riskiness in schedule performance went down as the number of interphases increased. Table 4.30 provides a summary.

Table 4.30: Project Performance Based on Dependency

Aspect of Dependency	Descriptive Statistics	No. of Dependences					
		1		Up to 5		Above 5	
		CPI	SPI	CPI	SPI	CPI	SPI
Critical paths in the project	Mean	0.81	1.09	0.95	0.71	0.87	0.69
	Std Dev.	0.20	0.37	0.14	0.19	0.17	0.22
	CV	0.25	0.34	0.15	0.26	0.20	0.32
Dependency relationships among the project's components	Mean	0.94	0.90	1.00	0.67	0.84	0.73
	Std Dev.	0.08	0.45	0.10	0.17	0.16	0.22
	CV	0.08	0.50	0.10	0.26	0.19	0.31

Interphases between the project's products and those of other projects within the organization	Mean Std Dev. CV	0.87 0.16 0.19	0.76 0.29 0.38	0.96 0.11 0.12	0.65 0.22 0.33	0.89 0.18 0.20	0.82 0.21 0.26

The number of critical paths in a project may determine the governance structure of a project and thus shape its management and control needs. Since it has been shown that a project structure could affect its outcomes, properly designed structure to deliver complexity that arises due to the number of critical paths may lead to better project outcomes. The findings of this study support this view given that the coefficients of variation for both cost and schedule performance went down as the number of critical paths increased. However, this finding does not support the postulation of normative literature that the percentage of work packages that have no float or have multiple or parallel critical paths are especially sensitive to failure (PMI, 2014).

Dependency determination enables the team to identify threats to the project plan so that ways of dealing with these threats can be designed into the project during planning. Being either systems or system of systems, the projects surveyed in this study had several components with dependencies. Some of these dependencies were mandatory or discretionary while others were external or internal to the project. The number of dependency relationships among the project's components increases with the complexity of the projects. This study established that cost and schedule delivery decreases with the number of dependency relationships among project components. The implication of this is that increased complexity arising from the number of dependency relationships reduces the chances of cost and schedule delivery.

Interphases between the project's products and those of other projects within the organization should be clearly mapped out to ensure proper prioritization and alignment of organizational as well as project resources. Misalignment may result in conflicting priorities and direction for the project team (PMI, 2014) which could impact project outcomes. This is compounded in a situation where there are many interphases. In attestation, the results of this study showed that both cost and schedule performance improved with increased number of interphases between the project's products and those of other projects within the organization.

System Dynamics

Complexity arising from system dynamics was measured using a 6-item Likert type scale with five response choices for each item (1=strongly agree, 2=agree, 3=somewhat agree, 4=disagree, 5=strongly disagree) where the respondent was required to check one response for each item in the scale. A choice of 1 and 2 implied low complexity while a choice of 4 and 5 implied presence of high complexity. Borderline response (3) was not considered in further analysis. Table 4.31 summarizes these responses.

Table 4.31: System Dynamic Responses

Item in the Scale	% of respondents stating that they:				
	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
There were only a few quality requirements that the project needed to conform that did not contradict each other	33.3	18.5	14.8	18.5	14.8
The deliverable(s) of the project utilized only a few technologies (e.g., electrical, mechanical, digital)	11.1	14.8	14.8	33.3	25.9
There was a high level of confidence that the interconnected components of the project performed in a predictable manner	33.3	48.2	11.1	7.4	-
All contracts related to the project were free of any financial, health or safety claims filed by suppliers, team members or customers	29.6	37.0	3.7	22.2	7.4
Project components were pre-fabricated, pre-assembled and tested offsite before being used in the project	22.2	18.5	3.7	33.3	22.2
Materials were only brought on site when the site was ready to receive them	40.7	29.6	14.8	7.4	7.4

Cost and schedule performance indices were calculated to determine whether projects that had low complexity (agree/strongly agree responses) due to system dynamics performed differently when compared with the projects with high complexity (disagree/strongly disagree responses) due to system dynamics. The results are summarized in Table 32. These results indicated that projects in which there were only a few quality requirements that the project needed to conform that did not contradict each other, had lower mean cost (0.89) and schedule (0.75) performance compared to those in which there were many quality requirements (CPI=0.91 and SPI=0.77). The mean cost and schedule performance for the projects in which there were only a few quality requirements that the project needed to conform that did not contradict each other, were riskier when compared to the performance of those in which there were many requirements.

For projects in which deliverable(s) utilized only a few technologies, the mean cost performance was higher and relatively stable (Mean= 1.00, CV= 0.10) compared to those in which the deliverables utilized many technologies (Mean= 0.84, CV= 0.19). However, the schedule performance results indicated that the mean performance increased with the number of technologies, though with increased risk (for mean SPI, 0.78>0.67; and for CV of SPI, 0.29<0.36).

For projects in which there was a high level of confidence that the interconnected components performed in a predictable manner, mean cost performance was higher (CPI=0.92) but riskier (CV=0.16) compared with those that indicated to the contrary (CPI=0.86, CV=0.10). Schedule performance results for these projects indicated that mean performance increased with complexity and that this increased performance was relatively more stable (for Mean SPI, 0.85>0.76; for CV, 0.08<0.32).

Projects in which all contracts were free of any financial, health or safety claims filed by suppliers, team members or customers, recorded the same mean cost performance (but with higher risk) compared to projects with financial, health or safety claims. However, schedule performance for these projects decreased with increased claims and the overall stability of the mean schedule performance also went down.

Projects in which components were pre-fabricated, pre-assembled and tested offsite before being used in the project recorded both higher cost and schedule performance compared to those that indicated to the contrary. The relative variability in cost and schedule performance was lower in cases where components were pre-fabricated, pre-assembled and tested offsite. The results indicated that projects in which materials were only brought on site when the site was ready to receive them recorded superior performance in both cost and schedule compared to those indicating to the contrary. Even though the riskiness in cost performance was lower in cases where materials were only brought on site when the site was ready to receive them, schedule performance was riskier in these projects compared to those in which materials were brought on site earlier than required. Table 4.32 summarizes the project performance based on system dynamics.

Table 4.32: Project Performance Based on System Dynamics

Item in the Scale	Cost and Schedule Performance Based on Responses							
	Agree				Disagree			
	CPI		SPI		CPI		SPI	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV
There were only a few quality requirements that the project needed to conform that did not contradict each other	0.89	0.20	0.75	0.36	0.91	0.16	0.77	0.25
The deliverable(s) of the project utilized only a few technologies (e.g., electrical, mechanical, digital)	1.00	0.10	0.67	0.29	0.84	0.19	0.78	0.36
There was a high level of confidence that the interconnected components of the project performed in a predictable manner	0.92	0.16	0.76	0.32	0.86	0.10	0.85	0.08
All contracts related to the project were free of any financial, health or safety claims filed by suppliers, team members or customers	0.91	0.17	0.79	0.32	0.91	0.08	0.64	0.41
Project components were pre-fabricated, pre-assembled and tested offsite before	0.98	0.10	0.70	0.34	0.87	0.18	0.76	0.37

being used in the project								
Materials were only brought on site when the site was ready to receive them	0.96	0.13	0.74	0.31	0.81	0.21	0.76	0.51

As illustrated by the findings of this study, inherent multiplicity of requirements actually affects the sensitivity of cost and schedule performance in such a way that as quality requirements increase cost and schedule performance become more stable. Multiple quality requirements for the project's products require multiple acceptance criteria and methods for their validation, verification and final acceptance. Connectedness of and interdependence among the various quality requirements and acceptance criteria and methods may operate in such a way as to cause interactions that could affect project outcomes.

As the findings of this study illustrate, the use of more technologies on a project is associated with increased cost and schedule performance risk. The number of technologies applied on a project introduces uncertainty in achievement of project metrics which could signal increased complexity. Technological integration on a project requires a properly designed and operational configuration and quality management system to enable tracking and control of changes to project baselines that may accompany such integration. Without such a system, the rate of changes to the project could exceed the rate of progress thus pushing the project to an uncontrolled change.

As illustrated by the findings of this study, unpredictability in the manner in which the interconnected components operate is associated with low relative variability in project cost and schedule performance. Whereas inference of this result is not apparent, it could explain the nature of the operation of system dynamics. System dynamics result from the connectedness and interdependency of many components that interact so as to cause change over time. The interactions among components of a system may cause interconnected risks, draw on resources, create emerging, unforeseeable issues, and unclear and disproportional cause-and-effect relationships (PMI, 2014). Where the interconnected components of the project do not perform in a predictable manner, the emerging uncertainty increases dynamic complexity which in turn could affect project outcomes.

A key approach to dealing with risks due to progressive elaboration is to pre-fabricate, pre-assemble and pretest components before using them on the project. This approach does not only ensure that quality is designed into the project but also minimizes chances of rework, rejects or off-specifications. As Brady and Davis (2014) have shown, this approach does improve cost and schedule delivery. In support of this, this study found that cost and schedule performance indices were more stable where project components were pre-fabricated, pre-assembled and tested offsite before being used in the project.

Construction sites are usually constrained for space. Some of the materials used are high value items that may not be stocked for long without considerable risk of pilferage. Yet, other items such as cement are perishable and require to be stocked just in time. The implication here is that the project procurement function must ensure a seamless flow of materials and other stock items. Just-In-Time stocking of materials ensures economic use of site space and avoids tying too much money into stock that may not be currently required. As the results of this study showed, this practice was associated with superior and more stable cost and schedule performance.

Hypothesis Testing

System Behavior has Significant Influence on Success of Public Infrastructural Megaprojects

In order to test the hypothesis that system behavior has a significant influence on success of public infrastructural megaprojects, the constructs of system behavior were scored to determine their complexity scores. System dynamics score was determined by multiplying the connectedness score with the dependency score, since system dynamics involves the interaction of connectedness and dependency. The scores for each of the constructs together with weighted score (calculated by taking a simple average of the mean scores for each of these constructs) are shown in Table 4.33.

The results showed that the construct of connectedness had a mean complexity score of 4.09 with a standard deviation of 0.80 while the dependency construct recorded a mean complexity score of 2.06 with a standard deviation of 0.60. System dynamics construct had a mean complexity score of 8.47 with a standard deviation of 3.17 whereas the weighted system behavior complexity score had a mean of 4.88 with a standard deviation of 1.40.

In terms of relative variability in the complexity scores, the construct of system dynamics ranked highest with CV=0.37 followed by dependency at CV=0.29 and connectedness at CV= 0.20. The weighted system behavior complexity scores had a relative variability of 0.29. To check the suitability of the data for parametric tests such as correlation and regression analysis, the coefficients of skewness and kurtosis were determined for the scores of each construct. The coefficients were within the acceptable range (-1 to +1 threshold for skewness and the -2.2 to +2.2 thresholds for kurtosis) as shown in Table 4.33.

Results of the other diagnostic tests indicated that: there was no serial correlation in the data given a Durbin-Watson statistic value less than 2; the predictors were not linearly related given VIF value equal to 1, a value much lower than the cut-off value of 4; the error terms had constant variance given that almost all the residuals had a mean of 0.000 and approximately equally spread around their mean

Table 4.33: System Behavior Complexity Scores

Project Code	System Behavior			
	Connectedness	Dependency	System Dynamics	Weighted Score
1	3.67	1.00	3.67	2.78
2	4.00	1.00	4.00	3.00
3	3.67	1.00	3.67	2.78
4	3.00	1.67	5.01	3.23
5	6.00	2.67	16.02	8.23
6	5.00	3.00	15.00	7.67
7	4.13	1.00	4.13	3.09
8	3.67	2.00	7.34	4.34
9	3.67	2.67	9.80	5.38
10	4.00	2.00	8.00	4.67
11	4.71	2.67	12.58	6.65
12	3.96	2.33	9.23	5.17
13	4.34	2.00	8.68	5.01
14	4.00	2.00	8.00	4.67
15	4.67	2.00	9.34	5.34
16	5.00	2.00	10.00	5.67
17	3.64	2.67	9.72	5.34
18	4.50	2.67	12.02	6.40
19	4.00	1.67	6.68	4.12
20	5.00	1.67	8.35	5.01
21	2.43	2.67	6.49	3.86
22	2.43	2.00	4.86	3.10
23	5.43	1.58	8.60	5.20
24	3.57	2.67	9.53	5.26
25	4.00	2.67	10.68	5.78
26	4.00	2.33	9.32	5.22
27	4.00	2.00	8.00	4.67
Descriptive Statistics				
Mean	4.09	2.06	8.47	4.88
STDEV	0.80	0.60	3.17	1.40
CV	0.20	0.29	0.37	0.29
Skewness	0.09	-0.46	0.45	0.43
Kurtosis	0.75	-0.65	0.30	0.27

As a first step to hypothesis testing, the scores of SB constructs were correlated with those of project success to determine if they had any association. The results showed that at 99% confidence level, both dependency and system dynamics had a significant negative correlation with process success (r=-0.653 and r=-0.572, respectively). The overall system behavior had a significant negative correlation with both process success and overall success (r=-0.542 and r=-0.551, respectively). Both dependency and system dynamics were negatively correlated with overall success and this relationship was significant (r= -0.719 and r=-0.583, respectively). The results also showed that system dynamics was positively correlated with dependency and connectedness. Table 4.34 summarizes the correlation coefficients.

Table 4.34: Correlation between System Behavior and Success

	Process Success	Product Score	Org. Score	Composite Score	Connectedness	Dependency	Syst. Dyn.	System behavior Score
Process Score	1	-0.074	-0.164	.589**	-0.078	-.653**	-.572**	-.542**
Product Score	-0.074	1	.709**	.710**	-0.014	-0.349	-0.25	-0.242
Org. Score	-0.164	.709**	1	.630**	0.063	-0.251	-0.17	-0.152
Composite Score	.589**	.710**	.630**	1	-0.034	-.719**	-.583**	-.551**
Connected.	-0.078	-0.014	0.063	-0.034	1	0.09	.639**	.690**
Depend.	-.653**	-0.349	-0.251	-.719**	0.09	1	.814**	.777**
Syst. Dyn.	-.572**	-0.25	-0.17	-.583**	.639**	.814**	1	.997**
System behavior Score	-.542**	-0.242	-0.152	-.551**	.690**	.777**	.997**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Causal relationship between system behavior and megaproject success was tested using OLS linear regression at the 95% confidence level. The results indicated that the overall model had a 30.4% predictive power (R^2=0.304). ANOVA results showed that the overall model was significant with $F_{(1,25)}$= 10.902 and $P<\frac{\alpha}{2}$. The regression equation is presented thus:

$$\bar{PS}_i = 6.012 - 0.551 SB_i$$

$$s(\hat{b}_i) = (0.404) \quad (0.080)$$

$$t = \ (14.875) \quad (-3.302) \qquad R^2 = 0.304$$

The results show that at 95% confidence level, the $s(\hat{b}_i) < \left(\frac{\hat{b}_i}{2}\right)$ for both the intercept and the slope of the equation. The null hypothesis that $b_0 = b_1 = 0$ was rejected and a conclusion made that the betas were significant. The results showed that the slope of system behavior was significant, implying that a one unit increase in the complexity score for system behavior reduces project success score by 0.551. Thus, the research hypothesis that system behavior has a significant influence on success of public infrastructural megaprojects was accepted. The full regression results are shown in appendix 3.

4.4.5 Project Leadership

The fourth objective of this study was to establish the moderating effect of project leadership on project complexity and success of public infrastructural megaprojects. Project leadership was assessed using a 53-item Likert-type scale in which the respondents were required to indicate on a scale of 1-5 (1=never, 2=rarely, 3=at times, 4=often, 5=always) the extent to which the project manager engaged in the behaviors described in the questionnaire and provide a brief comment (where applicable) to explain their response. A score of 1 depicted leadership behavior mapping onto goal-oriented leadership style while a score of 2 and 3 denoted leadership behavior mapping onto involving leadership style. A score of 4 or 5 depicted leadership behavior mapping onto complexity leadership style.

Project Leadership Styles

The four categories of leadership behaviors assessed were intellectual (IQ), managerial (MQ), emotional and social (ESQ), and adaptive (AQ). Given that STen scores are generally used in the analysis of personality-type questionnaires, the raw leader behavior scores were converted to Standard Ten scores (STens) and their standard deviations were determined. By definition, STens have a mean of 5.5 and standard deviation of 2.0 (Geoghegan & Dulewicz, 2008). All items satisfying this condition were considered for further analysis while those that did not satisfy this condition were dropped.

The results indicated that all items measuring intellectual behavior satisfied the STens condition and were included in further analysis. These items measured critical analysis and judgment, vision and imagination, and strategic perspective. The 18 items on managerial behavior scale measured managing resources, engaging communication, empowering, developing and achieving. Of these items, 7 did not satisfy the STens condition and were dropped from further analysis.

On emotional and social behavior, 6 of the 13 items on the scale did not satisfy the STens condition and were left out of further analysis. The items on this scale measured key leadership aspects of self-awareness, emotional resilience, intuitiveness, interpersonal sensitivity, influence, motivation and conscientiousness. Of the items measuring adaptive behavior, 13 did not meet the STens condition for further analysis. Items on this scale assessed key adaptive leadership aspects of ambiguity acceptance, ambidexterity, generative and loosening leadership behaviors. Means STens were calculated and summarized in Table 4.35. The results showed that the achieving leadership dimension had the highest STen score at 7.55 followed by the managing resources dimension (7.25) and the critical analysis and judgment dimension (7.16). Both the motivation and administrative dimensions had STen score of 6.97.

Table 4.35: Mean STens for Leadership Dimensions

Leader Behavior	STens
Intellectual Behavior (IQ)	
Critical Analysis & Judgment	7.16
Vision & Imagination	6.77
Strategic Perspective	6.77
Managerial Behavior (MQ)	
Managing Resources	7.25
Engaging Communication	5.61
Empowering	Dropped
Developing	5.74
Achieving	7.55
Emotional & Social Behavior (ESQ)	
Self-awareness	5.23

Emotional Resilience	5.23
Intuitiveness	5.61
Interpersonal Sensitivity	Dropped
Influence	Dropped
Motivation	6.97
Conscientiousness	6.19
Adaptive Behavior (AQ)	
Ambiguity Acceptance	Dropped
Ambidexterity	5.23
Generative	Dropped
Loosening	6.97

To check whether the leadership behavior mean STens were consistent with those of the norm group, a one-sample *t*-test was conducted at the 95% confidence level. The calculated *t*-statistics were then compared with the critical value of *t* obtained from the Student's *t* distribution table. Using a two-tailed test and given 26 degrees of freedom, the critical value of *t* was obtained as 2.056. The results showed that all the IQ dimensions had significantly higher STen mean scores when compared to the standardization sample. For the MQ dimensions, managing resources, empowering and achieving had statistically significant STen mean scores. For ESQ dimensions, interpersonal sensitivity, influence, motivation and conscientiousness had statistically significant STen mean scores when compared to the standardization sample. Except for the ambidexterity dimension, all AQ dimensions had statistically significant STen mean scores. Empowering, Interpersonal sensitivity, influence, ambiguity acceptance, and generative dimension, all had lower STen mean scores but were statistically significant. Table 4.36 summarizes the significance of the leadership dimensions.

Table 4.36: Significance of Leadership Dimensions

Leader Behavior	Mean STens	STDEV	Test Value=5.5 t-statistic	*df*	Significance
IQ Dimensions					
Critical Analysis & Judgment	7.16	1.02	8.47	26	Significant
Vision & Imagination	6.77	1.52	4.35	26	Significant
Strategic Perspective	6.77	1.18	5.61	26	Significant
MQ Dimensions					
Managing Resources	7.25	1.84	4.95	26	Significant
Engaging Communication	5.61	1.85	0.31	26	Not Significant
Empowering	2.33	1.50	-11.00	26	Significant
Developing	5.74	2.23	0.56	26	Not Significant
Achieving	7.55	2.08	5.13	26	Significant
ESQ Dimensions					
Self-awareness	5.23	1.29	-1.09	26	Not Significant
Emotional Resilience	5.23	1.80	-0.78	26	Not Significant
Intuitiveness	5.61	0.89	0.64	26	Not Significant
Interpersonal Sensitivity	3.68	1.93	-4.89	26	Significant
Influence	0.98	1.19	-19.78	26	Significant
Motivation	6.97	1.34	5.69	26	Significant
Conscientiousness	6.19	1.40	2.57	26	Significant
AQ Dimensions					
Ambiguity Acceptance	3.30	1.72	-6.64	26	Significant
Ambidexterity	5.23	0.82	-1.71	26	Not Significant
Generative	2.86	2.44	-5.63	26	Significant
Loosening	6.97	2.13	3.59	26	Significant

Each of the leader behavior dimensions was assessed based on a descriptive 3-point scale of “High” (STens of 8 and above), “Medium” (STens above 6.5 but less than 8), and “Low” (STens between 5 and 6.5 inclusive). Based on IQ, the results indicated a leadership style characterized by medium score on critical analysis and judgment, vision and imagination, and strategic perspective. On MQ, the results indicated a leadership style characterized by medium score on managing resources, low score on both engaging communication and developing and medium score on achieving. On ESQ, the results indicated a leadership style characterized by low Self-awareness, emotional resilience, intuitiveness and consentiousness; and medium score on motivation. On AQ, the results indicated a leadership style characterized by low score on ambidexterity and medium score on loosening dimension.

These results were mapped onto 3 key leadership styles namely; Complexity Leadership (CL), Involving Leadership (IL) and Goal-Oriented Leadership (GL) to understand whether infrastructural megaproject managers have a typical leadership style. The results showed that out of the 14 leadership dimensions that met the STens threshold (mean=5.5 and standard deviation=2.0), 9 dimensions mapped onto Goal leadership, 5 dimensions mapped onto Involving leadership while 4 dimensions mapped onto Complexity leadership. Thus, the results portrayed a typical leadership style that is long on goal-leadership but short on both involving and complexity leadership. Table 4.37 summarizes the mapping of the leadership styles.

Table 4.37: Mapping of Leadership Styles

Leader Behavior	Item in the Scale	STen Score		
		Low	Medium	High
Intellectual Dimension (IQ)				
Critical analysis and judgment	A1		CL, IL	
Vision and imagination	A2, A3, A4		CL	
Strategic perspective	A5, A6		CL, IL	
Managerial Dimension (MQ)				
Managing resources	B1,B2,B3,B4		IL	
Engaging communication	B5, B6, B7	GL		
Empowering	B8,B9			
Developing	B10,B11,B12,B13,B14	GL		
Achieving	B15,B16,B17,B18		CL, IL	
Emotional and Social Dimension (ESQ)				
Self-awareness	C1,C2	GL		
Emotional resilience	C3,C4	GL		
Intuitiveness	C5	GL		
Interpersonal sensitivity	C6,C7,C8			
Influence	C9			
Motivation	C10,C11		GL	
Conscientiousness	C12,C13	GL		
Adaptive Dimension (AQ)				
Ambiguity acceptance	D1,D2,D3			
Ambidextrous	D4	GL		
Generative	D5,D6,D7,D8,D9,D10,D11			
Loosening	D12,D13,D14,D15,D16		GL, IL	

Generally, project team members surveyed identified six key project leadership behaviors that inhibited their delivery, namely: rigidity to standards and lack of flexibility; poor people skills; indecisiveness and delayed decision making; poor stakeholder management; poor schedule management, and dictatorial tendencies. These behaviors generally block the application of complexity leadership style which requires that a leader oscillates from administrative leadership to generative and adaptive leadership as context evolves.

The findings of this study revealed that managers of public infrastructural megaprojects exhibited a leadership style that was short on adaptive behavior indicating reduced ability to navigate through inherent complexity. This finding is consistent with that in Uhl-Bien (2012) where a majority of organizations operating in a complex environment were found to be responding to complexity using traditional approaches to leadership. However, this finding runs counter to that by Baskovics (2014) and Pisarski et al. (2011), who argue that classical leadership style needs to be enhanced in order to achieve project success in complex contexts.

This study tailored the framework in Dulewicz and Higgs (2005) to analyze leadership style. This framework used three dimensions with 15 measures to map leadership styles. In the current study, an additional dimension with 4 measures was introduced to capture the essence of leadership in a complexity context (Snowden & Boone, 2007; Uhl-Bien, Marion, & McKelvey, 2007; Surie & Hazy, 2006). When the raw leadership scores were transformed to Standard Tens (STens), a total of 5 measures were dropped leaving 14 measures which were used in further analysis.

An important parallel between the findings of this study and those of Geoghegan and Dulewicz (2008) relates to the items that were dropped from the scale following transformation of raw scores to STens. Geoghegan and Dulewicz found that vision and imagination had STens lower than the norm group and was thus dropped from the scale. The findings of the current study did not agree with this. Indeed, envisioning is a critical determinant of the application of a tight-loose administrative leadership style in a complex project environment.

The present study dropped empowering, interpersonal sensitivity and influence from the scale. Whereas all these three leadership behaviors are important, their omission might have been as a result of introduction of adaptive dimension measures of ambidexterity and loosening. Ambidextrous teams pursue innovation and efficiency simultaneously, which generally require that the teams are empowered. The exploit-explore (loosening) decision is generally enhanced by interpersonal sensitivity of the leader and their ability to influence the team.

Of the four measures of adaptive behavior, ambiguity acceptance and generative behavior were dropped from the scale leaving ambidexterity and loosening. This study takes the view that both ambiguity acceptance and generative behavior are subsets of ambidexterity and loosening. Based on STens, the top ranking leadership behaviors commonly exhibited by project managers were: achieving, managing resources, critical analysis and judgment, loosening and motivation, respectively. This order does not seem to support the leadership decision-making framework developed by Snowden and Boone (2007). This framework shows that complex or chaotic contexts require a leader who can act or probe first before sensing and responding. In complex and chaotic contexts, a project manager figure is either a rhetor or a reflexive agent (Gauthier & Ika, 2012) implying that adaptive behavior anchored in complexity science should dominate the leadership style.

The findings of this study portrayed a style that is long on goal-leadership but short on both involving and complexity leadership. This practice is not supported by the postulations of both positive and normative leadership literature which recognize that in order to respond positively to complexity in megaprojects, there is need for transformational and appropriate leadership (Cooke-Davies, 2011; Hayes & Bennett, 2011; PMI, 2013a; Snowden & Boone, 2007; Uhl-Bien & Marion, 2009; Gauthier & Ika, 2012; Chen, Donahue, & Klimoski, 2004; Packendorff, 1995; Weiss, Donigian & Hughes, 2010). Generally, high complexity contexts require a more facilitative style of leadership (Higgs & Rowland, 2003) because leader-centric or directive style of leadership works best in relatively simple and straightforward contexts (Dulewicz & Higgs, 2005).

Most of the inhibitive leader behaviors cited by the project team members relate to the inability of project managers to act according to the contexts of the social world of their projects. The project manager figure in the complex contexts is either a rhetor or a reflexive agent (Gauthier & Ika, 2012) who exercises pattern-based leadership as opposed to fact-based leadership (Snowden & Boone, 2007). Complex projects require leadership styles that enable injecting adaptive pressure (Uhl-Bien & Marion, 2009) to foster complex problem solving across networks of agents rather than to force compliance with a singular perspective.

Project Leadership and Success of Public Infrastructural Megaprojects

To check for any association between project leadership and success of public infrastructural megaprojects, the raw leadership scores were determined and summarized based on individual behavior dimensions. The results of this summary showed that the Intellectual leadership dimension (IQ) and Emotional and Social dimension (ESQ) had a mean score of 3.99 while the Managerial dimension (MQ) and Adaptive dimension (AQ) recorded mean scores of 3.98 and 3.88 respectively. When relative variability in the leadership scores was considered, the results showed relatively high stability and consistency in the scores of managerial leadership dimension and adaptive leadership dimension compared to those of both intellectual and emotional and social leadership dimensions.

Bivariate correlation was performed between the scores of the constructs of project success and those of leadership dimensions. The coefficients of skewness and kurtosis in Table 4.38 indicates that the mean leadership scores approximately followed a normal distribution and were therefore suitable for correlation analysis.

Table 4.38: Descriptive Statistics for Leadership Scores

Descriptive Statistic	Intellectual Dimension (IQ)	Managerial Dimension (MQ)	Emotional and Social Dimension (ESQ)	Adaptive Dimension (AQ)
Mean	3.99	3.98	3.99	3.88
STDEV	0.70	0.58	0.68	0.63
CV	0.17	0.14	0.17	0.16
Skewness	-1.13	-0.50	-0.76	-0.60
Kurtosis	1.42	0.65	-0.19	-0.85

The bivariate correlation results showed that at the 99% confidence level, intellectual and managerial leadership dimensions were significantly positively correlated with process success. At the 95% confidence level, both emotional and social dimension and adaptive dimension had significant and positive correlation with process success.

Within the intellectual leadership dimension, the results showed that vision and imagination positively correlated with process success and this correlation was significant at the 95% confidence level. The strategic perspective aspect of intellectual leadership dimension had a strong and significant positive correlation with product success at the 99% confidence level. The results also showed moderately positive and significant correlation between strategic perspective and organizational success, at the 99% confidence level.

Within the managerial leadership dimension, the results indicated that at the 99% level of confidence, managing resources and achieving behaviors had strong positive and significant correlations with process success, while engaging communication and developing behaviors had moderate but significant correlation with process success. On emotional and social dimension, the results indicate that motivation and conscientiousness behaviors strongly and positively correlated with process success at the 99% confidence level. The results also showed moderate but significantly positive correlation between interpersonal sensitivity and process success. At the 95% level of confidence, emotional resilience was found to significantly positively correlate with process success.

In the adaptive leadership dimension, the results showed that loosening behavior had a strong positive correlation with product success and a moderate positive correlation with organizational success. Both these correlations were significant at the 99% confidence level. Overall, the results showed that project leadership had positive and medium correlation with product and organizational success and had a near strong positive correlation with overall project success. Table 4.39 presents these correlation coefficients.

Table 4.39: Correlations Between Leadership and Success

Leadership Dimensions	Project Success Dimensions			
	Process	Product	Organizational	Composite
Intellectual Dimension	**.765****	**-0.22**	**-0.28**	**0.31**
Critical Analysis & Judgment	0.27	-0.05	-0.02	0.16
Vision & Imagination	.413*	-0.11	0.03	0.25
Strategic Perspective	0.07	.801**	.553**	.653**
Managerial Dimension	**.584****	**-0.25**	**-0.12**	**0.23**
Managing Resources	.809**	-0.10	-0.21	.428*
Engaging Communication	.503**	-0.28	-0.11	0.17
Empowering	0.03	-0.18	-0.03	-0.07
Developing	.579**	-0.23	-0.22	0.20
Achieving	.739**	-0.05	-0.06	.461*
Emotional & Social Dimension	**.451***	**-0.14**	**-0.02**	**0.24**
Self-awareness	0.13	0.23	0.33	0.33
Emotional Resilience	.487*	0.00	0.13	.388*
Intuitiveness	0.16	-0.02	0.07	0.13
Interpersonal Sensitivity	.576**	-0.06	-0.08	0.34
Influence	0.11	-0.04	-0.06	0.03
Motivation	.737**	-0.37	-0.34	0.20
Conscientiousness	.772**	-0.27	-0.18	0.33
Adaptive Dimension	**.395***	**-0.28**	**-0.11**	**0.10**
Ambiguity Acceptance	0.24	0.13	0.14	0.29
Ambidexterity	0.07	0.29	0.33	0.32
Generative	0.17	0.16	0.03	0.21
Loosening	0.04	.736**	.576**	.610**
Leadership Score	**.195**	**.650****	**.617****	**.693****

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

This study confirmed the findings by Dulewicz and Higgs (2005) and Geoghegan and Dulewicz (2008) who showed that leadership competencies affect project success and organizational outcomes. Based on their correlation strengths, the study identified managing resources, conscientiousness, achieving, motivation and developing, in that order, as the most important leader behaviors that affect process success. However, what was surprising is the insignificance of critical analysis and judgment which is key in judging various scenarios to enable tight-loose decisions.

As expounded in both positive and normative project success literature, factors that lead to process success may not necessarily lead to product and organizational success. The results of this study resonate with this view given that the leadership behaviors that significantly correlated with process success were distinct from those that correlated significantly with product and organizational success. This study put forth the thesis that a leadership which is characterized by high strategic perspective and loosening was most likely to achieve both product and organizational success. Further, the findings of this study agree in part with the findings of O'Donnell (2010) that project leadership has positive and medium to strong correlation with project success.

Earlier studies have shown that there is a significant positive relationship between ambiguity acceptance and customer and organizational outcomes for team members (Hagen & Park, 2013). On the contrary, this study did not find any significant relationship between these variables. However, it is noted that loosening behavior heavily draws from a leader's ability to recognize that a complex project context can present ambiguous situations which require to be either explored or exploited. It can therefore be said that ambiguity necessitates loosening behavior and its acceptance facilitates decision making.

Whereas the individual behaviors within the adaptive leadership dimension did not portray a significant relationship with process success, they did have when combined. And with the loosening behavior having had a significant positive relationship with product and organizational success, adaptive leadership was the only leadership dimension that had significant relationship with all the dimensions of project success. Therefore, in line with the recommendation of Snowden and Boone (2007), there is need to broaden the traditional approach to leadership and decision making and form a new perspective based on complexity science. Such an approach to leadership is consistent with the central assertion of the meso argument that leadership is multi-level, processual, contextual, and interactive (Uhl-Bien & Marion, 2009).

Hypothesis Testing

Project Leadership has Significant Moderating Effect on Complexity and Success of Public Infrastructural Megaprojects

In order to test the hypothesis that project leadership has significant moderating effect on complexity and success of public infrastructural megaprojects, the overall complexity index for each project was determined by calculating a simple average of all the three complexity dimensional indices as shown in Table 4.40. The results showed that the projects had a mean complexity index of 3.23 with a standard deviation of 0.69. The relative variability in these indices was 0.21. Of the three complexity dimensions, SB had the greatest relative variability (CV=0.29) followed by HB (CV=0.27) and AM (CV=0.22). The results also showed that the overall complexity indices data satisfied the normality condition for parametric tests with both coefficients of skewness and kurtosis being within the acceptable ranges.

Table 4.40: Overall Complexity Scores

Project Code	Complexity Dimensional Scores			Overall Complexity Score
	HB Score	AM Score	SB Score	
1	1.97	1.17	2.78	1.97
2	2.22	2.14	3.00	2.45
3	2.29	1.79	2.78	2.29
4	2.35	1.96	3.23	2.51
5	2.77	2.10	8.23	4.37
6	3.41	2.83	7.67	4.64
7	1.33	1.63	3.09	2.02
8	2.76	2.59	4.34	3.23
9	4.18	3.25	5.38	4.27
10	3.77	2.50	4.67	3.65
11	2.63	2.00	6.65	3.76
12	2.63	2.25	5.17	3.35
13	1.60	2.38	5.01	3.00
14	2.33	1.92	4.67	2.97
15	2.55	2.75	5.34	3.55
16	2.59	2.75	5.67	3.67
17	2.24	1.83	5.34	3.14
18	2.72	2.38	6.40	3.83
19	2.42	2.50	4.12	3.01
20	1.33	1.84	5.01	2.73
21	2.30	2.33	3.86	2.83
22	2.30	2.33	3.10	2.58
23	1.99	1.96	5.20	3.05
24	3.25	3.21	5.26	3.91
25	2.07	3.13	5.78	3.66
26	1.93	2.63	5.22	3.26
27	3.25	2.83	4.67	3.58
Descriptive Statistics:				
Mean	2.49	2.33	4.88	3.23
STDEV	0.67	0.52	1.40	0.69
CV	0.27	0.22	0.29	0.21
Skewness	0.60	-0.05	0.43	0.04
Kurtosis	0.75	-0.17	0.27	-0.45

Further, the results indicated that there was no serial correlation in the data given a Durbin-Watson statistic value less than the cut-off 2. Data was also checked for collinearity using the VIF statistics. The results indicated that all the VIF values were less than 1, a value much lower than 4 which is used as the threshold to indicate multicollinearity (particularly in small samples). The problem of heteroscedasticity was checked using residual statistics and scatter plot. The results indicated that almost all the residuals had a mean of 0.000 and were approximately equally spread around their mean implying that the data was good for OLS regression analysis.

The overall complexity scores data also showed that the projects from the roads sector were the most complex with the mean complexity index of 3.32 followed by projects from the ports sector with a mean complexity index of 3.26. The projects from the energy sector had the lowest complexity with mean complexity index of 3.07. The results also indicate that the ports sector had the highest relative variability in complexity (CV=0.32) followed by projects in the energy sector (CV=0.18) while the roads sector had the lowest relative variability in complexity with CV=0.13. On average, therefore, projects from the ports sector were more complex compared to those in energy and roads sector. Table 4.41 summarizes the mean complexity per project sector.

Table 4.41: Mean Complexity per Project Sector

Project Sector	Overall Complexity Index		
	Mean	Standard Deviation	Coefficient of Variation
Ports	3.26	1.03	0.32
Energy	3.07	0.54	0.18
Roads	3.36	0.44	0.13

As a first step in testing the moderated model, a model combining the 3 dimensions of project complexity and success of public infrastructural megaprojects was constructed using OLS linear regression and tested at the 95% confidence level. The results indicated that the overall model had a 58.3% predictive power (R^2=0.583). ANOVA results showed that the overall model was significant with $F_{(3,23)}=10.711$ and $P<\frac{\alpha}{2}$. The regression equation is presented thus:

$$\bar{PS}_i = 7.107 - 0.479HB_i - 0.140AM_i - 0.324SB_i$$
$$s(\hat{b}_i) = (0.461) \quad (0.172) \quad (0.232) \quad (0.071)$$
$$t = (15.403) \quad (-2.785) \quad (-0.800) \quad (-2.175) \quad R^2 = 0.583$$

The results showed that at 95% confidence level, the $s(\hat{b}_i) < \left(\frac{\hat{b}_i}{2}\right)$ for both the intercept and the slopes of Human Behavior and System Behavior. However, in the case of Ambiguity, at 95% confidence level, $s(\hat{b}_i) > \left(\frac{\hat{b}_i}{2}\right)$. Thus only the betas of the constant, human behavior and system behavior were significant. The null hypothesis that $b_{HB} = b_{SB} = 0$ was rejected and a conclusion made that the betas are significant. However, we failed to reject the null hypothesis that $b_{AM} = 0$ and concluded that more investigation is required probably using an expanded sample size.

For the overall model, it was concluded that at the 95% confidence level, the research hypothesis that complexity had significant influence on success of public infrastructural megaprojects. With complexity explaining 58.3% of the variation in project success, this study agreed with conclusions of earlier studies which have confirmed that complexity predominantly determines project success (Meyer, 2014; Hargen & Park, 2013; O'Donnell, 2010; Shermon, 2011, Flyvbjerg, Holm, & Buhl, 2004; Vanston & Vanston, 2004).

The results of this study also indicated that complexity arising from human behavior had greater influence on project success followed by complexity arising from system behavior. This finding is in line with that of Williams (1999), Kahneman and Tversky (1979) and Lovallo and Kahneman (2003), who posit that human behavior is the main explanation for the "iron law of megaprojects" (delivery over budget, behind schedule, with benefit shortfalls, over and over).

The next step in hypothesis testing involved testing the moderated model by introducing project leadership into the model combining complexity and success of public infrastructural megaprojects. To do this, the mean leadership scores for the items that satisfied the STens condition for further analysis were taken for each project. Interaction between leadership and each complexity variable was determined by multiplying the individual complexity and leadership scores. Table 4.42 shows these scores.

Table 4.42: Leadership and Interaction Scores

Project Code	Complexity Dimensional Scores			L Score	Interaction Scores		
	HB Score	AM Score	SB Score		HB×L	AM×L	SB×L
1	1.97	1.17	2.78	3.89	7.66	4.55	10.81
2	2.22	2.14	3.00	4.05	8.99	8.67	12.15
3	2.29	1.79	2.78	4.14	9.48	7.41	11.51
4	2.35	1.96	3.23	4.00	9.40	7.84	12.92
5	2.77	2.10	8.23	3.70	10.25	7.77	30.45
6	3.41	2.83	7.67	3.00	10.23	8.49	23.01
7	1.33	1.63	3.09	4.40	5.85	7.17	13.60
8	2.76	2.59	4.34	3.00	8.28	7.77	13.02
9	4.18	3.25	5.38	3.00	12.54	9.75	16.14
10	3.77	2.50	4.67	3.26	12.29	8.15	15.22
11	2.63	2.00	6.65	4.00	10.52	8.00	26.60
12	2.63	2.25	5.17	2.11	5.55	4.75	10.91
13	1.60	2.38	5.01	4.40	7.04	10.47	22.04
14	2.33	1.92	4.67	4.40	10.25	8.45	20.55
15	2.55	2.75	5.34	4.30	10.97	11.83	22.96
16	2.59	2.75	5.67	4.00	10.36	11.00	22.68
17	2.24	1.83	5.34	4.30	9.63	7.87	22.96
18	2.72	2.38	6.40	3.50	9.52	8.33	22.40
19	2.42	2.50	4.12	4.11	9.95	10.28	16.93
20	1.33	1.84	5.01	4.30	5.72	7.91	21.54
21	2.30	2.33	3.86	4.15	9.55	9.67	16.02
22	2.30	2.33	3.10	3.50	8.05	8.16	10.85
23	1.99	1.96	5.20	4.50	8.96	8.82	23.40
24	3.25	3.21	5.26	4.00	13.00	12.84	21.04
25	2.07	3.13	5.78	4.68	9.69	14.65	27.05
26	1.93	2.63	5.22	3.96	7.64	10.41	20.67
27	3.25	2.83	4.67	3.56	11.57	10.07	16.63
Descriptive Statistics:							
Skewness	0.60	-0.05	0.43	-1.24	-0.28	0.49	0.15
Kurtosis	0.75	-0.17	0.27	1.66	-0.13	1.36	-0.95

Based on these scores, a stepwise OLS regression was run. The moderated regression model assumed the following relationship (as specified earlier in chapter 3) and was tested following the Baron and Kenny (1986) test for moderation.

$$\bar{PS}_i = \beta_1 + \beta_2 HB_i + \beta_3 AM_i + \beta_4 SB_i + \beta_5 L_i + \beta_6 HB_i L_i + \beta_7 AM_i L_i + \beta_8 SB_i L_i + \mu$$

The results indicated that when leadership was introduced into the regression model, human behavior completely ceased to explain success and it was excluded from the model. However, the interaction terms involving system behavior and leadership, and ambiguity and leadership, remained and were significant. Results of the stepwise regression showed three models. Model 1 showed the effect of leadership on success and the results therein indicated a 48% predictive power. The regression equation is shown below:

Model 1: $\bar{PS}_i = 1.68 + 0.79 L_i$

$s(\hat{b}_i)$ =(0.64) (0.16)

t= (2.62) (4.81) $R^2 = 0.48$

The results showed that at 95% confidence level, the $s(\hat{b}_i) < \left(\frac{\hat{b}_i}{2}\right)$ for both the intercept and the leadership. Thus, the intercepts were significant. Accordingly, a one unit increase in leadership score increased project success by 0.79.

Model 2 showed the effect of leadership and the interaction between leadership and system behavior on project success. The results showed a 66.3% predictive power of that model, representing 18.3% increase (from 48%) in variation explained by the introduction of the interaction term. The regression model is shown below:

Model 2: $\bar{PS}_i = 3.058 + 0.696 L_i - 0.208 SB_i L_i$

$s(\hat{b}_i) =$ (0.65) (0.137) (0.006)

t= (4.702) (5.062) (-3.611) $R^2 = 0.663$

With $s(\hat{b}_i) < \left(\frac{\hat{b}_i}{2}\right)$ for all intercepts at 95% confidence level, it was concluded that the model was significant.

Model 3 showed the effect of leadership, interaction between system behavior and leadership and interaction between ambiguity and leadership. The results therein indicated a 72.7% predictive power implying a 6% increase (from 66.3%) in variation explained by the introduction of the interaction between ambiguity and leadership. Table 4.43 summarizes these models.

Model 3: $\bar{PS}_i = 3.932 + 0.633L_i - 0.159SB_iL_i - 0.374AM_iL_i$

$s(\hat{b}_i) =$ (0.706) (0.129) (0.057) (0.161)

t= (5.572) (4.907) (-2.791) (-2.329) $R^2 = 0.727$

Again, with $s(\hat{b}_i) < \left(\frac{\hat{b}_i}{2}\right)$ for all intercepts at 95% confidence level, it was concluded that the model was significant. The research hypothesis that project leadership has a significant moderating effect on complexity and success of public infrastructural megaprojects, was therefore accepted.

Table 4.43: Moderated Model Summary

Model Summary[d]

Model	R	R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
				R Square Change	F Change	df1	df2	Sig. F Change	
1	.693[a]	0.48	0.4902	0.48	23.099	1	25	0.000	
2	.814[b]	0.663	0.40274	0.183	13.038	1	24	0.001	
3	.853[c]	0.727	0.37007	0.064	5.425	1	23	0.029	1.298

a Predictors: (Constant), Leadership score

b Predictors: (Constant), Leadership score, System behavior score

c Predictors: (Constant), Leadership score, System behavior score, Ambiguity score

d Dependent Variable: Composite Score

ANOVA results showed that the overall models were significant with $F_{(1,25)}$=23.10 and *P*-Value equal to 0.000 for model 1, $F_{(2,24)}$=23.63 and *P*-Value equal to 0.000 for model 2, and, $F_{(3,23)}$=20.47 and *P*-Value equal to 0.000 for model 3. Table 4.44 summarizes ANOVA results for the 3 models.

Table 4.44: Summary ANOVA Results

				ANOVA[a]		
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.551	1	5.551	23.099	.000[b]
	Residual	6.007	25	.240		
	Total	11.558	26			
2	Regression	7.665	2	3.833	23.630	.000[c]
	Residual	3.893	24	.162		
	Total	11.558	26			
3	Regression	8.408	3	2.803	20.466	.000[d]
	Residual	3.150	23	.137		
	Total	11.558	26			

a. Dependent Variable: Composite Score

b. Predictors: (Constant), Leadership score

c. Predictors: (Constant), Leadership score, System behavior score

d. Predictors: (Constant), Leadership score, System behavior score, Ambiguity score

Tests of diagnostics on data to establish their suitability for OLS regression analysis indicated that there was no serial correlation in the data given a Durbin-Watson statistic value of 1.298. Data was also checked for collinearity using the VIF statistics. The results indicated that all the VIF values were much lower than 4 implying that the predictors were not linearly related. The problem of heteroscedasticity was checked using residual statistics and scatter plot. The results indicated that almost all the residuals had a mean of 0.000 implying that the data had equal spread and was therefore good for OLS regression analysis. Normality test using coefficients of skewness and kurtosis showed that the data was approximately normal.

The findings of this study agree with the postulation of Zimmerer and Yasin (1998) that leadership is the dominant determinant of project success. Using the coefficients of determination, the results showed that project leadership had the highest predictive power compared to regression results involving human behavior, ambiguity and system behavior, individually on project success. Complexity alone explained 58.3% of variation in project success. However, when project leadership was introduced, the predictive power of the model jumped to 72.7%.

Further, the results of this study support the view that leadership skills are the most important for successful navigation of complexity (PMI, 2013a) in megaprojects. Apparently, when leadership was introduced into the regression model combining the dimensions of complexity, it totally eclipsed human behavior as a predictor of success and had significant interaction effect with both ambiguity and system behavior. As such, the study agrees with the view suggesting that problems related to successful project outcomes and inevitably the solution to achieving project objectives that meet stakeholders' expectations, originates with people in leadership roles and the procedures adopted by project managers (Standish Group, 2006, 2009).

The findings of this study reinforce the proposal of the 2009 ICCPM round table series on complex project management that future managers of complex projects need to be developed and selected based on a range of leadership skills that enables them to operate in uncertain and ambiguous environments (Hayes & Bennett, 2011).

4.5 Implications of the Findings and Optimal Model

4.5.1 Implications for Theory and Practice

This study confirmed that individually, human behavior, ambiguity and system behavior significantly influences success of public infrastructural megaprojects. Even though ambiguity was not significant when these three dimensions were combined into one model, the central implication of the findings was that complexity indeed influences success. This puts the application of the Complex Adaptive Systems theory at the centre of resolving the "iron law" of megaprojects. The study identified biases in individual as well as group behavior that represent a systematic pattern of deviation from norm or rationality in judgment. The findings confirmed that these biases actually affect project outcomes, mostly negatively. Collectively, the study established that these biases affect the culture of the project organization. As showed in this study, the individual behavioral biases led to a culture that did not support delivery of megaprojects. Consequently, the findings underscore the significance and application of the Cognitive Bias theory in delivery of successful public infrastructural megaprojects. Results of this study also confirmed that there was no one best organizational structure to deliver projects. Rather, the appropriate organizational structure depends on the contingencies facing the organization . Based on the findings of this study, projects whose characteristics aligned with the contingencies within and outside their implementing organization performed more effectively compared to those that were misaligned. In effect, the findings of this study reinforce the application of the Structural Contingency theory in delivery of public infrastructural megaprojects.

Finally, the findings of this study confirmed that project leadership indeed influences successful delivery of public infrastructural megaprojects. This was in such a way that success was enhanced as project leadership tended towards complexity leadership style. This means that in order to deliver these projects successfully, project managers must be quick to take note of emerging patterns or contexts so as to tailor their leadership approach effectively. In essence, the findings pointed to the fact that megaproject leadership becomes depending on the context. When project leadership was introduced in a model combining the dimensions of complexity, human behavior completely ceased to be a predictor of project success but the interaction effect of leadership with ambiguity and system behavior remained significant. These findings put Complexity Leadership theory at the centre of delivering successful public infrastructural megaprojects.

4.5.2 Implications for Research

This study found that process success did not necessarily mean project success. It confirmed that a project delivered within budget, within schedule and to the right technical specifications is not necessarily a successful project. However, the study established that a project that attains product success is likely to exhibit organizational success. Thus, the findings of this study reinforce and contribute to the raging debate on research in the success school as to whether project management success implies project success.

The finding that individuals and groups exhibit cognitive biases which actually affect the project and organization culture, and thus the project outcomes, is a key contribution to research in the behavioral school of project management. With the finding that project leadership should become depending on the context, the study adds to the contingency school of project management research. The findings that: project leadership, top management support, organization structure, and project manager's authority, influence project success are key contributions to the governance school of project management research.

4.5.3 Optimal/Revised Model of the Study

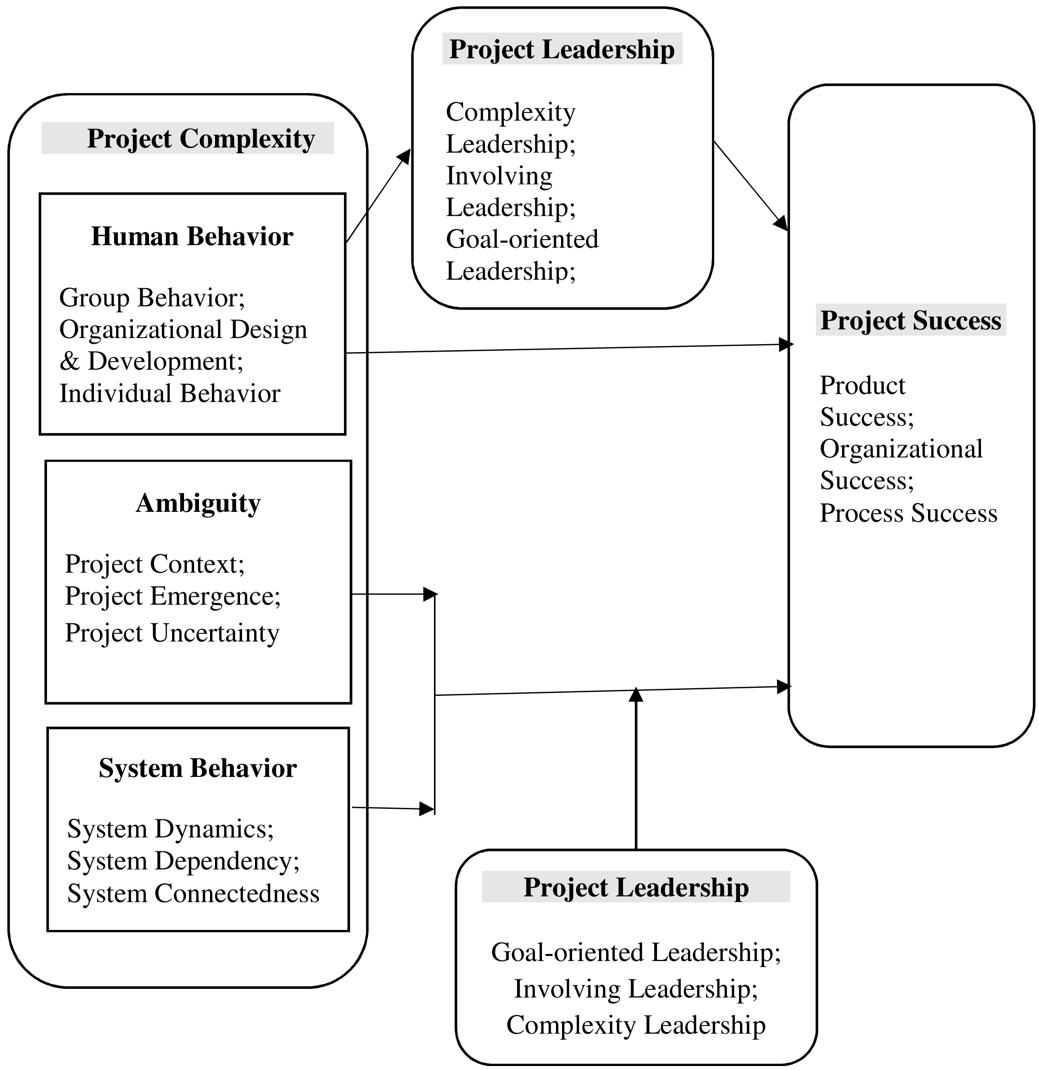
The optimal model of this study was derived based on the research findings. The model rearranges the constructs of each variable based on the magnitude of their coefficients of determination with the variable. The model also orders the variables based on the extent to which each explains the variability in the dependent variable. Based on the findings of this study, group behavior had the highest correlation with human behavior followed by organizational design and development, and individual behavior, in that order. Emergence correlated with ambiguity more than uncertainty while system dynamics correlated with system behavior more, followed by dependency and connectedness, in that order. Based on the complexity dimensions, human behavior explained more of the variation in project success followed by ambiguity and system behavior, in that order. Of the project success dimensions, product success explained more of the variation in overall success followed by organizational success and process success, respectively.

The results for project leadership showed that success was enhanced as the leadership style tended from goal-oriented towards involving and towards complexity leadership. When project leadership was introduced into the combined model, human behavior completely ceased to predict success but the interaction effect of project leadership with both ambiguity and system behavior remained significant. This would imply that project leadership influences (moderates) the strength of the causal relationship between ambiguity and system behavior with success of public infrastructural megaprojects but explains (mediates) the causal relationship between human behavior and success of public infrastructural megaprojects. To provide a brief proof of mediation using the Baron and Kenny (1986) test for mediation, Table 4.45 summarizes the results. Steps 1-3 showed that zero-order relationships among the variables exist since all the relationships were significant. As such, mediation was highly likely.

Table 4.45: Mediation of Project Leadership

Step	Analysis	Results
1	Simple regression analysis with human behavior predicting success	$\bar{PS}_i = 6.421 - 0.681HB_i$ $R^2 = 0.463$, P< $\frac{\alpha}{2}$
2	Simple regression analysis with human behavior predicting leadership style	$\bar{L}_i = 5.23 - 0.551HB_i$ $R^2 = 0.369$, $P < \frac{\alpha}{2}$
3	Simple regression analysis with leadership style predicting success	$\bar{PS}_i = 1.68 + 0.79L_i$ $R^2 = 0.480$, $P < \frac{\alpha}{2}$
4	Multiple regression analysis with both human behavior and leadership style predicting success	$\bar{PS}_i = 3.805 + 0.50L_i - 0.405HB_i$ $s(\hat{b}_i) =$ (1.068) (0.194) (0.170) Sig. 0.002 0.016 0.025 $R^2 = 0.580$, $P < \frac{\alpha}{2}$

The model in Step 4 showed that leadership style was still significant predictor of success after controlling for human behavior. Even though $s(\hat{b}_{HB}) < \left(\frac{\hat{b}_{HB}}{2}\right)$, $P - Value_{HB} = \frac{\alpha}{2}$ implying that the probability of accepting the hypothesis that $b_{HB} = 0$ was the same as the probability of rejecting it. In this case, the result suggested an almost full mediation. This system of results led to a revised conceptual framework as shown in figure 4.3.



Independent Variable **Mediating/Moderating Variable** **Dependent Variable**

Figure 4. 3: Optimal/Revised Model

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the rationale and methodology of this study together with the findings from the study. Based on the summary of the findings, conclusions are drawn as a basis of making both policy and research recommendations. The summary of the findings is presented based on each study variable, with the conclusions being presented based on each study objective. The recommendations are presented for both policy and practice, and for research.

5.2 Summary of Findings

The main objective of this study was to investigate the moderating role of project leadership on the influence of complexity on success of public infrastructural projects in Kenya. To operationalize this, a set of 4 specific objectives were used with the main variables of study being human behavior, ambiguity, system behavior and project leadership. The need for this study arose from the thesis that complexity is the main cause of waste and failure that results in infrastructural megaprojects being delivered over budget, behind schedule, with benefit shortfalls, over and over again; and that leadership skills are the most important for successful navigation of this complexity.

The study was designed as multiple-method research, based on virtual constructionist ontology recognizing that complexity is the mid-point between order and disorder. A cross-sectional census survey of 124 respondents (comprising 31 project managers, 62 project team members and 31 project sponsors) based on 31 completed public infrastructural megaprojects was conducted using three interlinked questionnaires.

Collected data was processed and analyzed using Microsoft Access 2010, IBM's SPSS version 20 and Microsoft Excel 2010. Quantitative data analysis was conducted using both descriptive and inferential statistics while qualitative data analysis was done through scenario mapping and triangulation. The main descriptive statistics used were the mean, standard deviation, coefficient of variation, skewness, kurtosis, percentages and STens. The inferential statistics used were *F*-test, *t*-test, Pearson correlation coefficients, coefficients of determination and tests of significance. Data presentation was largely through tables, charts, text, figures and equations. The findings of the study are summarized per each variable as follows:

5.2.1 Megaproject Success

Infrastructural Megaproject success was measured along three constructs namely process, product and organizational success. Process success incorporated the traditional measures of efficiency (delivery within budget and time schedule) and quality. Product success measured the effectiveness of the project in delivering a product that meets the customer requirements, improves customer performance, and satisfies customer needs. Organizational success measured the interaction of process and product success to meet organizational objectives, maximize stakeholder value, and enhance organizational innovation capacity to deliver future projects.

The findings agreed in part with the trending view that megaprojects are always delivered over budget, behind schedule. With 52% of the projects having been delivered overbudget and 82% having been delivered behind schedule, the "iron law of megaprojects" was partly confirmed. Whereas existing positive literature indicates that one out of ten infrastructural megaprojects is delivered on budget and one out of ten megaprojects is delivered on schedule, the study only confirmed this to the extent that 11% of the projects were delivered on schedule.

Further, the results showed that the megaprojects surveyed had a mean of 0.91 in cost performance, 0.73 in schedule performance and 0.82 in overall efficiency. This study found that more of the variability in overall project efficiency was attributed to schedule performance than to cost performance and most projects that were delivered on or under budget experienced schedule delay. This is a key finding that may be pointing to the fact that most emphasis in megaproject management is directed on the cost element rather than to an integrated trade-off among cost, time and quality.

Project success results based on sector showed that the energy sector projects had relatively the highest process success variability (CV=0.11) but had the lowest product (CV=0.45), organizational (CV=0.40) and composite (CV=0.28) success variability. The ports sector had the lowest relative process success (CV=0.29) but the highest relative product (CV=0.20), organizational (CV=0.13) and composite (CV=0.12) success. These findings add to the growing view that operational excellence or process success does not necessarily imply project success.

5.2.2 Human Behavior

Human behavior was measured using three constructs namely; individual behavior, group behavior, and organizational design and development. The study found that of the complexity dimensions, human behavior had the highest predictive ability on success of public infrastructural megaprojects with R^2=46.5%. The findings of this study agreed with the postulation of both positive and normative literature that optimism bias and the other biases in individual behavior have negative implications throughout the life cycle of programs and projects. Projects exhibiting optimism bias had more incidences of delivery over budget and behind schedule compared to those exhibiting misrepresentation and loss aversion. The findings also pointed to the fact that individual behaviors identified had more adverse effect on schedule performance compared to cost performance.

The findings of this study put misrepresentation bias in the second place among individual biases associated with cost overrun and schedule delay. The surprising bit was that this misrepresentation came from both in-project and corporate or programme management, as in the cases where project managers cited servitude to be the main reason for both cost and schedule underperformance. In terms of occurrence on projects, this study found that loss aversion had almost twice the frequency of optimism bias and thrice the frequency of misrepresentation.

In projects where groupthink was not inferred, delivery was superior when compared to projects in which groupthink was inferred. For this study, the findings established that project misalignment adversely affected schedule delivery and to a considerable extent, budget delivery. This finding supports and reinforces the Structural Contingency Theory which posits that an organization whose characteristics align with the contingencies in its situation will perform more effectively compared to an organization whose characteristics do not fit with the contingencies in its situation.

The results of this study agree with the postulation in extant literature that effective communication has an impact on project execution and/or outcome. As noted from this study, in projects where there was no open communication, collaboration and trust among the stakeholders and project team, the probability of delivery within cost and schedule dropped from 47.8% and 13% respectively, to 0%.

On whether project management maturity has a relationship with project performance, this study posted mixed findings-on one hand it was concluded that lack of process maturity had negative relationship with schedule delivery, on the other hand the results are mixed on the relationship between lack of process maturity and cost performance. For the projects in which the project manager had the authority to apply internal or external resources to project activities, 45.5% were delivered within budget and 18.2% were delivered within schedule.

Consistent with the postulations of the project management theory, strong matrix and projectized organization structures usually give the project manager full authority to make project decisions, within the constraints of the project charter. Where the project manager did not have authority to apply resources, the chance of delivery within budget went down to 40% while that of delivery on schedule diminished to 10%. The results of this study showed that projects utilizing strong matrix and projectized structures had more stable mean success results.

On stakeholder engagement, the main forms of engagement were through site meetings and progress reports, with some projects involving stakeholders only in preparatory stages. Stakeholder engagement was a formal role in only 4 projects (14.8%) with 6 projects (22.2%) having a clearly documented stakeholder engagement plan that was used to manage stakeholders. The findings of this study showed that there is an identifiable gap between the prescriptions of theory and actual practice. Indeed, the results showed a practice that is long on management for stakeholders and short on management of stakeholders.

All projects mapped onto a project culture that can be characterized as having a preference for an internal focus and stability. In line with the findings in positive literature, failed projects map onto a culture that can be characterized as having preference for internal focus and stability. This type of culture is generally suitable for organizations that operate in more deterministic environments characterized with more stable outcomes.

5.2.3 Ambiguity

Complexity arising from ambiguity was measured on a scale comprising three constructs namely; project context, emergence and uncertainty. The findings of this study established that ambiguity had significant negative influence on success of public infrastructural megaprojects. However, ambiguity did not have a significant influence on success of infrastructural megaprojects when the three dimensions of complexity are combined.

The results indicated that ambiguity had significant correlation with process success, implying that accepting and dealing with ambiguity should be a key aspect of project management. The study established that most infrastructural megaprojects utilized FP-EPA with one third of the projects surveyed utilizing FFP contracts. A larger proportion of projects that utilized FFP contracts recorded higher cost performance. This was followed by projects that utilized FP-EPA, which is a variation of FP contracts. Despite having recorded superior cost performance, projects that utilized FFP recorded the highest schedule slippage. However, projects whose contracts included late delivery penalties delivered on schedule.

The results of this study pointed to the thesis that projects utilizing outcome-oriented contracts lead to better results than those utilizing behavior-based contracts. Projects in which the client assumed full responsibility for risk of cost overrun and schedule delay met their cost and schedule objectives. The results showed that emergence in stakeholder requirements throughout the project's life cycle could lead to reduced cost and schedule performance thereby dimming chances of project management success. Instability in the political and physical environment adversely affected chances of delivery within budget and schedule.

Where the actual rate and type or propensity for change was not manageable, cost and schedule delivery slipped to zero. Further, in most cases where the project context was not stable, schedule delivery was adversely affected. Projects that had a documented change control system with identifiable change authority returned a higher probability of delivery within budget and schedule. It was also established that longer schedule duration was associated with increased delivery of projects under budget but with reduced delivery within schedule. Delivery over budget and behind schedule was equally high where the project had a large number of issues, risks and uncertainties. This study found that chances of delivery over budget and behind schedule were also high in circumstances where that type of project had not been undertaken by the organization before.

5.2.4 System Behavior

Complexity arising from system behavior was measured on a scale comprising three constructs namely; connectedness, dependency and system dynamics. The study established that system behavior had a significant influence on success of public infrastructural megaprojects. The results showed that system connectedness had some association with project outcomes, mostly failure to meet cost and schedule objectives. Projects with fewer channels of communication (given the stakeholder connections) had superior cost and schedule performance than those with many channels of communication.

Projects that had more than one critical path recorded superior cost performance but schedule performance seemed to be a decreasing function of the number of critical paths in the project. However, relative variability in both mean and schedule performance seemed to decrease as the number of critical paths in the project increased. Both mean cost and schedule performance appeared to go down as the number of dependency relationships among the project's components increased from one to above 5.

The relative variability in both the mean cost and schedule performance also appeared to decrease with the number of dependency relationships among the project's components. Both the mean cost and schedule performance appeared to increase as the number of interphases between the project's products and those of other projects within the organization increased. The relative riskiness in cost performance seemed to increase with the number of interphases but the riskiness in schedule performance went down as the number of interphases increased.

Coefficients of variation for both cost and schedule performance went down as the number of critical paths increased. This study established that cost and schedule delivery decreased with the number of dependency relationships among project components. The implication of this is that increased complexity arising from the number of dependency relationships reduced the chances of cost and schedule delivery.

The study also established that the use of more technologies on a project was associated with increased cost and schedule performance risk. Unpredictability in the manner in which the interconnected components operate is associated with low relative variability in project cost and schedule performance. Cost and schedule performance indices were more stable where project components were pre-fabricated, pre-assembled and tested offsite before being used in the project. Projects which embraced Just-In-Time stocking of materials were associated with superior and more stable cost and schedule performance.

5.2.5 Project Leadership

Project leadership was assessed using behaviors along four dimensions namely: intellectual (IQ), managerial (MQ), emotional and social (ESQ), and adaptive (AQ). Based on IQ, the results indicated a leadership style characterized by medium score on critical analysis and judgment, vision and imagination, and strategic perspective. On MQ, the results indicated a leadership style characterized by medium score on managing resources, low score on both engaging communication and developing and medium score on achieving. On ESQ, the results indicated a leadership style characterized by low Self-awareness, emotional resilience, intuitiveness and consentiousness; and medium score on motivation. On AQ, the results indicated a leadership style characterized by low score on ambidexterity and medium score on loosening dimension.

When the leadership behaviors were mapped onto three leadership styles namely: Complexity Leadership (CL), Involving Leadership (IL) and Goal-Oriented Leadership (GL), the results portrayed a typical leadership style that was long on goal-leadership but short on both involving and complexity leadership. Generally, project team members surveyed identified six key project leadership behaviors that inhibited their delivery, namely: rigidity to standards and lack of flexibility; poor people skills; indecisiveness and delayed decision making; poor stakeholder management; poor schedule management, and dictatorial tendencies.

This study confirmed that leadership competencies affect project success and organizational outcomes. Based on their correlation strengths, the study identified managing resources, conscientiousness, achieving, motivation and developing, in that order, as the most important leader behaviors that affected process success. Leadership behaviors that significantly correlated with process success were distinct from those that correlated significantly with product and organizational success. Based on the findings of this study, leadership which is characterized by high strategic perspective and loosening was most likely to achieve both product and organizational success.

Whereas the individual behaviors within the adaptive leadership dimension did not portray a significant relationship with process success, they did have when combined. And with the loosening behavior having had a significant positive relationship with product and organizational success, adaptive leadership was the only leadership dimension that had significant relationship with all the dimensions of project success.

In the absence of project leadership, human behavior was found to have the highest predictive power on success of public infrastructural megaprojects. However, when project leadership was introduced into the model linking complexity with project success, project leadership became the dominant determinant of project success and completely eclipsed human behavior from the final regression results. However, the interaction effect of project leadership with ambiguity, and with system behavior remained significant. This implies that leadership is not only a key determinant of project success but also mediates the effect of human behavior on success of public infrastructural megaprojects. Complexity alone explained 58.3% of the variability in project success but when the project leadership was introduced into the model, its explanatory power shot to 72.7%. The success rate was enhanced as the project leadership style tended to that of complexity leadership.

5.3 Conclusions

This study sought to investigate the influence of project complexity on success of public infrastructural megaprojects in Kenya. Having reviewed the literature on project complexity, leader behavior and megaproject success, a conceptual framework was developed consisting of three main causes of complexity as independent variables, leader behavior as the moderating variable and megaproject success as the dependent variable. A census survey of 31 completed public infrastructural megaprojects was conducted with 124 respondents comprising 31 project managers, 62 project team members and 31 project sponsors. Three separate but interlinked questionnaires were used to collect data on the projects' complexity, leader behavior and success. The conclusion were drawn based on the findings and summarized as per the study objectives.

Objective 1: To Determine the Influence of Human Behavior on Success of Public Infrastructural Megaprojects

From the findings, it was concluded that human behavior had significant negative influence on success of public infrastructural megaprojects. Individual behavior, group behavior and organizational design and development, all had significant but negative correlation with process success. However, only organizational design and development had significant correlation with product success.

Optimism bias was the main individual behavior that led to cost and schedule underperformance in infrastructural megaprojects but loss aversion was the most occurring cognitive bias. Projects in which the project manager had near total authority over resources had more stable outcomes compared to those in which the project manager had weaker authority.

Stakeholder satisfaction was not managed as a key project objective and in some cases it was considered as a front-end activity that was only important during project planning. Despite the rapid change, uncertainty, dependency and emergence that characterize public infrastructural megaprojects, implementation of these projects assumed a culture that was characterized by stability and internal focus.

Objective 2: To Determine the Influence of Ambiguity on Success of Public Infrastructural Megaprojects

The study established that ambiguity had significant negative influence on process success but had no significant relationship with product or organizational success. There was significant relationship between emergence and uncertainty and differentiating the effect of each on project outcomes could be difficult given this interrelationship. Infrastructural megaprojects majorly utilized FFP and FP-EPA contracts. Even though these contract types led to increased chances of delivery within budget, they carried with them an inherent risk of delivery behind schedule. Inclusion of late delivery penalties in these contracts could help remedy the risk of schedule slippage.

Projects in which the client assumed responsibility for cost and schedule risk had higher chances of meeting both cost and schedule objectives than those transferring or sharing this risk. Transferring or sharing project risk increased chances of achieving cost objective but greatly reduced the chances of meeting schedule objective.

Objective 3: To Determine the Influence of System Behavior on Success of Public Infrastructural Megaprojects

On the whole, system behavior had significant negative influence on success of public infrastructural megaprojects. However, the individual constructs of system behavior had mixed influence on project success. System connectedness was associated with project outcomes in such a way that the more the number of connections, the lower was the cost and schedule performance. The number of dependencies in a project were associated with project outcomes in such a way that increased dependencies improved cost and schedule performance except for case of the number of dependencies in the critical path.

Objective 4: To Explore the Moderating Effect of Project Leadership on Complexity and Success of Public Infrastructural Megaprojects

When the three dimensions of complexity were combined into a single model, human behavior and system behavior had significant negative influence on success of public infrastructural megaprojects. However, ambiguity was not significant in this combined model. When project leadership was introduced into this combined model, human behavior completely ceased to explain success but the interaction effect of project leadership with ambiguity and system behavior remained significant.

Thus, it was concluded that project leadership had significant mediating effect on human behavior and success of public infrastructural megaprojects; but had significant moderating effect on ambiguity and system behavior, and success of public infrastructural megaprojects. Project leadership was the dominant determinant of project success in such a way that it explained the relationship between human behavior and success but it influenced the relationship between ambiguity and system behavior on success of public infrastructural megaprojects. Project leadership was positively and significantly correlated with project management success. Strategic perspective and loosening were the specific leadership behaviors that had positive and significant relationship with product and organizational success. Thus, focusing on the project management process may not necessarily assure product and organizational success. In practice, project leadership was more goal-oriented than adaptive.

5.4 Recommendations

These recommendations were drawn from the conclusions presented in section 5.3. The recommendations are presented at two levels with the first level being recommendations for policy and practice and the second level being recommendations for future research and academia.

5.4.1 Recommendations for Policy and Practice

Since project leadership was shown to dominate over the influence of human behavior on success of public infrastructural megaprojects, the traditional approach to project leadership and decision-making that is generally characterized by discharge of intellectual, managerial and emotional and social behaviors, needs to be broadened in order to form a new perspective based on complexity science. Such new perspective to leadership should allow for generative behaviors such as loosening, ambiguity acceptance and ambidexterity so as to enable project teams to respond effectively to the adaptive pressure, dependency, uncertainty, rapid change and emergence that generally characterize the context of public infrastructural megaprojects.

To achieve this shift in leadership perspective, it is recommended that implementing organizations utilize structures that: allow project managers sufficient authority over project resources; allow for stakeholder satisfaction to be managed as a key project objective; allow for transparency in the manner in which organizations make project decisions; ensure right people with the necessary skills and competences as well as the tools, techniques or resources support the project; encourage innovation, creativity, learning and attainment of process maturity; and ensure continued business case justification to assure that the project is and remains viable, desirable and achievable.

Whereas focus on process and activity is important for project management success, project implementation should focus on products in order to achieve both product and organizational success. Projects are a means of operationalizing and delivering organizational strategic objectives and so a functional project portfolio management process should exist to ensure that only projects whose products contribute to organizational success are selected for implementation. During implementation, a clear focus on products should be maintained to ensure fidelity to the baselines.

Effective implementation of this recommendation requires that implementing and sponsoring organizations: put in place an effective change management and control system with clearly defined change authority; manage projects in stages with a clear benefits realization approach; proactively manage stakeholder satisfaction as a key project objective; adopt a planning approach that allows for progressive elaboration in project scope; develop, document and deploy clear product descriptions, quality requirements and their related acceptance criteria and methods.

Design of infrastructural megaprojects should recognize that transferring risk to the contractor (as in the use of Fixed Price contracts) offers no real protection for the client because the client is always accountable for cost, time, quality and safety. Given that projects in which the client assumed responsibility for cost and schedule risk had higher chances of meeting both cost and schedule objectives than those transferring or sharing this risk, and since the parties involved in the project may prefer different actions because of their different risk preferences, it is recommended that public infrastructural megaprojects consider utilizing outcome-based contracts as opposed to behavior-based contracts.

5.4.2 Recommendations for Further Research

As pointed out in normative literature, project management talent is 3-dimensional. These dimensions are technical project management, strategic and business management, and leadership. Since leadership skills have been shown to be the most important for successful navigation of complexity, this study recommends that future research focuses on determining the relative importance of the other two dimensions-technical project management and strategic and business management-in determining the success of public infrastructural megaprojects.

Given the overwhelming number of projects that utilized fixed price contracts, a more elaborate study is required to convince project planners, sponsors and implementers of public infrastructural megaprojects in Kenya that outcome-based contracts deliver superior project performance than behavior-based contracts.

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APPENDIX 1: DATA COLLECTION INSTRUMENTS

INSTRUMENT 1: PROJECT COMPLEXITY ASSESSMENT (HUMAN BEHAVIOR, SYSTEM BEHAVIOR AND AMBIGUITY)

Project Title

A. Complexity Context

The following questions assess the project complexity context factors. Please respond to them as precisely as possible.

B1. From the list below, please select the choice that best describes the main contract types for your project:

1. Firm Fixed Price/Lump sum: ☐
2. Cost-Plus Fixed/Percentage Fee: ☐
3. Fixed Price Incentive Fee: ☒
4. Cost-Plus Incentive Fee: ☐
5. Fixed Price with Economic Adjustment: ☐
6. Cost-Plus Award Fee: ☐
7. Time and Materials: ☐
8. Cost Contract: ☐
9. Other (Please specify): ________

B2. From the list below, please select the statement(s) that best describe(s) your project:

1. The project was delivered in-house within the corporate setup: ☐
2. A special purpose vehicle was formed to manage the delivery of the project: ☐
3. The project was delivered through joint venture arrangement: ☐
4. The project was delivered through consortium arrangement: ☐
5. Other (Please specify): ________

B3. From the list below, please select the delivery mechanism that best describes your project:

1. Build-Operate-Transfer: ☐
2. Build-Own-Operate-Transfer: ☐
3. Build-Own-Operate: ☐
4. Build-Lease-Transfer: ☐
5. Design-Build-Operate-Transfer: ☐
6. Design-Build-Finance-Operate: ☐
7. Design-Construct-Manage-Finance: ☐
8. Other (Please specify):

B4. From the list below, please select the statement that best describes how risk of cost overrun, schedule delays and benefit shortfalls was handled on this project:

1. This risk was contractually shared between the client and the contractor: ☐
2. The client assumed full responsibility for all the risk and insured all project risks: ☐
3. The contractor assumed responsibility for all the risk and provided guarantees: ☐
4. Other (Please specify):

B5. From the list below, please select the statement that best describes the organization structure of this project:

1. ☐Traditional hierarchical: Project authority and control was exercised by the senior most person within the client organizational structure. The project was managed in a "one-size-fits-all" approach
2. ☐Pure functional: Project authority and control was exercised by the functional head of the unit in which the project was domiciled. Only the staff of the functional unit were involved in the delivery of the project. The project was managed in a "one-size-fits-all" approach
3. ☐Weak matrix: Staff from different functional units were involved in project delivery but the client project manager had no authority and control over the project resources and teams. Only acted as an

expediter or coordinator. The project was managed in a "one-size-fits-all" approach

4.	☐Balanced matrix:	Staff from different functional units were involved in project delivery but the client project manager shared 50-50 authority and control of project resources and teams with functional managers. S(h)e could not take any decision without consulting with the functional heads. The project was managed in a "one-size-fits-all" approach
5.	☐Strong matrix:	Staff from different functional units were involved in project delivery on full time and dedicated basis and reported to an identifiable project manager who had sole project authority and control. The project was managed in a "one-size-fits-all" approach
6.	☐Projectized:	A special purpose vehicle was formed to manage delivery of the project. The unit was headed by a senior person in the corporate hierarchy and had own dedicated team. The project was managed in a "one-size-fits-all" approach
7.	☐Composite:	The project was broken down into sub-projects/components and integrated teams, including staff from the client and suppliers were established to deliver each component/sub-project. The entire structure was coordinated and controlled by an identifiable authority and the project was managed as an array of systems (system of systems).

8. ☐Other (Please specify):

B6. From the following list of statements regarding stakeholder management, please select the one(s) that best apply/applies) to this project. (Please provide a brief comment to explain your choice):

Statement	Brief Comment
1. ☐The project had a clearly documented stakeholder engagement plan that was used to manage stakeholders	
2. ☐Stakeholder engagement was a formal role on the project	
3. ☐The project documents included a stakeholder register that was constantly updated	
4. ☐The project actively managed stakeholder engagement	

B. Complexity Dimensions

The following questions assess complexity of the project based on complexity dimensions of human behavior, ambiguity and system behavior. Please respond to them as precisely as possible.

C1. On a scale of 1-5 (1=strongly agree, 2=agree, 3=somewhat agree, 4= disagree, 5= strongly disagree) please indicate the extent to which you agree with each of the following statements regarding the complexity of this project:

Complexity Dimension 1: Human Behavior						
i.	Individual behavior	1	2	3	4	5
a.	There was consistency between what the customer communicated and what the customer actually needed	☐	☐	☐	☐	☐
b.	There was a high level of confidence that new information generated from progressive elaboration was captured appropriately in the project plan	☐	☐	☐	☐	☐
c.	There was a high degree of confidence in the Estimate to Complete (ETC) for the project	☐	☐	☐	☐	☐
d.	Realistic expectations were set around project success criteria	☐	☐	☐	☐	☐
e.	Estimation of costs, time and benefits was free of any misrepresentation	☐	☐	☐	☐	☐
f.	There was support from the team whenever an approved change was implemented on the project	☐	☐	☐	☐	☐

g.	It was possible to terminate, suspend or cancel the project activity whenever there was evidence that achievement of the desired outcome was not possible	☐	☐	☐	☐	☐
	ii. Group, organizational and political behavior	1	2	3	4	5
a.	Senior management team and other key stakeholders were fully committed to the project	☐	☐	☐	☐	☐
b.	The project had the support, commitment and priority from the organization and functional groups	☐	☐	☐	☐	☐
c.	The project team was cohesive and always worked towards common goals and objectives	☐	☐	☐	☐	☐
d.	Contractual terms were well understood by all parties involved	☐	☐	☐	☐	☐
	iii. Organizational design and development	1	2	3	4	5
a.	The project had clearly defined boundaries with other projects and initiatives that were running in parallel	☐	☐	☐	☐	☐
b.	It was feasible to obtain accurate status reporting throughout the life of the project	☐	☐	☐	☐	☐
c.	The organization had the right people with the necessary skills and competences as well as the tools, techniques or resources to support the project	☐	☐	☐	☐	☐
d.	The client created and ensured the use of common processes across all projects	☐	☐	☐	☐	☐
e.	There was an effective portfolio management process within the organization to facilitate strategic alignment and enable successful delivery of projects	☐	☐	☐	☐	☐
f.	The sponsor or project organization made decisions, determined strategies, and set priorities in a manner that promotes transparency and trust	☐	☐	☐	☐	☐
Complexity Dimension 2: Ambiguity						
	i. Emergence	1	2	3	4	5
a.	The project assumptions, metrics and constraints remained stable throughout its life	☐	☐	☐	☐	☐
b.	The stakeholder requirements remained stable throughout the project life	☐	☐	☐	☐	☐
c.	The project was conducted in a politically and environmentally stable context	☐	☐	☐	☐	☐

		1	2	3	4	5
	ii. Uncertainty	1	2	3	4	5
a.	The project was conducted over a relatively short period of time with a manageable number of stakeholder changes	☐	☐	☐	☐	☐
b.	The project requirements, scope and objectives were clearly developed	☐	☐	☐	☐	☐
c.	The success criteria for the project was defined, documented and agreed upon by the stakeholders	☐	☐	☐	☐	☐
d.	Funding for the project was obtained from a single source or sponsor	☐	☐	☐	☐	☐
e.	This type of project had been undertaken by the organization before	☐	☐	☐	☐	☐
f.	The actual rate and type or propensity for change was manageable	☐	☐	☐	☐	☐
g.	The project had a manageable number of issues, risks and uncertainties	☐	☐	☐	☐	☐
h.	Suppliers were able to meet commitments to the project	☐	☐	☐	☐	☐
i.	The project delivered to the committed deadlines	☐	☐	☐	☐	☐
j.	The client was prepared in advance to accept and sign off deliverables	☐	☐	☐	☐	☐
k.	The project documents and files were kept current in an accessible location by the team	☐	☐	☐	☐	☐
l.	There were a manageable number of critical paths in the project	☐	☐	☐	☐	☐
	iii. Communication and control	1	2	3	4	5
a.	The project manager had the authority to apply internal or external resources to project activities	☐	☐	☐	☐	☐
b.	The project team members were co-located, co-incentivized and co-responsible for the outputs of their projects	☐	☐	☐	☐	☐
c.	The project team members primarily worked face to face (rather than virtually) throughout the life of the project	☐	☐	☐	☐	☐
d.	There was open communication, collaboration and trust among the stakeholders and project team	☐	☐	☐	☐	☐
e.	Team members or stakeholders were able to accept the project information that may have been contrary to their beliefs, assumptions or perspectives	☐	☐	☐	☐	☐

C1. Complexity Dimension 3: System Behavior

The following section assesses complexity of the project arising from system behavior. Please respond them as precisely as possible:

C2.1 Connectedness (Please check as appropriate)	1	2	3
How many:	<10	≥10<20	>20
a. Stakeholders were involved in this project?	☐	☐	☐
b. Sub-projects/components were in this project?	☐	☐	☐
c. Third-party relationships (contracts-main and sub) were in this project?	☐	☐	☐
d. Layers were in the project organogram?	☐	☐	☐
C2.2 Dependency (Please check as appropriate)	1	Up to 5	>5
How many:	☐	☐	☐
a. Critical paths were in this project?	☐	☐	☐
b. Dependency relationships were there among the project's components?	☐	☐	☐
c. Interphases were there between this project's products and those of other projects within the organization?	☐	☐	☐

C2.3 System Dynamics

The following statements assess the complexity of the project due to system dynamics. Please indicate the extent to which you agree with each statement on a scale of 1-5 (1=strongly agree, 2= Agree, 3=somewhat agree, 4=Disagree, 5=strongly disagree).

		1	2	3	4	5
a.	There were only a few quality requirements that the project needed to conform that did not contradict each other	☐	☐	☐	☐	☐
b.	The deliverable(s) of the project utilized only a few technologies (e.g., electrical, mechanical, digital)	☐	☐	☐	☐	☐
c.	There was a high level of confidence that the interconnected components of the project performed in a predictable manner	☐	☐	☐	☐	☐

d.	All contracts related to the project were free of any financial, health or safety claims filed by suppliers, team members or customers	☐	☐	☐	☐	☐
e.	Project components were pre-fabricated, pre-assembled and tested offsite before being used in the project	☐	☐	☐	☐	☐
f.	Materials were only brought on site when the site was ready to receive them	☐	☐	☐	☐	☐
g.	The project had a documented change control system with identifiable change authority	☐	☐	☐	☐	☐

INSTRUMENT 2: PROJECT SUCCESS ASSESSMENT

Project Title: (Required)

This questionnaire assesses the success of your project along three dimensions namely; process success, product success and organizational success. Please respond to each question as appropriate

A. Process Success

1. Please indicate in the spaces below the budgeted and actual cost of this project in Kenya Shillings:

Budgeted Cost: Ksh. ____________________ Actual Cost: Ksh. ____________________

2. If the budgeted cost is different from the actual cost as indicated in (1) above, please use the space below to provide a brief explanation as to what in your opinion led to this difference:

……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………
……………………………………………………………………………………………………

3. Please indicate in the spaces below both the scheduled/planned and actual duration of this project in months:

Scheduled Duration: Months	____________	Actual Duration: Months	____________

4. If the scheduled/planned duration is different from actual duration as indicated in (3) above, please use the space below to provide a brief explanation as to what in your opinion led to this difference:

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
……………………………………………………………………

5. How many scope changes were implemented during the life of this project? (Please tick as appropriate)

1. Several (above 3): ☐
2. Few (up to 3): ☐
3. None: ☐

6. If any scope changes were implemented as indicated in (5) above, how would you describe their cumulative impact on project cost, time and quality? (Please check whichever choice applies)

Dimension	Impact		
	1	2	3
	Major	Minor	None
Cost	☐	☐	☐
Time	☐	☐	☐
Quality	☐	☐	☐

7. If your response to (6) above is either 1. Major or 2. Minor, please use the space below to briefly describe these changes and what in your opinion caused them:

………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………
………………………………………………………………………………………………

B2. Product and Organizational Success

Please indicate the degree to which you agree or disagree with the following statements by marking one response for each item based on a scale of 1-5 (1=strongly disagree, 2=disagree, 3=somewhat disagree, 4=agree, 5=strongly agree).

	1	2	3	4	5	Please provide a brief comment to explain your response
Product Success						
B1. The project improved the customer's performance	☐	☐	☐	☐	☐	
B2. The customer is satisfied with the project result(s)	☐	☐	☐	☐	☐	
B3. The project met the customer requirements.	☐	☐	☐	☐	☐	
B4. The customer is using the project result(s)	☐	☐	☐	☐	☐	
B5. The customer will come back for future work	☐	☐	☐	☐	☐	
Organizational Success						
C1. The business case and the objectives of the project investment were met	☐	☐	☐	☐	☐	
C2. The project contributed to stakeholder value.	☐	☐	☐	☐	☐	
C3. The project contributed to the organization's direct performance.	☐	☐	☐	☐	☐	
C4. The project enhanced the organization's innovation capacity in delivering future projects	☐	☐	☐	☐	☐	

INSTRUMENT 3: LEADERSHIP STYLE ASSESSMENT

Project Title:

A. Leader Behavior

1. Please respond to the following questions regarding the behavior of this project's leader by filling in the blank space after each question

a. What leadership behavior did you like most about this leader? (Please explain briefly)

b. What leadership behavior did you hate most about this leader? (Please explain briefly)

c. If you were to work on another project of similar complexity headed by this leader, what behaviors would you like him/her to improve on? (Please specify and explain briefly)

2. On a scale of 1-5 (1=never, 2=rarely, 3=at times, 4=often, 5=always) indicate the extent to which the leader engaged in the behaviors described in this questionnaire. Please provide a brief comment to explain your response

Leader Behavior	Scale				
i. Intellectual Behavior	1	2	3	4	5
A1. Probed the facts before taking any decision	☐	☐	☐	☐	☐
A2. Was imaginative and innovative in all aspects of work	☐	☐	☐	☐	☐
A3. Focused the project team on the future direction of the organization to meet business imperatives	☐	☐	☐	☐	☐
A4. Assessed all changes to the project to reflect implementation issues and business realities	☐	☐	☐	☐	☐
A5. Explored wide range of relationships, balanced short- and long-term considerations before making a decision	☐	☐	☐	☐	☐
A6. Was sensitive to stakeholders' needs and the implications of external factors on decisions and actions	☐	☐	☐	☐	☐
ii. Managerial Behavior	1	2	3	4	5
B1. Planned ahead, organized all resources and coordinated them efficiently and effectively.	☐	☐	☐	☐	☐
B2. Established clear objectives by converting long-term goals into action plans.	☐	☐	☐	☐	☐
B3. Monitored and evaluated staff's work regularly and effectively	☐	☐	☐	☐	☐
B4. Gave sensitive and honest feedback to staff	☐	☐	☐	☐	☐
B5. Believed in lively, enthusiastic and interactive communication	☐	☐	☐	☐	☐
B6. Believed in engaging others and winning their support before making a decision or taking action	☐	☐	☐	☐	☐
B7. Clearly communicated instructions and vision to staff	☐	☐	☐	☐	☐
B8. Tailored and focused communications to the audience's interests.	☐	☐	☐	☐	☐
B9. Inspired staff and audiences using communication style	☐	☐	☐	☐	☐

B10. Used communication style that conveys approachability and accessibility	☐	☐	☐	☐	☐
B11. Gave staff autonomy and encouraged them to take on personally challenging and demanding tasks.	☐	☐	☐	☐	☐
B12. Encouraged staff to solve problems, produce innovative ideas and proposals and developed their vision and a broader vision.	☐	☐	☐	☐	☐
B13. Encouraged a critical faculty and a broad perspective, and encouraged the challenging of existing practices, assumptions and policies	☐	☐	☐	☐	☐
B14. Believed others have potential to take on ever more-demanding tasks and roles, encourages them to do so.	☐	☐	☐	☐	☐
B15. Ensured direct reports have adequate support.	☐	☐	☐	☐	☐
B16. Developed their competencies, and invested time and effort in coaching them so they contribute effectively and develop themselves.	☐	☐	☐	☐	☐
B17. Was willing to make decisions involving significant risk to gain an advantage.	☐	☐	☐	☐	☐
B18. Selected and exploited activities that result in the greatest benefits to the organization and its performance.	☐	☐	☐	☐	☐
ii. Emotional and social behavior	1	2	3	4	5
C1. Was aware of one's own feelings and capable of recognizing and managing these in a way that one feels that one can control.	☐	☐	☐	☐	☐
C2. Exhibited a degree of self-belief in one's capability to manage one's emotions and to control their impact in a work environment	☐	☐	☐	☐	☐
C3. Performed consistently in a range of situations under pressure and adapts behavior appropriately.	☐	☐	☐	☐	☐
C4. Balanced the needs of the situation and task with the needs and concerns of the individuals involved.	☐	☐	☐	☐	☐
C5. Retained focus on a course of action or need for results in the face of personal challenge or criticism	☐	☐	☐	☐	☐
C6. Arrived at clear decisions and drove their implementation when presented with incomplete or ambiguous information using both rational and "emotional" or intuitive perceptions of key issues and implications	☐	☐	☐	☐	☐

C7. Was aware of, and took account of, the needs and perceptions of others in arriving at decisions and proposing solutions to problems and challenges.	☐	☐	☐	☐	☐
C8. Was willing to keep open one's thoughts on possible solutions to problems and to actively listen to, and reflect on, the reactions and inputs from others	☐	☐	☐	☐	☐
C9. Persuaded others to change views based on an understanding of their position and a recognition of the need to listen to this perspective and provide a rationale for change	☐	☐	☐	☐	☐
C10. Exhibited drive and energy to achieve clear results and make an impact.	☐	☐	☐	☐	☐
C11. Balanced short- and long-term goals with a capability to pursue demanding goals in the face of rejection or questioning	☐	☐	☐	☐	☐
C12. Displayed clear commitment to a course of action in the face of challenge and to match "words and deeds" in encouraging others to support the chosen direction.	☐	☐	☐	☐	☐
C13. Showed personal commitment to pursuing an ethical solution to a difficult business issue or problem	☐	☐	☐	☐	☐
iii. Adaptive Behavior	1	2	3	4	5
D1. Stepped back and assessed the dynamics of people involved when difficulties emerged in the project	☐	☐	☐	☐	☐
D2. In complex situations, got people to focus on the issues they were trying to avoid	☐	☐	☐	☐	☐
D3. Welcomed the thoughts of group members with low status during times of difficult change	☐	☐	☐	☐	☐
D4. Challenged people to concentrate on the "hot topics" during organizational change	☐	☐	☐	☐	☐
D5. Encouraged staff to think for themselves when they sought answers from him/her	☐	☐	☐	☐	☐
D6. Valued listening to team members with radical ideas	☐	☐	☐	☐	☐
D7. Encouraged staff to take initiative in defining and solving problems	☐	☐	☐	☐	☐
D8. Was open to people who bring up unusual ideas that seem to hinder the progress of the group	☐	☐	☐	☐	☐
D9. Held steady in the storm	☐	☐	☐	☐	☐

D10. Empowered people to decide for themselves when faced with uncertainty	☐	☐	☐	☐	☐
D11. Accepted multiple solutions and encouraged differing opinions within the group	☐	☐	☐	☐	☐
D12. Injected pressure within the team to cope with rapid changes in the project	☐	☐	☐	☐	☐
D13. Leveraged interaction through documenting and communicating lessons and establishing centers of excellence	☐	☐	☐	☐	☐
D14. Understood people and social systems within the project organization	☐	☐	☐	☐	☐
D15. Ensured stability by setting clear rules and regulations	☐	☐	☐	☐	☐
D16. Loosened administrative systems within the project to allow for innovation among team members but sometimes tightened them to ensure efficiency	☐	☐	☐	☐	☐

APPENDIX 2: LIST OF COMPLETED INFRASTRUCTURAL MEGAPROJECTS SURVEYED

1	Dredging Channel at Port of Mombasa
2	Mombasa Port Development Project
3	Sinendet-Kisumu Pipeline
4	Nairobi-Eldoret Pipeline
5	Terminal 1A Arrivals at JKIA
6	Terminal 1A Departures at JKIA
7	Rehabilitation of Existing Runway at JKIA
8	Primary Security Screening at JKIA
9	Emergency Terminal 1E at JKIA
10	Terminal 2 at JKIA
11	Kenya Electricity Expansion Project
12	Energy Sector Recovery Project
13	Mombasa Street Lighting Project
14	Kindaruma Upgrade Project
15	Rehabilitation and Upgrade of Upper Hill Roads
16	Rehabilitation and Upgrade of Eastleigh 1st Avenue Roads
17	Construction of Eastern and Northern Bypass
18	Rehabilitation and upgrade of Langata Road
19	Construction of Kapsoya Eldoret Road
20	Construction of KCAA Headquarters
21	Mau Summit-Kericho-Nyamasaria Road
22	Kisumu Airport-Kisian Road
23	Nairobi Southern Bypass Road
24	Upgrade to Bitumen Standard of Homa Bay-Mbita Road
25	Rehabilitation of Timboroa-Eldoret (A104) Road
26	Rehabilitation of Webuye-Malaba (A104) Road
27	Menengai Geothermal Development Project
28	Construction of Marsabit-Turbi Road
29	Construction of Nairobi-Thika Superhighway
30	Construction of Londian-Fortenan Road
31	Construction of Machakos Turn-off at JKIA

Source: Kenya Vision 2030 Secretariat

APPENDIX 3: REGRESSION RESULTS

HUMAN BEHAVIOR AND PROJECT SUCCESS

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.680[a]	.463	.441	.49840

a. Predictors: (Constant), HB_Score

a. Dependent Variable: Composite_Score

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.348	1	5.348	21.530	.000[b]
	Residual	6.210	25	.248		
	Total	11.558	26			

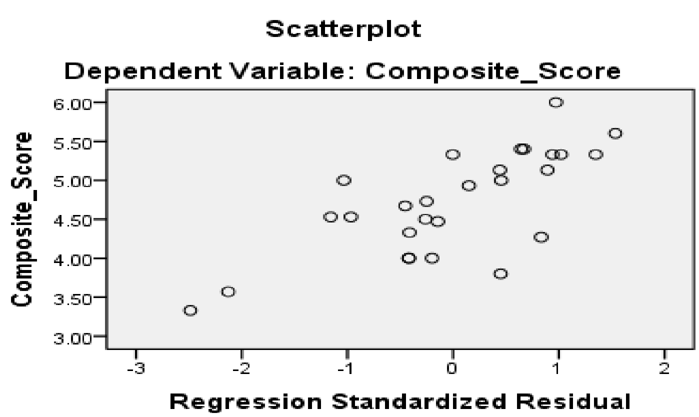
a. Dependent Variable: Composite_Score

b. Predictors: (Constant), HB_Score

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.421	.377		17.015	.000
	HB_Score	-.681	.147	-.680	-4.640	.000

a. Dependent Variable: Composite_Score



AMBIGUITY AND PROJECT SUCCESS

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.561[a]	.315	.288	.56269

a. Predictors: (Constant), Ambiguity_score

b. Dependent Variable: Composite_Score

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.643	1	3.643	11.504	.002[b]
	Residual	7.916	25	.317		
	Total	11.558	26			

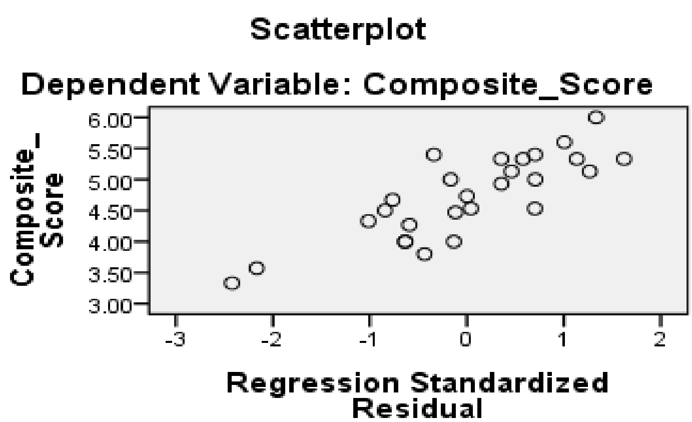
a. Dependent Variable: Composite_Score

b. Predictors: (Constant), Ambiguity_score

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.461	.522		12.368	.000
	Ambiguity _score	-.743	.219	-.561	-3.392	.002

a. Dependent Variable: Composite_Score



SYSTEM BEHAVIOR AND PROJECT SUCCESS

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.551[a]	.304	.276	.56739

a. Predictors: (Constant), System_behavior_score

b. Dependent Variable: Composite_Score

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.510	1	3.510	10.902	.003[b]
	Residual	8.048	25	.322		
	Total	11.558	26			

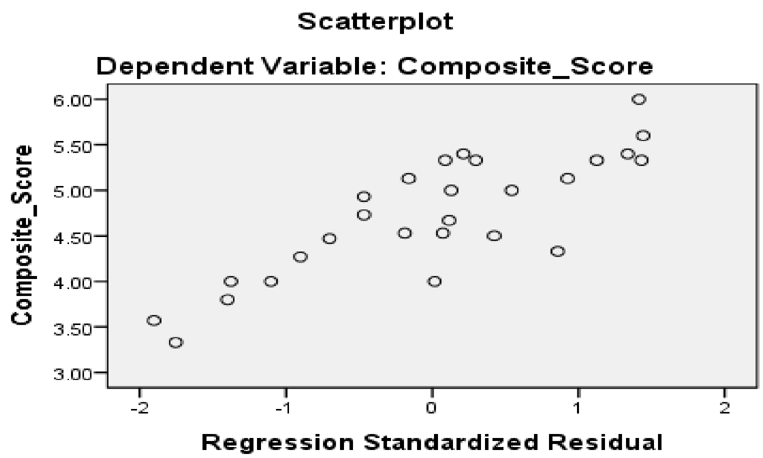
a. Dependent Variable: Composite_Score

c. Predictors: (Constant), System_behavior_score

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.012	.404		14.875	.000
	System behavior	-.264	.080	-.551	-3.302	.003

a. Dependent Variable: Composite_Score



COMBINED EFFECT OF HUMAN BEHAVIOR, AMBIGUITY AND SYSTEM BEHAVIOR ON PROJECT SUCCESS

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.763[a]	.583	.528	.45786

a. Predictors: (Constant), Ambiguity_score, System_behavior_score, HB_Score

b. Dependent Variable: Composite_Score

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.736	3	2.245	10.711	.000[b]
	Residual	4.822	23	.210		
	Total	11.558	26			

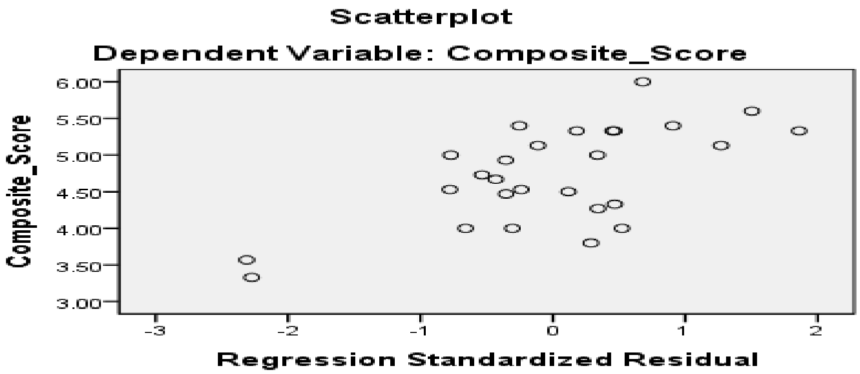
a. Dependent Variable: Composite_Score

b. Predictors: (Constant), Ambiguity_score, System_behavior_score, HB_Score

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	7.107	.461		15.403	.000
	System_behavior_score	-.155	.071	-.324	-2.175	.040
	HB_Score	-.479	.172	-.479	-2.785	.011
	Ambiguity	-.186	.232	-.140	-.800	.432

a. Dependent Variable: Composite_Score


Scatterplot
Dependent Variable: Composite_Score
Composite_Score
6.00
5.50
5.00
4.50
4.00
3.50
3.00
-3
-2
-1
0
1
2
Regression Standardized Residual