

**AN INTEGRATED APPROACH TO SUSTAINABLE URBAN
INFRASTRUCTURE DEVELOPMENT IN ZAMBIA**

By

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**A dissertation submitted to the University of Zambia in partial fulfillment of the
requirements for the degree of Master of Engineering in Project Management**

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Certificate of Approval

This dissertation by **Chilando Exter Musanda** entitled: ‘‘An integrated approach to sustainable urban infrastructure development in Zambia’’ has been approved as a fulfilling requirement for the award of the Degree of **Master of Engineering in Project Management** by the University of Zambia

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Abstract

The ‘integration’ of infrastructure development has become a global focal point because it forms a backbone for economic growth, enables more productive urban spaces and improves the quality of urban life by optimizing interactions among essential infrastructure. Infrastructure systems differ greatly across regions, states, nations and continents. However, it is not clear how this integration of urban infrastructure development can be achieved to address the rising challenges of urbanization in Zambia.

In attempting to meet current and future infrastructure needs of a growing population in urban cities of Zambia, this study was aimed at establishing a framework which could enhance the integrated planning, delivery and management of critical urban infrastructure; roads, railways, telecommunication, electricity, water and sewerage.

Using literature review, structured interviews and questionnaire surveys to collect data, the results of the study established key ingredients, processes and methods that could enhance urban infrastructure planning, delivery and management. The results reviewed that integrated approach to urban infrastructure development has great potential to improve service delivery of sustainable urban infrastructure. Furthermore, there was 75% agreement among respondents regarding the ranking of ingredients for integrated urban infrastructure development in Zambia. In addition, a conceptual framework that attempts to integrate organizational infrastructure planning, delivery and management was proposed.

The conceptual framework developed in this study could be used to improve urban infrastructure development systems in Zambia, thereby accelerating the attainment of economic, social and environmental goals. Appropriate policy support and technical practices focused on improving infrastructure development outcomes at the national and urban level have been recommended.

Keywords: infrastructure, sustainability, integrated urban development, Zambia

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TABLE OF CONTENTS

Copyright declaration.....	i
Declaration.....	ii
Certificate of approval.....	iii
Abstract.....	iv
Acknowledgement.....	v
Table of contents.....	vi
List of figures.....	vii
List of tables.....	viii
List of annexures.....	ix
CHAPTER 1: INTRODUCTION	1
1.1 Background.....	1
1.2 Justification of the research	2
1.3 Statement of the Problem	5
1.4 Objectives of the research	5
1.4.2 Specific Objectives.....	5
1.4.3 Research Questions	5
1.5 Organization of the dissertation	6
CHAPTER 2: LITERATURE REVIEW	7
2.1 Introduction.....	7
2.2 Theoretical review and global perspective	7
2.2.1 Concept of Infrastructure	7
2.2.2 The integrated nature of infrastructure systems.....	9
2.2.3 The systems thinking	13
2.2.4 Integrated system for urban infrastructure development.....	15
2.2.5 Sustainable Development Paradigm.....	17

2.2.6 The concept of sustainability	18
2.2.7 Integrated urban infrastructure design process	21
2.2.8 Barriers to sustainable integrated infrastructure development	25
2.2.9 Enablers for integrated sustainable infrastructure development	26
2.2.10 Infrastructure delivery mechanisms	27
2.2.11 Infrastructure governance	29
2.3 Zambia’s infrastructure development landscape	32
2.3.1 Zambia’s infrastructure perspective	33
2.3.2 Infrastructure development reforms in Zambia	35
2.4 Critique of literature review and existing theories	37
2.5 Summary	39
CHAPTER 3: METHODOLOGY	44
3.1 Introduction	44
3.2 Research design and Approach	44
3.3 Study population	46
3.4 Sample	47
3.4.1 Sampling procedures	47
3.4.2 Sampling size and justification	48
3.5 Methods of data collection and instruments	48
3.5.1 Interviews	49
3.5.2 Questionnaire survey	50
3.6 Methods of data analysis	51
3.7 Model development	52
3.8 Ethical considerations	53

3.9 Summary.....	55
CHAPTER 4: RESEARCH FINDINGS, ANALYSIS AND DISCUSSION.....	56
4.1 Introduction.....	56
4.2 Interview data and analysis.....	56
4.2.1 Respondents profile.....	56
4.2.2 Impact of integrated approaches to infrastructure development.....	57
4.2.3 Integrated infrastructure development processes.....	58
4.2.4 Challenges to the implementation of integrated approaches in Zambia	60
4.3 Questionnaire Survey.....	63
4.3.1 Profile of respondents.....	63
4.3.2 Statistical analysis.....	64
4.3.3 Ingredients of urban integrated infrastructure development.....	64
4.3.4 Analysis of design principles and practice ingredients.....	68
4.3.5 Analysis of methodological ingredients.....	69
4.3.6 Analysis of policy ingredients.....	69
4.3.7 Analysis of institutional ingredients.....	70
4.3.8 Analysis of substantive ingredients.....	70
4.4 Interpretations of the findings.....	71
4.5 Integrated framework for planning, delivery and management of urban infrastructure development for Zambia.....	73
4.5.1 Development of the urban infrastructure framework.....	73
4.5.2 Processes in the proposed conceptual framework.....	76
4.6 Discussion.....	79
4.6.1 Benefits of integrated urban infrastructure development.....	79

4.6.2 Factors and ingredients of urban infrastructure development	80
4.7 Summary of the chapter	82
CHAPTER 5: CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS ..	83
5.1 Introduction.....	83
5.2 Conclusions	83
5.3 Limitations.....	86
5.5 Recommendations.....	87

List of Figures

Figure 2-1: Components of the Infrastructure Environment.....	10
Figure 2-2: Munasinghe’s approach to Sustainable Development.....	19
Figure 2-3: Sustainability aspects forming a concept as a whole system.....	19
Figure 2-4: Daly’s Triangle of Equity, Economy and Environment.....	20
Figure 2-5: New computer technologies in the process of urban design.....	23
Figure 2-6: Infrastructure governance cycle	30
Figure 2-7: Components found in systems thinking framework.....	31
Figure 3-1: Summary of the qualitative and quantitative research.....	46
Figure 4-1: Proposed conceptual framework for integrated urban infrastructure development for Zambia.....	75

List of Tables

Table 2-1: Advantages and disadvantages of integrated and silo based approaches 122

Table 2-2: Comparison between integration and traditional project delivery 155

Table 2-3: Summary of key literature reviewed40

Table 3-1: Strengths and weaknesses of quantitative and qualitative methods of research44

Table 4-1: Summary of interview responses 61

Table 4-2: Descriptive statistics of integrated urban infrastructure development65

List of Annexures

ANNEXURE 1: Interview Guide.....	98
ANNEXURE 2: Questionnaire.....	100
ANNEXURE 3: Submitted journal paper under review.....	107

CHAPTER 1: INTRODUCTION

1.1 Background

The Government of the Republic of Zambia faces challenges in the delivery of critical urban infrastructure from the pressure of rapid urbanization such as; poor sanitation, lack of sufficient water supply, floods and disposal of waste produced in cities. Over time, the government has noted that the legal framework for managing and planning the development of land in the country is neither efficient nor effective (Berrisford, 2011). It was further noted that obsolete urban legislation, weak regulatory frameworks, poor coordination and low institutional capacity pose challenges to the effective delivery of urban infrastructure development (Ministry of local government and housing, 2015).

With the move to deliver sustainable infrastructure, national governments all over the world have increasingly recognized the role that ‘infrastructure integration’ approach offers opportunities for infrastructure systems to become smarter, more cost-effective and environmentally-friendly (United Nations Environment Programme [UNEP], 2012). At the same time, organizations involved in the urbanization process are also experiencing a need to change their planning, delivery and management models and develop new capabilities that enable them to carry out innovative services for an ever more complex system that is the urban environment (Torguet, 2009). This is because existing approaches to planning and delivering infrastructure are disjointed, silo-based and repeatedly criticized for returning poor value for money to the taxpayer and being too narrow to capture the wide range of benefits infrastructure provides to the economy, society and environment (iBUILD, 2015).

Systems integration is an interesting topic as it enables organizations to achieve a better organization and planning in different fields (Torguet, 2009). In this case, this study focuses on urban planning, delivery and management of critical urban infrastructure services: roads, railways, telecommunications, water and sewage, and energy systems. The study of interactions among organizations delivering infrastructure and current urban design process may enable the development of a workable framework organized for building and providing integrated infrastructure services in urban areas (Eid, 2017).

According to iBUILD (2018) research centre, it was established that adopting a broader, integrated and more holistic appreciation of infrastructure as one of the priority action area to help governments and infrastructure policymakers and practitioners “close the gap” in the uncoordinated and wasteful way of planning and managing infrastructure in the United Kingdom (UK). This is attributed to the traditional planning and delivery of infrastructure being at odds with environmental objectives and no longer appropriate in the contexts of urbanization exerting pressure on limited resources (Marlow, Moglia, Cook, and Beale, 2013). The need to evolve urban infrastructure development functions away from just providing electricity, roads and railways, water supply, sewerage supply and drainage to encompass a range of wider integrated solutions, has become an increased approach for consideration (Casey, Silva, Guthrie, and Considine, 2016). This is understood by many urban practitioners in the provision of urban infrastructure such as transportation, sanitation, electricity and telecommunications as critical components for quality urban areas, seeing that it enables increased productivity and so drive economic growth of cities.

This study builds on the knowledge and present insight on the important role of the need to move from silo-based practices of urban infrastructure development on to a more integrated development strategy of infrastructure planning, delivery and management of infrastructure. Several academic experts and business professionals have claimed that integrated practices in infrastructure development throughout the life cycle of infrastructure, minimizes loss of capital investments in infrastructure, cost and time overruns in infrastructure development (McLean, 2017). Enhancing coordination and collaboration in urban infrastructure of planning, delivery and management of infrastructure would enable infrastructure systems to provide an efficient level of service at the lowest levels of resources used in the wake of the urban population increase.

1.2 Justification of the research

In recent years, migration trends have led to high population growth in urban areas, without matching infrastructure service provision (Kafungwa, 2017). The

responsibilities of local authorities with regards to infrastructure maintenance and management have increased due to the pressures of rapid urban growth and in the pursuit of sustainable urban development (UN-Habitat, 2012).

A wealth of research has been directed at Zambia's development challenges in the last 5 years (Falvey, 2016). It is noted that institutional inefficiencies, entrenched power dynamics, poor governance, and a lack of collaboration among organizations are among some of the constraints to the effective delivery of basic urban infrastructure services. It appears Zambia's urban infrastructure planning, delivery and management still follow the traditional silo-based approach thus not encouraging collaborative behaviour and practices among organizations in urban infrastructure development (Mabelo and Sunjika, 2017). The urban challenges noted are lack of basic urban services, social-economic disparities and environmental degradation. Despite the challenges, Zambia could improve its infrastructure to the level of middle-income countries in the region (Foster, 2011).

The International Energy Agency (2006), noted that the lack of a reliable transportation network, electrical power, communication networks, water supply, sanitation and other infrastructure puts severe constraints on economic growth and a reduction in productivity of urban areas. Infrastructure is the major driving factor of any urban development and enables economic growth of a country. As for Zambia, several problems resulting from an increase in population growth of urban cities has not been matched by increase in infrastructure delivery needs of urban areas. Moreover, the problems have aggravated due to a lack of capacity among organizations in urban areas to provide adequate infrastructure (Ministry of Works and Supply, 2006). The problems due to urbanization are interconnected and that each problem tends to complicate the solution of one or more others infrastructure within the whole system.

Between 1990 and 2010, the population of Lusaka, the capital city grew from 757,000 million to 1.7 million inhabitants that is more than double (UN Population Division 2015). The fast population growth has placed increasing pressure on the city's basic services and infrastructure, resulting in an expansion of informal settlements and falling living standards. According to Head (2008), he noted that the delivery of public

infrastructure has great difficulty because, traditionally, departments of transport, environment, those addressing social issues in cities and in regions, economic departments, have all operated independently, silo-based approach.

Despite the challenges to effectively plan, deliver and manage infrastructure, Zambia has seen an increase in infrastructure development in the last decade. These include: roads, water and sanitation facilities, schools, hospitals, as well as upgrading of existing infrastructure (Zambia Habitat III National Report, 2015). Some important policies and infrastructure projects to counter the effects of rapid urbanization include the Ministry of Local Government and Housing (MLGH) preparation of a National Urban Policy, review of Spatial Planning legislation through the Urban and Regional Planning Act, 2015, Lusaka water and sanitation projects and the preparation of Integrated Development Plans (IDPs) in emerging towns like Solwezi, in North-Western Province of Zambia.

The Government of the Republic of Zambia launched the implementation of the 7th National Development Plan (7NDP) 2017 - 2021, which departs from sectoral based planning to an integrated (multi-sectoral) development approach under the theme “Accelerating development efforts towards Vision 2030 without leaving anyone behind”. The policy direction of 7NDP recognizes the multi-faceted and interlinked nature of infrastructure and so calls for tackling infrastructure development through an integrated approach among all sectors implementing infrastructure projects.

The adoption of the 2030 Agenda and the Sustainable Development Goals (SDGs) is crucial for cities to strengthen their role in providing sustainable infrastructure. The urban goal, SDG11, underlines the need to “Make Cities and Human Settlements inclusive, safe, resilient and sustainable” (Eisenbeiß, 2016). Organizations, as well as Government agencies, are an important element in the implementation of national policies, programmes, projects, tools and methodologies for infrastructure development (Lorrain, 2005).

1.3 Statement of the Problem

Although Zambia has in place approaches and systems including those in 7NDP for guiding the development of urban infrastructure, these approaches and systems appear not to integrate planning, delivery and management of infrastructure development. There appears to be no or little research that has been conducted to investigate an approach based on integrated approach and systems thinking to urban infrastructure development. Therefore, this research investigates existing approaches and systems employed in the planning, delivery and management of urban infrastructure development in Zambia with a view to design and propose a conceptual integrated urban infrastructure framework.

1.4 Objectives of the research

1.4.1 Main Objective

The main aim of this research was to design a workable framework to be used to integrate planning, delivery and management of urban infrastructure among organizations.

1.4.2 Specific Objectives

The specific objectives of this study were to:

- i. establish key processes, tools and methods used to integrated urban sustainable infrastructure planning, delivery and management among organizations;
- ii. identify key factors and ingredients of urban integrated approach to infrastructure development in Zambia; and
- iii. propose a conceptual framework for an integrated approach to urban infrastructure development.

1.4.3 Research Questions

This research investigated the following questions;

- i. What are the key processes, tools and methods used in integrated infrastructure planning, delivery and management among organizations in Zambia?

- ii. What are the key factors and ingredients of urban integrated approach to infrastructure development?
- iii. What are the benefits, opportunities and challenges of using integrated approaches to infrastructure development?
- iv. What constitutes an integrated approach framework for urban infrastructure planning, delivery and management?

1.5 Organization of the dissertation

This dissertation consists of five (5) chapters.

Chapter one introduces the research topic, justification for the research, outlines the research problem, objectives the study and research questions are stated.

Chapter two draws into objectives and forms a firm ground through the review of relevant literature to the study of integrated sustainable infrastructure development and the systems thinking theory.

Chapter three discusses the methodology adopted for this research and justification for the adopted methodology is highlighted.

Chapter four presents the data collected and the findings of the research are analyzed. The chapter further recommends the necessary steps that could be adopted in the design of the integrated conceptual framework.

Chapter five discusses the results in comparing and contrasting from the existing body of knowledge in the field of study. Conclusions and recommendations are presented in the chapter.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The previous chapter outlined an overview of integrated urban infrastructure development. The rationale, objectives and research questions of the study were also presented. This chapter presents a review of the available literature on integrated urban infrastructure development. The chapter begins with examining a broader perspective on approaches and ‘systems thinking’ of sustainable urban infrastructure planning, delivery and management. Then focuses on particular approaches, regulations, guidelines and methods in urban infrastructure development currently practised in Zambia. A critique of the validity of existing theories and literature is also presented in this chapter.

2.2 Theoretical review and global perspective

2.2.1 Concept of Infrastructure

Many definitions have been developed to understand the infrastructure and make it stand out from other meanings, such as business networks and information and communications technologies. On one hand, ‘Infrastructure’ is defined as the basic physical and organizational structures and facilities e.g. buildings, roads, power supplies needed for the operation of a society (Oxford dictionary, 2018). On the other hand ‘Infrastructure’ are many and diverse: roads, tunnels, bridges, railways, airports, harbours, drainages, subways, dams, water pipes, water purification plants, sewer, power plants and power lines, oil and gas pipelines, telephone exchanges and networks as well as heating and cooling equipment systems (Prud'homme, 2004).

In urban cities, infrastructure is often present not only physically seen as electrical cables and pylons but also in telecommunications processes and practices, water network systems, transportation systems guidelines and practices. Assfaw (2006) defined infrastructure to denote the hard components that comprise all systems of the physical structure that are mainly laid under the ground (e.g. water mains) and on the ground (e.g. roads) or above the ground (e.g. telephone and electric lines) delivered by organizations and institutions to the general public. According to Jan, Chani, Pervaisz, and Chaundhary, (2012), infrastructure was defined as facilities like electricity, piped gas,

telecommunications, piped water, sanitation and sewerage system, solid waste collection and disposal, roads, railways, airports, drainage systems and now mobile phones and internet facilities which are directly used by people.

Further, Neuman (2011) defined infrastructure as the physical network that channels a flow of water, fluids, electricity, energy, material, people, digital signal or analogue signal through conduits; tubes, pipes, canals, channels, roads, rails, wires, cables, fibre lines, or through a medium with the purpose of supporting life.

In this study, the definition of infrastructure is embedded in urban development which includes the physical infrastructure (roads, railways, water and sewer supply, electricity, and telecommunication lines) on one side and the processes, methods, guidelines and key factors used to plan, deliver and manage infrastructure on the other side. That is the complete integration of planning, delivery and management of urban infrastructure and maximizing the economic value of the integrated approach to urban infrastructure development (Torrise, 2009). Infrastructure remains the foundation upon which prosperous economies and societies are built and function (iBUILD, 2018). It also forms part of crucial components to the development of a country, enhancing the country's productivity, improving the travel duration in transportation and communication, with which a person can barely live without in today's business world (Arias and Gonzalez-Jorge, 2016).

Over time, there have been many perspectives on the fundamental paradigm for developing infrastructure. According to Cirolia and Rode (2019), there are four broad infrastructure paradigms that have emerged at different times through history and continue to inform the aspirations, debates and political actions today. These include:

1. **Universal access**, which is an approach that looks at ensuring basic access to infrastructure services is a key objective as stated in Sustainable Development Goals.
2. **Connecting competitive space**, this is concerned with economic growth, productivity and effective deployment of resources. This follows the logic of 'strengthening strengths', advocating where prioritizing infrastructure

investments where they can have the most impact on growth and economic development.

3. **Ecological modernization**, in terms of infrastructure development, is a central policy tool to proactively support environmental transitions and a break with business-as-usual development and incorporate ideas such as integrated transport authorities or re-municipalisation of infrastructure utilities.

4. **New self-sufficiency**, has taken up two groups in approaching infrastructure development. On the one hand, those who are deeply sceptical of centralised (and state-led) systems have opted for the development of off-grid systems that enable access irrespective of the functioning of the citywide system.

It is noted that integrated approaches to infrastructure development will need to find ways to address the cutting-edge issues within the current context, in particular those with relevance to African and developing cities (Cirolia and Rode, 2019). The understanding of varied lenses through which urban infrastructure development can be looked at and used presents a way through which to solve infrastructure problems and create desired outcomes for urban cities. The proposed framework in this dissertation attempts to provide a workable tool to be used in urban infrastructure development from whichever angle infrastructure development inspirations, debates and political actions are looked at. While a strong case for infrastructure development is clear, there is a danger that poorly planned and built infrastructure will be a hazard to society especially due to increased service demand on existing infrastructure resulting from urbanization and natural disaster events occur (Pant, Thacker, and Hall, 2017).

2.2.2 The integrated nature of infrastructure systems

The idea of integrated infrastructure development is not a new one but the development efforts of the 1970s and 1980s which were often hampered by a “one-size-fits-all” mentality, prescribing reforms from a centralized or silo-based perspective, without regard for the specific needs of a given population or urban community (United Nations Economic council and social council [UNECOSOC], 2003). The new model of integrated development recognizes no such barriers ‘all have a role to play in integrated development efforts. The challenge, of course, is to coordinate the efforts in infrastructure system so that they complement, not contradict each other.

Infrastructure system denotes a category of a large interconnected system comprising operations of transportation, communication, energy, water supply and sewerage (Ejigu, 2007). It was further noted by Roelich, Bale, Turner, and Neal (2018) that infrastructure must be seen as a complex integrated system in society being planned, delivered and managed by public and private institutions. The definitions highlight the physical aspect of infrastructure as well as the social side of infrastructure that offer an in-depth understanding of what constitutes infrastructure development. Generally, the physical infrastructure, commonly known as ‘hard infrastructure’, includes roads and transport facilities; telecommunications facilities; water and sewerage facilities; and other networked services. On the other hand, social infrastructure, commonly known as ‘soft infrastructure’, includes educational and health care facilities; sport and leisure facilities; law and order; and public administration, policy formulation, guidelines and regulations that guide how infrastructure development is carried out (Steele and Glesson, 1988)

A further perspective on the integrated infrastructure planning, delivery and management processes may be obtained by studying the several factors that influence infrastructure development over its life cycle (Thorpe, 2000). These include; population change, infrastructure owner goals, legislation, political environment social needs, usage maintenance practices and stakeholder needs. See Figure 2-1. These factors serve as factors that influence the outcome of infrastructure development in modern urban areas.

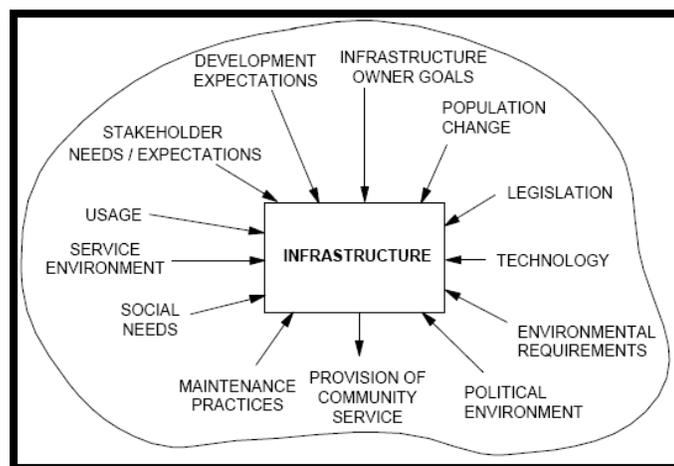


Figure 2-1: Components of the Infrastructure Environment

Source: (Thorpe, 2000)

This complexity of infrastructure development and the system it creates leads to a holistic, integrated view, where proper considerations of planning, delivery and management of infrastructure are carried out. Since infrastructure planning by nature is a multi-disciplinary process, whether by choice or by default, the cooperation of agencies is expected (Ejigu, 2007).

It is noted that systems integration should only be applied in those cases where the complexity of the goals we want to achieve requires planning, delivery and management framework or tool which takes into account the interaction between different subsystems to get the best possible solution. The main advantages and disadvantages of systems integration in the planning, delivery and management of urban infrastructure development compared to silo-based (conventional) approach is shown in Table 2-1.

Table 2-1: Advantages and disadvantages of integrated and silo based approaches

	Advantages	Disadvantages
Silo-based (Conventional) planning, delivery and management	<ul style="list-style-type: none"> ➤ Each organization works on its own, they don't have to co-operate or reach to an agreement. It is better for the self-interests of companies. ➤ It is quite straight-forward. The standardized way of working requires less effort and this saves money and time. 	<ul style="list-style-type: none"> ➤ Less resource-efficiency in operation. ➤ Only valid for simple solutions (doesn't take into account possible synergies with other systems).
Integrated planning	<ul style="list-style-type: none"> ➤ An integrated approach enables the urban practitioners to work out customer-oriented integrated design solutions in co-operation with the utility organizations and other stakeholders. That is to say: specific solutions for complex problems. ➤ Better understanding of the interaction of the multitude of variables relevant to urban planning which results in better solutions. ➤ Innovation in urban solutions towards and optimization of resources if integrated planning, delivery and maintenance of an infrastructure system network is at the core of urban practitioners. Results in infrastructure that is easier-to-use and easier to maintain. 	<ul style="list-style-type: none"> ➤ Complex organization and working structures (but necessary to develop complex solutions for infrastructure systems). ➤ May take more time than conventional planning. ➤ Demands making an effort in learning new knowledge and skills.

It was noted by (Torguet, 2009) that in integrated design processes, some organizations are more willing to offer innovative infrastructure solutions. Urban problems do not develop due to inherent characteristics of the cities but due to lack of effective governance and management (Jenkins and Burgess, 2000). Usually, municipalities take the lead or act as an integrator organization in proposing innovative solutions for their cities and administer or propose workable framework through which planning, delivery and management of urban infrastructure development will be carried out.

2.2.3 The systems thinking

The systems thinking is about gaining insights into the whole by understanding the linkages and interactions between the elements that comprise the whole system (Ejigu, 2007). A system is a collection of entities (subsystems) interrelated in a specific way to accomplish a particular objective (Torguet, 2009). It reveals that systems are a group of interacting, interrelated or interdependent elements forming a complex whole. The systems approach emerged when scientists and philosophers identified common themes in the approach to managing and organizing complex systems. In an urban environment, we will be studying what can be called integrated infrastructure or 'systems of systems' (Prencipe, Davies, and Hobday, 2005) which can be defined as a collection of distinct but interrelated systems, each performing independent tasks but organized to achieve a common goal. The integrated urban infrastructure represents the energy, telecommunications, transportation and sanitation infrastructure of the economy (Torguet, 2009).

The systems approach means that designers consider the whole system, its components, and the relationship between them throughout the design process (Carthorpe, Duany, Moule, Plater-Zyberk, and Polyzoides, 1991). In the words of Knoeri, Julia, and Katy (2015), designers should "get the best of the system," meaning they should understand system behaviour and use key factors to model the system they are designing. This principle means adopting a holistic approach to design by moving from patterns or business as usual of urban planning to in-depth examining of problems from multiple perspectives and replacing linear thinking with cyclical design (Spangenberg, Faud-Luke, and Blincoe, 2010).

Systems thinking is a way of thinking about systems of all kinds. According to Shaked, and Schechter (2017), systems thinking is not a discipline with defined borders but rather comprise an interdisciplinary framework that can be adapted to an exceptionally wide range of disciplines. It was defined as a functionally related assemblage of interacting, interrelated or interdependent elements forming a complex whole. This is likened to a variety of systems falling under such a definition encompassing natural systems such as the human body, the earth and space, human-made systems ranging from high tech electronic chips to global commercial integration and conceptual systems like ethics and policy and many more (Shaked and Schechter, 2017). In spite of the difficulty of this analysis three ingredients have united to make systems analysis feasible and useful nowadays in urban development. These are a substantial improvement of the information on key enablers of the urban environment, a better understanding of land use theories and software applications capacity for urban infrastructure modelling (Tortajada and Biswas, 2014).

In urban planning, delivery and management of infrastructure, system integration involves integrating existing infrastructure systems with new infrastructure thereby adding value to the urban system. However, due to increased complexity of organizations and infrastructure systems, there has been a need to coordinate multidisciplinary teams of engineers and scientist to work together in a way which optimizes planning, delivery and management of infrastructure keeping operations costs and risks under control (Tortajada and Biswas, 2014). This approach breaks down traditional planning and delivery of infrastructure in silos, thereby bringing different organizations and allowing them to develop a much higher level of common understanding and delivery of sustainable urban infrastructure systems. Knowledge of the differences between silo-based approaches to infrastructure development and integrated approaches is imperative in understanding the preparedness of an industry for its development integration (Chiponde, 2015). Table 2-2 presents a comparison between an integrated delivery process and a traditional silo approach which have a strong influence on how planning, delivery and management of urban infrastructure makes up the quality of cities.

Table 2-2: Comparison between integration and traditional project delivery

Traditional Project Delivery		Integrated System
Fragmented	Teams	Integrated team, assembled early, collaborative
Linear, distinct, segregated	Process	Concurrent, early contributions of knowledge and expertise, open
Individually managed, transferred	Risk	Collectively managed, appropriately shared
Individually pursued: first-cost based	Reward	Team Success tied to project success; value-based
Blame, exploiting loopholes	Culture	Learning, continual improvement,
Separate from work	Decisions	Integrated with work: based on data
Budget output, an activity	Measures	Focuses on capability and variation
Functional, silo fragmented based	Organization design	Based on demand, value and flow: open, integrated team
Hoarded in silos	Knowledge	Shared openly and early

Source: Adapted from (American Institute of Architects [AIA], 2007)

According to Chiponde (2015), he concluded that planning and delivery of infrastructure should be integrated so that implementing organisation can offer their knowledge and innovation at early stages of infrastructure projects. This approach strengthens team relationships and avoids the blame game when problems materialize and encourage organizations to combine their efforts in ensuring that the whole team attaining the shared infrastructure development goals.

2.2.4 Integrated system for urban infrastructure development

Urban design when developed correctly can be the basis for the creation of vibrant places which should be well built, well operated, well connected and well served, environmentally sensitive, inclusive and safe. These aspects are interrelated and urban planning, delivery and management have to be based on an integrated thorough

understanding of the relationships between critical infrastructure and functions of urban areas (Torguet, 2009). There exists a potential link between economic development and infrastructure development in transportation and communication resulting in increased regional and national connectivity by the efficient movement of goods and overall economic performance.

The provision of user clients with physical infrastructure that can easily deliver the services as part of the solution to a user's need, organizations are developing integrated systems in planning, delivery and management capabilities. According to Torguet (2009), conscious planning, delivery and management at certain moments in urban infrastructure development are order to realise the synergies inside the different infrastructure systems and between them. This results in innovation towards sustainability and optimizations of resources. Moving into integrated infrastructure provision should be regarded as a big challenge (Nathan and Reddy, 2008). It is noted that organizations ought to be capable of efficiently delivering infrastructure and having a good return on infrastructure investments entailing that organizations have to gain control of efficient methodologies to manage risks associated with urbanization, as this study earlier noted. However, Brady, Davies, and Gann (2005) noted that efficient delivery in integrated urban infrastructure planning, delivery and management should be repeatable and improved through feedback from user clients so that a good return on the infrastructure investment is realised.

Integrated planning, delivery and management of infrastructure in urban areas is thus not just reducing the environmental impacts of cities but also ensuring healthy economic growth, citizen satisfaction levels and adequate maintenance, development and redevelopment of infrastructure (Munasinghe, 2007). In order to put into practice such planning and management visions of infrastructure, a clear understanding of urban systems, their subsystems and interactions is required in order to find out what effects the specific urban policies will have on the sustainability of these infrastructure systems (Hawkesworth, 2015).

Despite a large number of infrastructure planning decision support tools and implementation frameworks, there are still relatively few with clear methods and an

enabling policy framework of carrying planning, delivery and management of infrastructure development for specific goals and through a well-defined urban process. Integrated infrastructure development using a framework that is holistic can help to achieve higher efficiencies in planning, delivery management of infrastructure, especially when the goal of this development is to achieve sustainable development (Culligan, 2010).

2.2.5 Sustainable Development Paradigm

Arias and Jorge (2016) pointed out that sustainable infrastructure refers to the designing, building, and operating of infrastructure in ways that do not diminish the social, economic, and ecological process required to maintain human activities, diversity, and functionality of natural systems. The sustainable urban infrastructure that supports the built environment is essential for the survival, health and wellbeing of society (Culligan, 2010). The goal of sustainable development is to provide the current and future generation with an improved built environment that is less vulnerable to the socioeconomic, political and environmental factors (Eid, 2017).

It can be argued that, in the past, sustainability has often been more a political agenda than a vision. In this context Ejigu (2007), noted that though the goal of sustainable development is well established in many developed countries, the road to ensuring that it is accurately incorporated into everyday practice in both the public and private organizations still remains way off. The crucial challenge urban cities are facing is to be sustainable in the face of rapid urban population growth coupled with changes in economic, social and environmental change. The links between infrastructure provision and urban growth remain understudied and infrastructure research has been developed in isolation from large literature on urban growth (Song, 2017). Further, the full implementation of the sustainable programmes is hampered by a lack effective capacity to effectively manage land use and to finance the public infrastructure services that are essential for economic growth and social inclusion (Sustainable Development Solutions Network, 2012). As such, sustainable development considers the dynamic nature of the society in rebuilding and modifying itself, guided by sustainable principles and practices as key ingredients to sustainable integrated infrastructure development. It is noted that sustainable infrastructure development requires consideration of specific key factors for addressing challenges of limited resources, ecological deterioration and

climate change (Dlamini, 2016).

2.2.6 The concept of sustainability

Sustainability is defined as the process that improves the quality of human life within the limitations of the global environment (Mensah, and Castro, 2004). It involves solutions for enhancing human living standards that do not result in degrading the environment or restrict the well-being of all humanity. There seems to be a consensus that three basic factors are involved in sustainable development; society, economic and environment. It was pointed out by Emas (2015) that the key principle of sustainable infrastructure development, which acts a foundation to build on, is the integration of environment, social and economic factors into the planning, delivery and management of urban infrastructure.

The understanding of the complexity of sustainable infrastructure development utilizes the classification of sustainable factors into three main categories; social, environmental and economic factors. While there is no doubt about the importance of integration of the pillars of sustainable development onto the urban development, implementation of this concept has proved challenging in practice. However, effective integration of these three categories requires the implementation of a set of focused and specific actions, which are complementary and fit within an overarching sustainable development framework (Jovovic, Draskovic, Delibasic, and Jovovic, 2017).

These classes of issues discussed above can be arranged as vertices of a triangle, as depicted by Munasinghe's, triangle in Figure 2-2 to imply that achieving sustainable development involves finding solutions which balance the importance and impacts of each of these three categories (Munasinghe, in Pearce, 1999). This provides a good classification system for sustainable development and highlights issues such as social and political impacts which have been omitted from consideration in traditional planning and delivery processes for infrastructure development (Jovovic, Draskovic, Delibasic, and Jovovic, 2017). In business, this notion of three integrated aspects is sometimes called the 'Triple Bottom Line' meaning increasing profits, improving the planet and improving the lives of people.

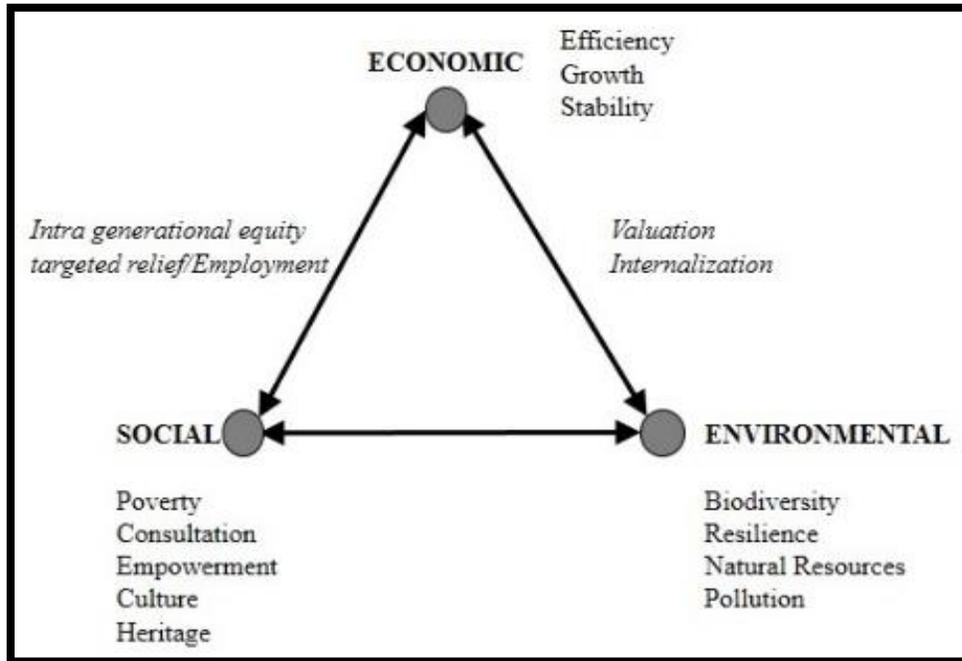


Figure 2-2: Munasinghe’s approach to Sustainable Development

Source: Pearce, 1999

A redefined model of sustainable development is viewing it as a whole system, made of up of three circles; the economy is found within the society and both the economy and society exist within the environment. Sustainability is the acknowledgement of various environmental and cultural diversities which could be transformed into advantages at different geographical scales; local, national or regional (Pearce, 1999)

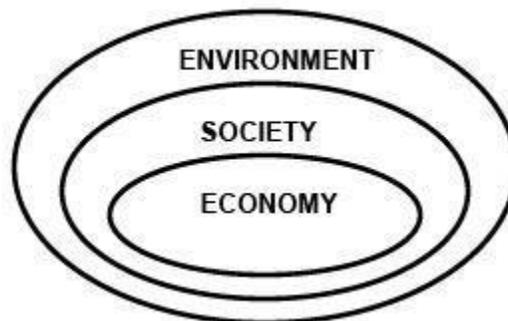


Figure 2-3: Sustainability aspects forming a concept as a whole system

Source: Pearce, 1999

According to Kennedy, Baker, Dhakal, and Ramaswani (2012) infrastructure is seen as a socio-technical system, in which innovations in technical and institutional approaches to service provision can help leverage efforts in planning, delivery and management of infrastructure development thereby attain sustainable development. Sustainability is seen as the optimization of natural resources and integrating the sustainable aspects in the process of planning, delivery and management of urban infrastructure.

A different framework was proposed by the economist who rearranged sustainability into a triangular set-up of the 3E's – Environment, Equity and Economy see Figure 2-5. At the bottom of the triangle is the Environment or the 'Ultimate means' which represents natural resources as a precondition for decent human life. The Economy which includes technology, politics and ethics is on the next rung, is not independent but serves as a vehicle for achieving ultimate ends. At the top is the Equity, or 'Ultimate End' which refers to the wellbeing of human being. According to Daly (1992), the economy, therefore, succeeds to the extent that it conserves and restores ultimate means, the environment and enables the achievement of ultimate ends, equity.

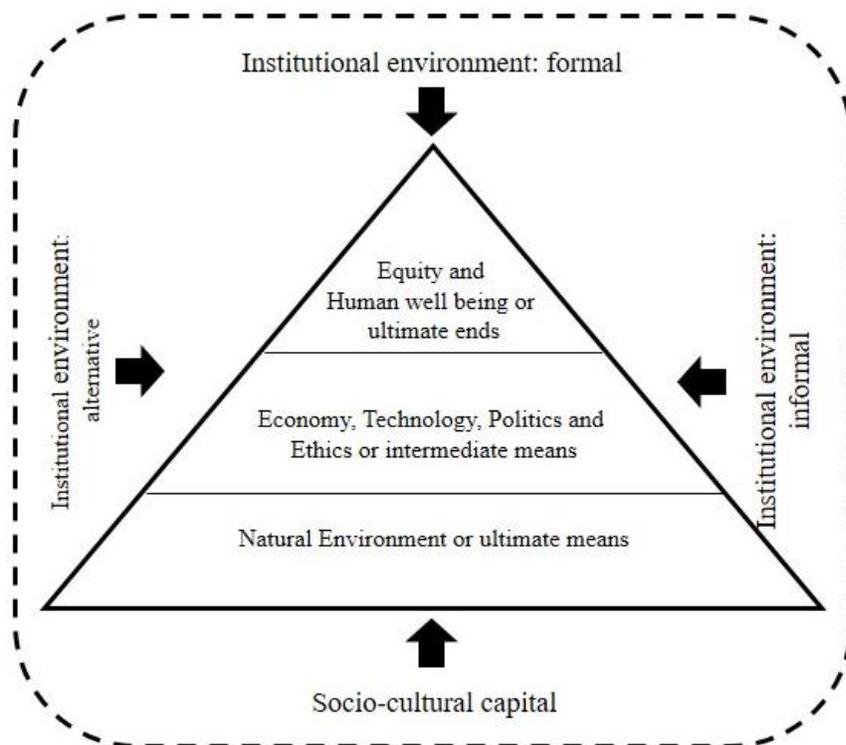


Figure 2-4: Daly's Triangle of Equity, Economy and Environment
Source: Jovovic, Draskovic, Delibasic, and Jovovic (2017)

Sustainability concept is currently used as a hub for many different approaches in response to specific issues in different regions. According to Jovovic, Draskovic, Delibasic, and Jovovic (2017), it is used for addressing various policy issues, infrastructure development processes and planning strategies and tools to enable economic and social development of its people. There are several important features related to the term “sustainability”. The first is that sustainability requires awareness of the interconnections of social, ecological and economic problems; secondly, all concepts of sustainability are based on different needs within the region and therefore require a lot of knowledge of how to deal with different interests; thirdly, implementation of sustainability concepts at the regional level should integrate local infrastructure needs into design processes and ensured co-operation from all stakeholders in resolving varied problems in urban areas. Generally, sustainable infrastructure development is most interested in considering the relationships between sustainability outcomes in planning, delivery and management of infrastructure to ensure urban areas deliver the required social, environmental and economic objectives.

2.2.7 Integrated urban infrastructure design process

The current best practices in search of attaining integrating urban infrastructure management focus on the development of robust and integrated approach systems to enable urban practitioners in decision making processes for sustainable infrastructure development (Au-Yeung, Saad, and Tan, 2010). According to Abdulgader and Aina, (2005) planning, delivery and management processes have a vital role in achieving sustainable urban development; the planning process and the outcome of planning should be guided by the principles of sustainable development. Cities with physical infrastructure that are strictly delivered from economic factors rather than being planned become sterile, functionally inadequate and unsustainable and so such cities fail to maintain sustainability, productivity and quality urban spaces (Frey, 1999).

Urban infrastructure development should not be solely driven by economic forces but by the integration of all relevant factors. Thus cities need to be designed and planned to foster sustainable urban infrastructure development (Abdulgader and Aina, 2005). This poses a challenge for sustainable urban design to identify guidelines and factors that improve environmental quality while leading social and economic infrastructure development of the city.

According to Hawkesworth (2015), successful application of the infrastructure planning and management frameworks relies upon the engagement of a wide selection of stakeholders into an urban design process to enable them to understand infrastructure development of the whole system of infrastructure in urban environments. On one side this involves; identifying infrastructure organizations for collaboration and coordination. On the other side; develop interdependency planning and management practice in a context-dependent on the learning process that can inform the development of strategic policy for an urban area. However, it was argued that integrated approaches can help us in breaking down the key components of the whole system into parts that can be individually analyzed and then brought together again in a manner that tries not to offer the desired outcome of effective collaboration in the urban development process (Eggenberger and Partidario, 2000).

The infrastructure framework system developed by Hawskeworth (2015) does not highlight how the integration of computer information technologies and software applications could be integrated into the urban design infrastructure systems.

Another framework was developed by Batty, Dodge, Jiang, and Smith (1998) for urban design process amongst urban practitioners, policymakers and other stakeholders who carry out planning and implementation of urban infrastructure development in a scientific manner. The framework, as shown in Figure 2-5 places emphasis on showing how computer technologies or software could enhance the planning, delivery and management of infrastructure so that the potential of such technologies and software applications can be seen in context with the sequential urban design process. The right-hand side of the chart illustrates the stages through which an urban practitioner passes through in generating and adopting an infrastructure solution. The left-hand side of the chart illustrates the array of software applications and representational issues that the urban practitioner or organization could use in taking into account the planning, delivery and management of urban infrastructure.

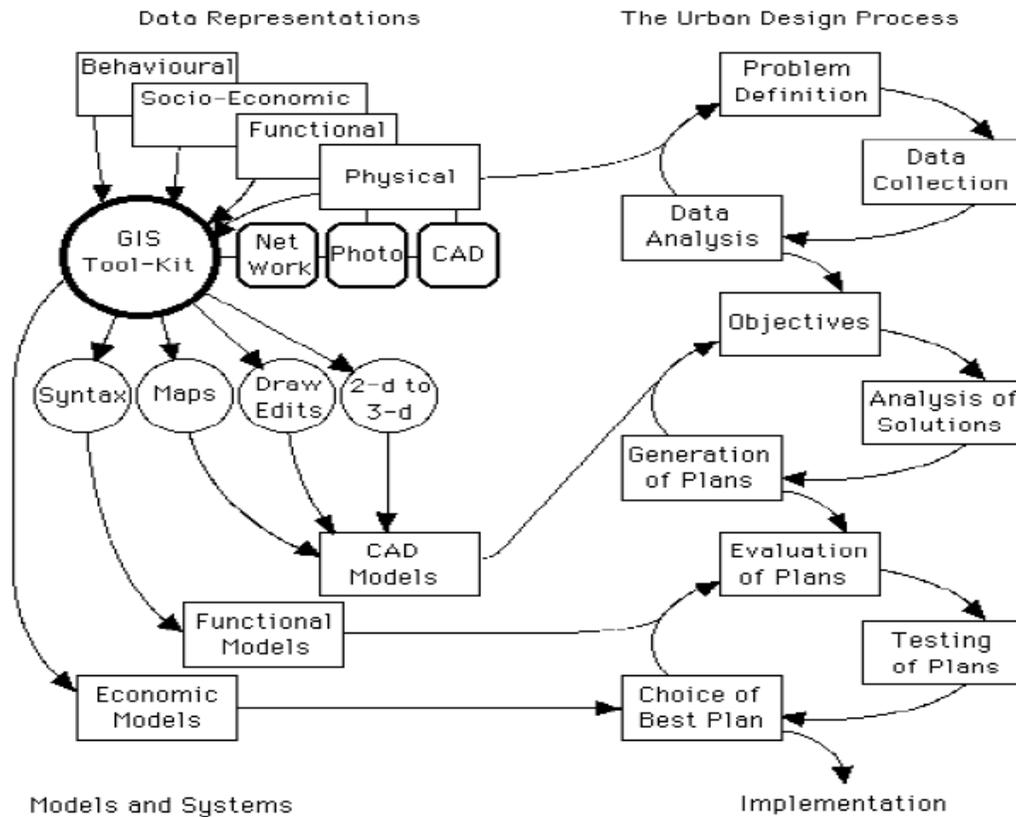


Figure 2-5: New computer technologies in the process of urban design
Source: (Batty, Dodge, Jiang, and Smith, 1998)

In Figure 2–5, urban infrastructure system framework identifies four ways of representing the urban systems. These are clustered as socio-economic information of traditional urban areas and locations in the city, usually inserted and contained within some kind of Geographic Information Systems (GIS), (Batty, Dodge, Jiang, and Smith, 1998). A key function of planning for infrastructure is the projection of future population and economic growth of which GIS can be used for prediction and projection (Longley, Higgs, and Martin, 1994). For example, GIS can be used to evaluate the impact of development on the environment to see whether adjustments of the plan are needed.

Finally, the framework highlighted the relevance of incorporating critical information obtained from social-economic, functional and behavioural environmental and environmental factors. However, there is no well-defined process of synthesizing these requirements but it was noted that the urban practitioner taking control over the process,

takes into account these various factors by dipping them into the GIS tool kit as and when required during the processes of infrastructure planning, delivery and management (Batty, Dodge, Jiang, and Smith, 1998).

The integrated strategy for successful sustainable urban infrastructure planning frameworks highlighted by Abdulgader and Aina (2005), adapted from Eggenberger and Partidario (2000) identifies different factors of sustainable urban design planning to include; procedural, substantive, methodological, institutional and policy aspects which should be integrated into a collaborative form to foster sustainable cities in urban areas. The substantive aspect involves the integration of different issues relevant to sustainable design such as land use density, environmental performance and mixed-use. The procedural aspect involves the urban design process. Sustainability principles involve the different tools for supporting urban design, for example, software application while institutional and policy aspects borders around good urban governance, integration of urban policies and coordination of infrastructure planning, delivery and management with relevant stakeholders. It is understood that these factors could provide an enabling environment for infrastructure systems integration which foster urban integrated solutions of services provision.

In the context of an urban design framework that organizations use to plan, deliver and manage infrastructure, certain capabilities are needed for delivering integrated development (Torguet, 2009). These include; systems integration, operational services, business infrastructure consultancy and financing. Systems integration and operational refers to organizations planning, delivery and management of infrastructure in close collaboration with other relevant organizations. Financing and business consultancy refers to ensuring organizations capabilities to provide finance for infrastructure development processes and advise customers or other stakeholders on how to design, build, maintain and operate systems. Local authority municipalities are suitable to grow these capabilities and take the role of integrators (Torguet, 2009).

Infrastructure interrelations can be modelled primarily around the urban design processes, taking in organizational collaboration behaviour towards integrated urban infrastructure development. This provides urban practitioners, infrastructure

developers and decision-makers with a better platform for understanding the complexities of the integrated nature of urban infrastructure development.

2.2.8 Barriers to sustainable integrated infrastructure development

There are several barriers to integrated urban infrastructure development. These include:

i. Weakened infrastructure management capacities

Cities in developing countries have very weak economies and inadequate communication among organizations delivering infrastructure (International Monetary Fund [IMF] Research Department, 2013). This has hampered the access to basic infrastructure resulting in increased costs for users to pay for the service. Further, poorly coordinated policies among organizations delivering infrastructure development have reduced the real possibilities for improving sustainable urban infrastructure development (Cohen, 2006).

ii. Institutional fragmentation ('Sectoral silos')

Departments usually work in line with their own vision, legal frameworks and procedures, and use their own sectoral language to infrastructure development. Different responsibilities distributed among several organizations and departments act as a barrier for the effective delivery of infrastructure and limit the opportunities for integrating innovation in infrastructure planning and management processes. The split among responsibilities to infrastructure development can cause confusion about who is the owner, who should operate and maintain the infrastructure in the long-term.

iii. Scattered regulations supporting infrastructure development

Sarabi, Han, Romme, De-Vries, and Laura (2019) generalized that the prevailing regulations have been developed from single sector infrastructure as the main, or only available, option to address given urban challenges. In other cases, the principle of whole systems protection may not underpin regulations, or legislation may not encompass all environmental components.

iv. Increased Urbanization

On the African continent, the population is estimated to double from the current 1,186 billion to 2.5 billion in 2050 based on the medium-fertility scenario. There is limited understanding of the complexity and risks of the large-scale infrastructure systems being developed to serve cities with the increasing population and Kafungwa (2017) put it out the importance of providing enough resources to prevent social inequality and conflicts as to who has adequate infrastructure, thereby making sustainable infrastructure development very important.

v. Lack of resource availability

Lack of electricity is associated with informal urban settlements where people typically have high transportation costs and poor-quality housing. The use of cheap fuels implies increased deforestation, pollution, health risks, energy cost and time burden thereby negatively impacting the environment.

2.2.9 Enablers for integrated sustainable infrastructure development

Various mechanisms or actions can be adopted to address the challenges of urban infrastructure development. The most identified enablers are a social and institutional partnership, collaboration and coordination among stakeholders and organizations in urban areas (Sarabi, Han, Romme, De-Vries, and Laura, 2019).

i. Knowledge sharing and communication technologies

The communication technologies in urban areas are typically used for sharing ideas, getting feedback or planning for infrastructure development in urban areas. The communication aspect issue becomes more important for the infrastructure urban design process because many different professional groups with different backgrounds participate in the process, and a variety of media types are used for sharing information and knowledge in this process. These groups include architects, planners, engineers, and infrastructure developers (Kim, 2005).

ii. Developing a shared goal and benefits

According to Sarabi, Han, Romme, De-Vries, and Laura (2019), the key to successful partnership and collaboration in infrastructure development is developing a shared

understating of the infrastructure goals and their benefits. Collaborative planning to infrastructure development is being advocated for by planning academics and practitioners as a new paradigm for planning practice because it generates commitment to commonly accepted objectives and goals, thereby fostering a commitment to implementation (Margerum, 2002).

iii. Education and training programmer for stakeholders

Training and education programmer on integrated infrastructure development for stakeholders from different organizational scales including citizens and urban practitioners is an enabler to decrease the high complexities regarding urban infrastructure delivered or planned.

iv. Programmes and legislation

Clear methodologies to attain the set environmental objectives enable effective infrastructure urban development. At a local level, legislation similar to the strategic green infrastructure plan developed by the Barcelona city council can facilitate mainstreaming the integrated sustainable infrastructure development concept by considering its social-environment-economical system perspective.

2.2.10 Infrastructure delivery mechanisms

With the background of barriers and enablers to urban infrastructure development highlighted, the different types of infrastructure delivery mechanisms will be discussed. Infrastructure is a fundamental component in the survival of humans in cities and it is a critical public and private service. Hawkesworth (2015) concluded that sound infrastructure development is a key driver of enhanced capacity for real economic growth, both in the short and long terms. Infrastructure networks reduce the effect of distance, help integrate markets (selling and buying of goods), and provide the necessary connections to international markets.

According to Hawkesworth (2015), the different methods of infrastructure delivery mechanism include:

i. Direct provision

Direct provision of infrastructure involves the government taking responsibility for all

aspects of infrastructure delivery, including financing, construction and subsequent service delivery. This model affords the government a maximum level of control over the infrastructure asset.

ii. Traditional public procurement

In the traditional public procurement method, a government body enters into a contract(s) with private partners to provide infrastructure services. The government will contract separately for the design, construction, operation and maintenance of infrastructure assets. Contracts are allocated using competitive tender processes in order to obtain the best bundle of quality features and price.

iii. State-owned enterprises

Infrastructure, particularly in network industries such as water, public transport and electricity is often provided by state-owned enterprises (SOEs) that are owned (fully or partially) by the government. The government may relinquish infrastructure investments to an SOE if the latter is able to raise finance independently, although the actual investment decision may still be subject to government controls if they have fiscal implications. This may be an efficient mechanism for the delivery of infrastructure, especially if the SOE is a corporate that is operating as an independent legal entity and subject to demand and supply dynamics within the urban market.

iv. Public-Private Partnerships (PPP) and Concessions

Public-private partnerships (PPPs) involve private investors financing and managing the construction of an infrastructure asset, which they then typically operate and maintain for a long period, often extending to 20 or 30 years. In return, the private partner receives a stream of payments to cover the capital expense as well as the operating and maintenance costs during this period of operation. This payment stream may be derived from the national budget, user fees or a combination of the two. Private firms are responsible for financing, constructing and operating the infrastructure assets.

v. Privatization with regulation

In this mode of infrastructure delivery, private firms are not only responsible for the financing and delivery of infrastructure, but they also make investment decisions

relating to which infrastructure assets are to be built. When conditions for a competitive market exist in a sector, private firms subject to the discipline of market forces may provide the most efficient mechanism for the provision of infrastructure.

2.2.11 Infrastructure governance

Infrastructure governance refers to the processes, tools and framework for decision-making and monitoring used by organizations to provide infrastructure services to the public (Hawkesworth, 2015). It simply relates to interaction and coordination between government organizations internally, as well as their interaction with the private sectors, users and citizens. The entire life cycle of the physical infrastructure typically passes through the planning, delivery and management processes.

Hawkesworth (2015) pointed out that it is helpful to bear in mind the various stages of infrastructure development and how they interact with the urban design process as can be seen in Figure 2-6. This differs from the infrastructure development phases by Ejigu (2007) where it was noted that infrastructure arises, grow, mature and sometimes fade away and categorized three (3) phases of development as; establishment, expansion and stagnation.

The five (5) phases in the life cycle of an infrastructure project are identified and these include: First, there is the issue of evaluating infrastructure needs or problem identification. Hawkesworth (2015) noted that this requires the ability to gather evidence to identify the relevant needs across sectors. Second, a prioritization of these needs or setting a goal should take place based on integrated planning processes and allow aggregation of the many project dimensions and preferences of stakeholders. Third, is the project preparation phase, suitable procedures and skills in terms of technical design, affordability and value for money issues need to be applied. Fourth, in the construction phase, appropriate skills and systems should be available to ensure that project goals are met or that any changes to the infrastructure plans are subject to appropriate scrutiny. Fifth, in the operational or implementation stage of the project, the right incentives and tools for appropriate monitoring of infrastructure performance and maintenance should be in place as well as mechanisms for reflection on the service provided.

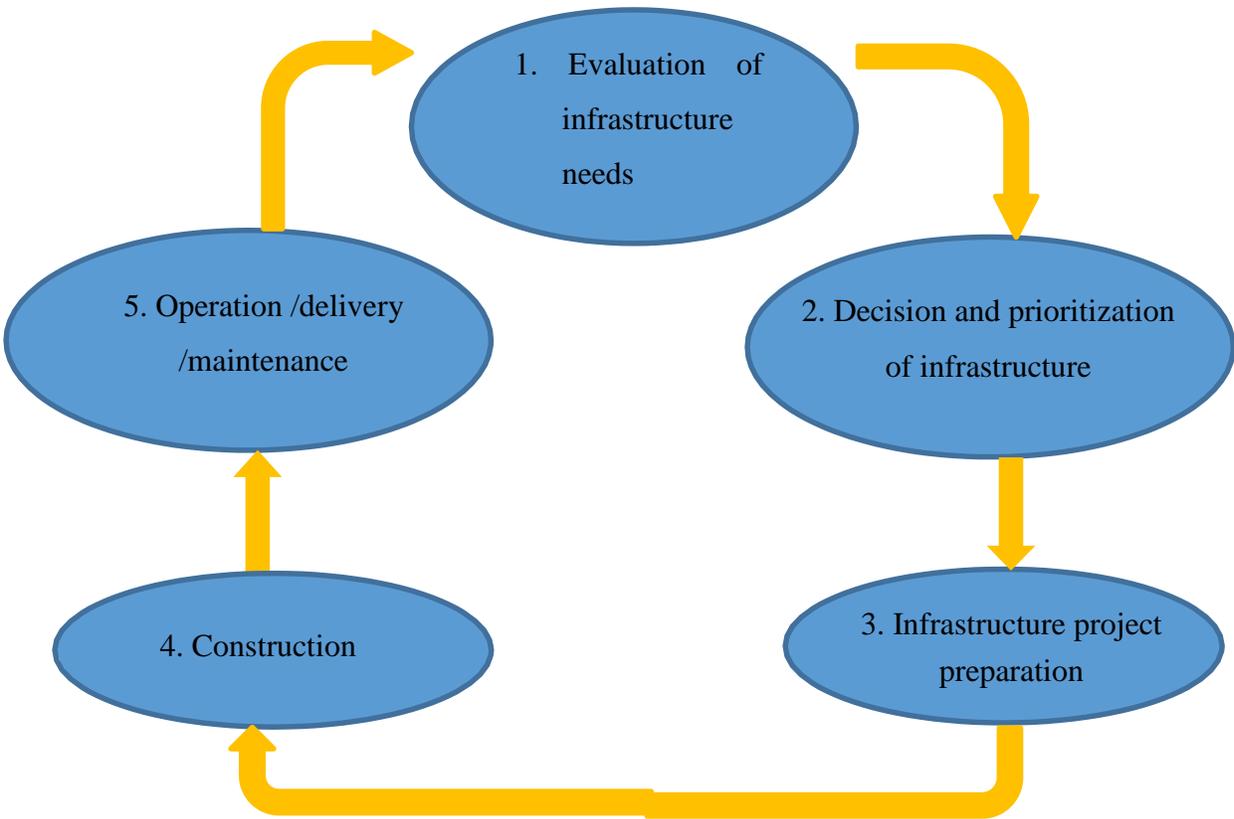


Figure 2-6: Infrastructure governance cycle

Source: Adapted from (Hawkesworth, 2015)

Another model in Figure 2-7, for analyzing the urban design process for infrastructure highlights common goals which urban designers or infrastructure organizations agree to and build consensus for development (Blizzard, 2011). According to (The World Bank, 2000) in most developing economies, there is still a high demand for electricity, road infrastructure and decentralized forms of energy, with a potential to support sustainable growth.

Dlamini (2016) emphasized that it is imperative that infrastructure investment decisions be informed by a thorough analysis of potential mitigation measures, adaptation, development synergies in developing economies and suggests that this will be well achieved by setting clear cut goals and integrating all other key sectors in a well-defined framework.

As for the systems thinking in frameworks, Blizzard (2011) identified that systems thinking is related more to process and principle as opposed to design methods. The main goal in the whole system design framework process is to establish a desired common goal. In this study it is to establish a common infrastructure goal as the processes of planning, delivery and management are carried by urban practitioners. The three steps forming part of the methodology to urban design methods: define the infrastructure scope and align it with an urban vision and desired outcomes, seek simple elegant solutions and consider the entire life cycle of infrastructure and build feedback.

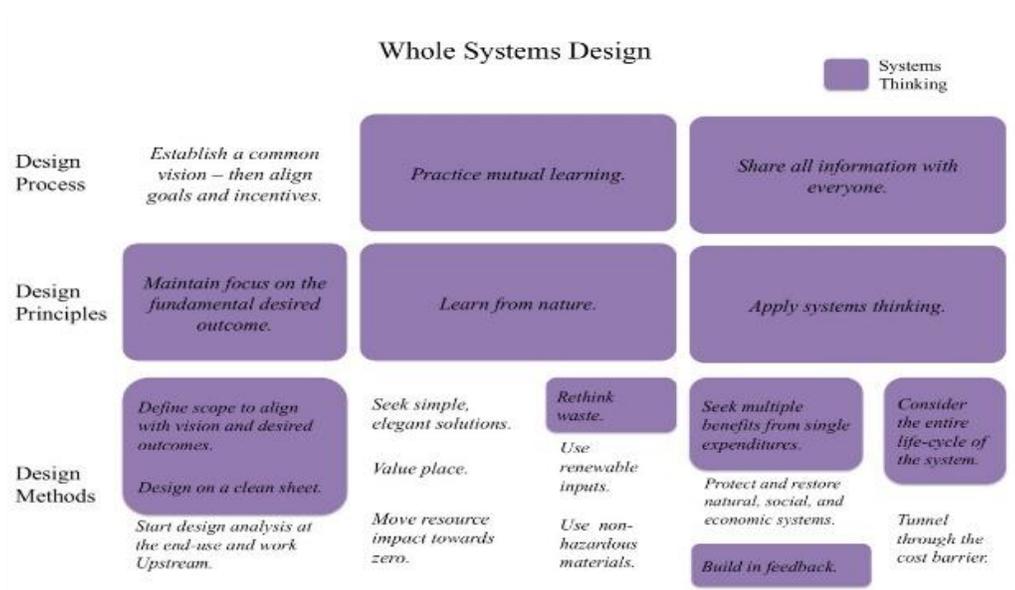


Figure 2-7: Components found in systems thinking framework

Source: (Blizzard, 2011)

The development of a broad framework for whole systems design rather than tailoring a framework for each individual field of infrastructure is essential to creating a synergistic mindset amongst design teams and organizations (Blizzard, 2011). The framework in figure 2-7, highlights that each field or infrastructure sector brings a unique perspective when planning for urban infrastructure and that when combined in a holistic approach with other sectors, more efficient and effective urban solutions become possible. Whole systems design is one approach that urban practitioners can use to holistically optimize urban infrastructure problems. However, it has remained largely undefined and its own principles ambiguous making it a difficult design paradigm to implement (Dlamini, 2017).

2.3 Zambia's infrastructure development landscape

A wealth of research has been directed at Zambia's development challenges in the last five (5) years (Falvey, 2016). It is noted that institutional inefficiencies, entrenched power dynamics, poor governance, and system or endemic corruption are key constraints to the effective delivery of basic infrastructure services. Constraints are intertwined, representing not a simple cause and effect model, but a far more multidimensional challenge. The underlying development solutions for an improved Zambia is infrastructure based on the recognition that multidimensional development challenges require multidimensional development approaches (Silungwe, Danstan, Lawrence, and Naloobo, 2015). The main motivation of governments' intervention is set, that is the need to put into place infrastructure and legal frameworks where the national economy is able to produce the maximum returns on infrastructure investment (Raphael and Morris, 2016). In Zambia, economic status and population growth have put pressures on existing infrastructure and hence the need for improvements and new construction, even more, pressing (Ngoma, 2015).

Infrastructure development for urban areas has suffered the consequences of silo-based infrastructure planning with the increasing urban population growth. Among these include; difficulties to manage the failure of infrastructure, cost overruns and delayed completion time (Silungwe, 2015). Further, it is noted that the reduction of risks on infrastructure projects cannot be effectively achieved through traditional methods of planning due to the fragmentation of the organizations involved. In particular, Foster (2011) noted that improving Zambia's infrastructure service provision requires a reformation of the policy guidelines for urban infrastructure development and regulatory processes. The current planning approach to urban infrastructure suggests low support for integration of duties and roles performed by organizations who are operating in silo operations.

Zambia has achieved progress in infrastructure development by strengthening public organizations that support infrastructure service development; improving the regulatory framework; encouraging private investment in infrastructure; business facilitation and economic diversification (Siame, 2007). Zambian laws and regulations on infrastructure development generally provide for oversight of how development

should be carried out but is lacking in application and enforcement. Moreover, organizations that support public infrastructure delivery have a weak institutional capacity, lack of a regulatory framework to operate in, discouraged private investment in infrastructure and lack of citizen's empowerment (UN-Habitat, 2012). It is noted that Zambia's developmental problems are complex and so policy and developmental solutions should focus on integrated goals and achieve results from a variety of sectors in a concerted focus on key infrastructure development objectives (Silungwe, Danstan, Lawrence, and Naloobo, 2015).

2.3.1 Zambia's infrastructure perspective

According to (Foster, 2011) improving Zambia's infrastructure requires reform in regulatory processes as well as physical investment in urban infrastructure development. Inefficiencies in planning and delivery in infrastructure development cause the loss of \$300 million (or 4.3 per cent of GDP) a year that could be recouped by suitable policy and institutional reforms. Zambia's infrastructure funding gap of \$500 million a year (6.5 per cent of GDP) could be largely offset by strategic policy choices. Within Sub-Saharan Africa, Zambia is one of the more urbanized countries with an urbanization rate of over 50 per cent. The infrastructure landscape and efforts to close the gap in infrastructure development is outlined below.

i. Railways

The Zambia National Transport Policy of 2003 is the main transport policy document for the main railway sector that addresses problems of rail transportation. Mwila and Mwanaumo (2015) considered the link between economic development and access to transport in general and railways in particular. Using literature review and survey results of a research on a comparative study of access to railways relative to rail transport in Zambia revealed that Zambia's position of the railways in Zambia transport is extremely bad and poorly used in Zambia. Findings further showed that rails transport in Zambia is challenged by inter alia, poor infrastructure and equipment through poor management and unfavourable government policies. If not checked this could adversely affect the economic development that the country has recorded in recent past of more than 7.9% GDP growth in the period 2005-2013.

Mwila and Mwanaumo (2016), further notes that development of an integrated railway

transport system will support competition among the various modes of transport thereby cause the industry to achieve success in service delivery of rail infrastructure.

ii. Water and Sanitation

Zambia's water utilities have relatively high levels of hidden costs due to inefficient service delivery and lack of maintenance for infrastructure (Foster, 2011). First, utilities recover only about two-thirds of the total cost of service provision when full capital costs are taken into account. Second, utilities are collecting only about 70 per cent of the revenues owed by their customers. Third, about 45 per cent of the water produced is lost in distribution due to technical failures (Kafungwa, 2017).

iii. Telecommunications

The state-owned telecommunication company, Zambia Telecommunications Company Ltd. (ZAMTEL), is characterized by inefficiency and an inability to compete with private mobile operators and has become increasingly dependent on state financial support (Foster, 2011). According to the Information and Communications Technologies (ICT) Act 2009 for Zambia, the legal framework for network expansion noted that lack of coordination among authorities issuing Right of Ways (ROWs) leading to confusion in the rollout of fibre networks (Zambia Information Communications Authority [ZICTA], 2017). Several problems have arisen due to this poor delivery system, such as laying of parallel fibre cables resulting in multiplied infrastructure investment costs and distortions in national totals of Zambia's fibre network length, compromised road infrastructure due to frequent excavation, traffic disturbances and interruption of power supply and other utility infrastructures like water and sewerage pipes and communication cables. This method of infrastructure delivery implies inefficient and uneconomic use of network infrastructure.

To deliver infrastructure services most effectively, efficiently and sustainably, the many sectors of infrastructure must be considered as interconnected systems (United Nations Environment Programme, 2012).

Accordingly, on the 21st June 2017, the Government of the Republic of Zambia launched the implementation of the Seventh National Development Plan (7NDP)

2017 - 2021, which envisions guidance to the new era of development planning which is premised on an integrated multi-sectoral approach. The integrated approach recognizes the multi-faceted and interlinked nature of sustainable development which calls for interventions to be tackled simultaneously through a coordinated approach in implementing development programmes (Ministry of National Development Planning, 2017). This is the potential role that integrated approaches to sustainable urban infrastructure development could play in Zambia.

2.3.2 Infrastructure development reforms in Zambia

The provision of urban infrastructure such as roads, water, electricity and sanitation takes up significant amounts to support economic development and production of the urban built environment in Zambia's cities. However, by the 1980s, the state of infrastructure in towns and cities had reached serious levels of deterioration as local authorities were unable to deliver these needed services (UN-Habitat, 2012). The World Bank (2003) noted that one of the contributing factors for the infrastructure gap in Zambia was the over-reliance of copper, being the main product sustaining economic growth. However, after a slump in copper prices resulted in an increase in urban migration and the developed infrastructure due soon became inadequate and could not be maintained due to its high costs.

It is noted Taylor and Thole (2015) that contemporary town planning practice is not a unitary action but an integrative one. Effective urban planning requires all stakeholders in all sectors to fully participate in the planning and delivery process to formulate a comprehensive master plan that all stakeholders would be proud of. An integrated approach to urban infrastructure development would incorporate feedback mechanisms that would ensure checks and balances to the planned infrastructure in an urban design process, thus avoiding the non-operation of the plan. At this juncture, it can be stated that the Government of the Republic of Zambia through the Ministry of Local Government and Housing has initiated a process of developing Integrated Development Plans (IDPs) for all Districts, Municipal and City Councils.

The approaches to infrastructure planning, delivery and management constraints directly impact the efficiency of infrastructure service delivery in Zambia (African Development Bank, 2013). Mthethwa (2018) pointed out key drivers or factors that

enable quality infrastructure planning and promotes economic growth. These include:

i. Robust governance

Robust governance leadership and capable organizations that support transparency, rule of law and consultation with independent decision-making structures for infrastructure investment.

ii. Enabling regulatory urban framework

Consistent and predictable regulatory frameworks that are transparent and welcoming of investment and competition of all stakeholders.

iii. Efficient processes for building permits, approvals and land acquisition processes

Permits, approvals and land acquisition processes that are timely and predictable minimize inefficiencies.

iv. Proactive planning

Planning, not just of projects, but the setting of strategic social-economic environment goals and integrated sectorial and system plans, enabling projects to be measured against clear objectives.

v. Procurement methods

Procurement practices that are effective, enable efficient risk allocation and innovation, deliver value-for-money, enhance competition and provide a high-level undertaking to sustainable infrastructure development.

The underlying development solutions for improved Zambia infrastructure is based on the recognition that multidimensional development challenges require multidimensional development approaches (Silungwe, 2015). This establishes a clear understanding of the binding development constraints and the need to operate in a focused and concerted way of looking at infrastructure development as a whole system. Evidently, the traditional approach does little in effectively managing risk within infrastructure development due to fragmentation of the parties or organizations and hence the industry needs a more innovative integrated approach (Silungwe, 2015).

According to Foster (2011), improving Zambia's infrastructure development agenda

for urban cities requires a reformation of the administrative and regulatory processes. Urbanization in Zambia has come with major development challenges that impinge on human and economic development and result in environmental degradation (Ministry of National Development Planning, 2017). According to the Ministry of local government and housing (2015), 4 categories were cited as challenges to the rapid urban population on infrastructure. These are; social-economic problems such as poverty and high living costs in cities, environmental and spatial challenges such inefficient urban practices and environmental degradation, policy, legal and institutional challenges as well such as weak regulatory framework, poor coordination and low institutional capacity.

Despite that challenges that rapid urbanizations bring on infrastructure development, it should be viewed as an opportunity for greater economic opportunities through focused urban planning frameworks. It is noted that urban areas present a variety of opportunities due to concentrated economic activity that can drive country-wide economic growth by facilitating productivity increases and innovation by way of large product and labour markets and ease of exchange of knowledge and ideas (Ministry of National Development Planning, 2017).

According to a survey carried by Silungwe (2015) key conditions for successful infrastructure planning, delivery and management that results in economic growth for urban areas include open communication 38%, knowledge sharing 20% collaboration 13%, risk-sharing 9%, mutual trust 8% and understanding each others' objectives and equitable and clear allocation of risks 7% and 5% respectively. It was concluded from their study that the involvement and the use of all stakeholders throughout the project lifecycle can result in a successful project.

2.4 Critique of literature review and existing theories

Infrastructure development has received significant attention from the construction industry in recent years, especially from research groups lead by Ejigu (2007) and Aien (2015). Recent publications and conferences also show this attention (Kennedy, Baker, Dhakal, and Ramaswani, 2012). According to Hawkesworth (2015), the successful application of the infrastructure planning and management frameworks relies

upon the engagement of a wide selection of stakeholders and institutions/agencies in a well-coordinated framework and policy establishment to enable them to understand and implement infrastructure development successfully.

The government of Zambia is making efforts as well to close the gap in infrastructure development as noted by the national policy direction of the 7NDP to spearhead integrated approaches among the variety of sectors in infrastructure development (Ministry of National Development Planning, 2017). However, there exists no literature that attempts to provide an urban integrated approach that integrates the planning, delivery and management of infrastructure in the urban design process with sustainability categories; environment, social and economic aspects into one framework for Zambia.

Studies on key factors for urban infrastructure development have recognized the importance of strategic planning for nature-based solutions in urban infrastructure development. However, there is none that attempts to evaluate the key factors; policy, methodology, principles and practices, institutional and substantive aspects within an integrated framework for urban infrastructure development in general.

There have been a number of studies into infrastructure system and the development of a broad framework for whole systems design but little on tailoring a framework for each individual infrastructure into a whole system design for urban areas. Blizzard (2011) identified that systems thinking is related more to process and principle as opposed to planning, delivery and management methods. However, systems thinking theories have remained largely undefined and its own principles ambiguous making it a difficult design paradigm to implement (Dlamini, 2017).

2.5 Summary

A review of available literature has indicated that the most relevant studies were undertaken in other countries within the construction industry. The literature reviewed establishes the relevance of integrated approaches to infrastructure development in the construction industry by understanding and studying the interdependencies that exist among infrastructure. The review also showed that inefficiencies and uncoordinated infrastructure delivery result in poor delivered infrastructure and loss of value for money invested. Finally, the chapter reviewed some of the barriers that limit organizations to adequately coordinate the planning, delivery and maintenance of infrastructure and reviewed enablers to urban infrastructure development.

Table 2-3 summarizes literature reviewed and provides the critique on each one of them.

Table 2-3: Summary of key literature reviewed

<u>Item No.</u>	<u>Author</u>	<u>Objective</u>	<u>Method</u>	<u>Conclusions</u>	<u>Comments, Critique (if any)</u>
1	Abdulgader and Aina (2005)	To develop an integrated framework, in local context of Saudi Arabia, for promoting sustainable urban design.	Literature review	That substantive urban design could only be achieved if the procedural, substantive, institutional, policy and methodological aspects of urban design are interlinked and guided by sustainable principles.	The paper lays a foundation for understanding factors for urban design framework. The information provided in this paper could be used as a bases for developing the integrated conceptual framework for planning, delivery and management of urban infrastructure.
2	Blizzard (2011)	To define and unify general principles of whole systems design and develop a conceptual framework for whole systems design for sustainable infrastructure.	Literature review	Whole systems design is one approach that offers designers the opportunity to holistically optimize solutions for social, environmental and economic sustainability.	This paper provides a foundational for understating whole systems design and development of urban integrated infrastructure framework.
3	Cirolia and Rode (2019)	To provide a selective and stylized review of the key and contemporary urban infrastructure debates.	Literature review	Interdisciplinary approaches to infrastructure development will need to find ways to address the cutting-edge issues within the	The research paper presents good contents but not clearly showing the methodology.

				propositional lens used to address infrastructure development.	
4	<p>Eggenberger and Partidario (2000)</p>	<p>To contribute to the establishment of an integrated planning framework, which will ensure early consideration of environmental, social, economic and institutional issues, thus enabling more sustainable planning practices.</p>	<p>Literature review and case studies</p>	<p>For a balance urban development, the principles of sustainable development should be integrated with the urban design process to rescue cities from the negative impacts of market-driven spatial organizations.</p>	<p>This paper deals with various aspects of urban integrated planning and sustainable concepts but does not provide means of understanding of the role of organizations within the context of the framework.</p>
5	<p>Ejigu (2007)</p>	<p>To develop a new framework that better reflects complex evolutionary nature of infrastructure and attempt to use systems approach to study the nature of infrastructure systems.</p>	<p>Literature review, semi-structured interview questions and case study.</p>	<p>Systems approach is not a package of solution but rather a call to holistic view- a new paradigm to looking at our problems.</p>	<p>The findings of this paper provides insights for future research and development of understanding of complex problems such as infrastructure system.</p>

6	Foster (2011)	To make contribution to development policy discussions for Zambia's infrastructure landscape.	Literature review	Despite the numerous infrastructure challenges that Zambia faces, the solution looks much more tractable than in the case of many African countries.	The paper is good in terms of content except it does not clearly show the methodology.
7	Jovovic, Draskovic, Delibasic, and Jovovic (2017)	How to use sustainable techniques for better infrastructure development and avoid irreversible damage to the environmental systems that support life?	Literature review	Sustainable development has been defined in a variety of ways, but in practice, it has three dimensions economic, environment and social. The overarching aim in infrastructure development is to meet wider economic and social needs while limiting environmental impact.	They present sustainable concepts in infrastructure development which forms a foundation for further research.
8	Taylor and Thole (2015)	To address the nature of town planning practice by planners that seems to hinder the effectiveness of the activity to guiding and directing social, economic and physical	Literature review	Urban practitioners together with government should acknowledge planning realities, such as urbanization, urban growth, that specifically seeks to connect forms of knowledge with forms	The contents in the paper provides insight on planning practices for urban areas in Zambia. The information provided in this paper could be used as basis for

		infrastructure development in urban areas in Zambia.		of action in the public domain.	further research.
9	Thorpe (2000)	To describe a life cycle modelling and analysis process for infrastructure development and management, and its application to the construction of such a framework.	Literature review and Case study approach	By following a systematic process that uses flowcharting, structured analysis, and paired comparisons, the methodology provides understanding of linkages between the main factors in the infrastructure life cycle.	Paper highlights the significant factors influencing infrastructure development of roads. This paper doesn't not show how the key factors could be applied into the urban planning and delivery process for infrastructure.
10	Torguet (2009)	Review systems approach literature related to integrated urban planning processes and build a business model for organizations	Literature review and case studies	Systems integration is a good approach for urban planning because it takes a holistic view on the way infrastructure systems are planned.	Significant work by researchers is provided in this paper. It therefore forms a basis for development of integrated urban infrastructure framework and further research.

CHAPTER 3: METHODOLOGY

3.1 Introduction

The previous chapter reviewed the literature on integrated urban infrastructure development and outlined the theoretical framework of the research. This Chapter outlines the methodology adopted in the research process to address the study aim and objectives.

3.2 Research design and Approach

A mixed-method approach was adopted for this research. Mixed method research is a type of research in which a researcher mixes or combines qualitative and quantitative research into a single study (Johnson, 2014). It is noted that the combined method was considered suitable for infrastructure development enquiries which combine highly complex, technical and social systems and is also at the centre of natural and social sciences (Kothari, 2004). Further, a balanced choice of research methods helps the study to limit potential bias while maintaining flexibility and variation (Johnson, 2014)

The combined method technique allows the use of qualitative and quantitative methods for investigation. However, Brewer and Hunter (2006) argue that the fundamental objective of a combined or mixed-method research is to attack a research problem with an arsenal of methods that have no overlapping weaknesses in addition to their complementary strengths. This is illustrated in Table 3-1.

Table 3-1: Strengths and weaknesses of quantitative and qualitative methods of research

Quantitative method (Strengths)	Qualitative method (Strengths)
Representativeness	Holistic and detailed
Possibility of impartial disproof	Reactivity
Control (rigour)	Naturalism
Weaknesses	Weaknesses
Limited scope	Non-representative
Artificiality	Lack of control bias

Research employing this approach benefits from world view of social reality which encompasses the assumptions underlying both methods. Further when different approaches are used to focus on the same phenomenon and they provide the same results, there is “collaboration” which means there could be superior evidence for the results

In order to address the research problem stated in Section 1.2 and achieve the objectives in section 1.2.2 various elements of the research were set out in a logical sequence, so as to avoid misunderstanding at any point in the research. The problem statement, aim and objectives of the research were therefore stated at the outset. Then in order to present clear perspectives about integrated infrastructure urban development approaches among organizations in Zambia, the research design comprised of four activities. These were literature review, data collection and data analyses, drawing conclusion and recommendations. The qualitative research formed the first part and quantitative research formed the last part of the research. The research instrument used to collect data for the qualitative part comprised of structured interviews whereas the questionnaire survey was used for the quantitative part. The qualitative approach to research strategy is characterized by lower sample numbers, than in quantitative, and participants are selected to expand variability and represent the natural population. Normally, forms of non-probability sampling such purposive sampling are used (Taylor-Powel, 1998). It is further noted that qualitative research relies on the collection of qualitative data and the other terms used are interpretive or subjectivist when carrying out the research. In this study, it involves an examination of perceptions in order to gain an understanding of social, human and organizations activities regarding urban infrastructure development processes.

That is qualitative procedures has been used in this study to purposefully enhance understanding of the information-rich case of integrated approaches to urban infrastructure development while quantitative research involved representative sampling to permit statistical inference to be made (Judd, Smith, and Kidder, 1991). The summary of the research methodology is shown in Figure 3-1.

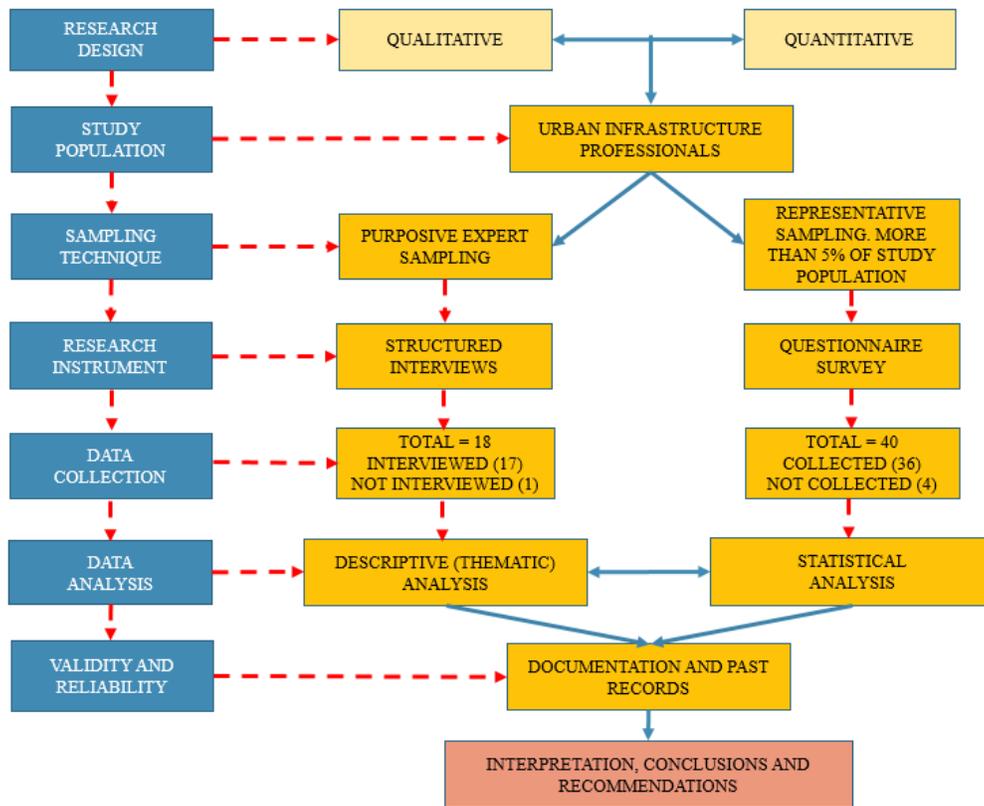


Figure 3-1: Summary of qualitative and quantitative research

Source: Adapted from (James, Svendsen, Fisher, and Campbell, 2011)

3.3 Study population

The study of this research comprised of Project and Construction Managers, Engineers (Civil and Structural) Quantity surveyors, Town planners and Architects working in state-owned organizations and agencies mandated to deliver infrastructure and were listed on the Industrial Development Corporation (IDC) of Zambia, which operates the economic affairs of the organizations targeted. In addition, urban practitioners working in Road Development Agency (RDA), Lusaka Water and Sewerage Company (LWSC) and Local authority councils formed part of the study population. Buns and Groove (2003) define eligibility criteria as “a list of characteristics that are required for the membership in the target population.” These practitioners were targeted because they are directly involved in planning, delivering and managing infrastructure development in Zambia and understand how sustainable concepts could facilitate improving the built environment while delivering infrastructure projects.

3.4 Sample

The sample is chosen from the study population that is commonly referred to as the ‘‘ target population or accessible population’’ and is a relatively small subset of a population (Heiman, 2011). The sample selected for this study includes organizations and agencies listed on the (IDC) which provide critical urban infrastructure; railways, roads, water and sewerage, telecommunication and electricity. These organizations include; Zambia railways, Zambia Electricity Supply Corporation (ZESCO) and Zambia Telecommunications Limited (ZAMTEL). In addition, the Road and Development Agency (RDA) and Lusaka Water and Sewerage Company (LWSC) and the Local authority council. This covers the critical infrastructure in this study; railways, roads, water and sewerage, electricity and telecommunications infrastructure.

3.4.1 Sampling procedures

The purposeful non-probability sample is known as also known as a judgment or deliberate sampling (Kothari, 2004). This sampling strategy is oriented towards the development of scientific knowledge from the generalizations of nomothetic or general scientific knowledge from samples of the population (Patton, 1990).

The sample was purposively selected from the population of interest for the qualitative research part. Further, the inclusion criteria were used to establish that the interviewees are experts in urban infrastructure development. The criteria used was firstly: academic qualifications in the fields relevant to infrastructure development, that is, a bachelor’s degree in architecture, civil engineering, town planning, transportation and logistics, and secondly at least 10 years’ experience in urban infrastructure planning, delivery and management service provision. The rationale used for choosing this approach was that it enables the use of judgment to select cases that can best answer the research question(s) and meet the research objectives.

Kothari (2004) noted that stratified random sampling is applied to a population which does not constitute a homogeneous group, so as to obtain a representative sample. In this technique, the population is stratified into a number of non-overlapping groups or strata and sample items are selected from each group. The first step in stratified sampling is to divide the population into groups (strata) based on mutually exclusive criteria followed by random or systematic samples taken from each group.

3.4.2 Sampling size and justification

In academic research such as this one, the sample size must not be less than 5% of the population under investigation (Judd, Smith, and Kidder, 1991). The professionals targeted were working for organizations and agencies providing infrastructure development Zambia.

The qualitative research part comprising structured interviews with experts employed the inclusive criteria involving 3 respondents from each organization targeted were interviewed, thus having a total of 18 interviewees. The experts were sampled purposefully based on the organizations mandate to provide and deliver infrastructure in Zambia. This was undertaken to ensure the respondents who are qualified, experienced and facing the challenges of infrastructure development in Zambia can provide success factors, challenges and opportunities in urban infrastructure planning and tools or methods that could support sustainable urban integrated infrastructure development. Further, interviews allowed interviewees' to explain or help clarify questions, thereby increasing the likelihood of useful responses and collecting more information on details and new insights on their experience as practitioners in urban infrastructure planning, delivery and management.

Regarding the stratified sampling for the quantitative research part, organizations listed with Industrial Development Corporation (IDC) had an average of 130 infrastructure professionals for each organizations in the three categories of Chief Executive officer, Senior Management and Junior level Management. Having targeted 6 organizations, the total population amounts to 780. Applying greater than 5% of the population as a representative sample results into 39 respondents. One additional respondent was added to round off the figure to 40 and so increase the representativeness of the population. The profile of targeted respondents included 6 Chief executive officers (CEOs), 20 Senior Management, 8 Middle-level management and 6 Junior management level.

3.5 Methods of data collection and instruments

There are various methods of research available in use today and different types of research have different data gathering methods. These include using methods such as

interviews, participant observation, questionnaire survey, focus group discussions, narratives and case studies or histories through the use of quantitative or qualitative methods. The types of data collection methods and instruments for this research approach; combining both qualitative and quantitative, includes the use of instruments such as structured interviews as well as mailed and self-administered questionnaires.

3.5.1 Interviews

This is a data collection method involving oral questions to either individuals or groups but more often to individuals. According to Burns and Grove 2003), interviewing refers to structured or unstructured verbal communication between the researcher and the subject in which information is presented to the researcher. Each question is read out the response recorded on a standardized schedule, usually pre-coded answers. Structured interviews were used in this research to obtain answers to questions that required respondents to give detailed but yet extensive explanations. The interviews were conducted prior to the questionnaire survey. The interviews were aimed at obtaining preliminary data which would further enhance the questionnaire survey, as such the sample did not exceed 18 participants. The participants were selected to ensure that various viewpoints of the main stakeholders in infrastructure delivery were incorporated in the questionnaire survey as such the interviews targeted experts working for organizations mandated to planning, delivery and manage urban infrastructure in Zambia. The interviews were limited to participants within Lusaka, the capital city, due to the short time required to get preliminary data.

Advantages of interviews

- Usually yield rich data, details, new insights
- Permit face-to-face contact with respondents
- Permits clarification of questions, increasing the likelihood of useful responses
- Allow the interviewer to experience the effects as well as cognitive aspects of responses

Disadvantages of interviews

- the presence of the interviewer may influence responses

- personal interviews are costly in terms of time and money
- the danger of serious disparities is likely if more than one interviewer is used as it reduces the comparability of responses

3.5.2 Questionnaire survey

A questionnaire is any written instrument that presents respondents with a series of questions or statements to which they are to react either by writing out their answers or selecting from among existing answers (Brown, 2001). Interviewer administered questionnaires, as well as self-administered questionnaires, were used in this research relative to situational appropriateness.

The questionnaire survey was designed to have two parts. The first part aimed at collecting the respondent's attributes as well as the profile. Multiple questions were presented with respondents restricted to circle one choice for each question. The second part was aimed at establishing ingredients of integrated sustainable infrastructure development and find out methods and tools used to enhance urban infrastructure planning and delivery. The second part was categorized into key five factors for integrated urban design; methodology factor, institution factor, urban design and practices, policy factor and substantive factor (Batty, Dodge, Jiang, and Smith, 1998) and (Eggenberger and Partidario, 2000). Further, the questionnaire aimed at obtaining challenges in current urban infrastructure development in Zambia.

Advantages of Questionnaires

The Questionnaire was used because of the following advantages as cited in (Kothari, 2004).

- i. less expensive than interviews,
- ii. it allows for anonymity that could result in more honesty responses
- iii. it does not require research assistants questionnaires eliminate bias due to phrasing because questions are phrased and framed the same way for all respondents.
- iv. It ensures anonymity to its respondents, and so respondents have greater confidence that they will not be identified by anybody for giving a particular view or opinion.

- v. It allows greater validity of information because the responses given by the subjects are available in their own language and version thereby cannot be wrongly interpreted by the researcher.
- vi. It enables replies to be received quickly and so no need to visit respondents personally or continue the study over a long period of time.

Disadvantages

- i. Self-administered questionnaires cannot be used with illiterates
- ii. Low response rates may result as some respondents may decide to put the questionnaires in the rubbish bins as opposed to completing them
- iii. Questions may be misunderstood in the absence of the interviewer
- iv. Questionnaires are standardized so it is not possible to explain any points in the questions that participants might misinterpret
- v. open-ended questions can generate large amounts of data that can take a long time to process and analyze
- vi. It is difficult to know whether respondents are truly representative

3.6 Methods of data analysis

In general, data analysis refers to the computation of certain measures along with searching for patterns of relationship that exist among data-groups (Kothari, 2004). It consists of examining, categorizing, tabulating, testing or otherwise recombining both quantitative and qualitative evidence to address the initial propositions of study.

Thematic analysis was adopted for qualitative data collected in this research. This involved coding of similar and different content in the data collected (Vaismoradi, Jones, Turunen, and Snelgrove, 2016). Then challenges from interviewees' account highlight the descriptive level of data and the interpretation or inferred meaning is stated in the extracted code. Different types of codes are recognized in qualitative content analysis and thematic analysis. The type of codes adopted in this study include; "Conceptual code" which identifies key elements and dimensions of the study phenomenon; "relationship code" identifies links between elements and dimensions; "participant perspective code" identifies the participant's positive, negative, or indifference comments about a particular experience; "participant characteristic code"

and “setting code” shows the general characteristics of participants and the place in which the phenomenon has happened, respectively. The presentation took the form of tables, Microsoft excel and word were used to present the results collected during the field survey.

The quantitative data collected was analyzed using statistical methods. Using the 5 point Likert scale to measure and rate key factors of urban integrated infrastructure development, the rating scale used included: 5 – Strongly disagree, 4 – Disagree, 3 Unsure, 2 Agree and 1 Strongly Agree. The key ingredients to integrated urban infrastructure planning, delivery and management identified from the literature and confirmed during interviews were compiled and evaluated in the questionnaire survey. Further, the urban design process and software applications support were identified and evaluated in the questionnaire survey.

The data collected from the questionnaire survey was obtained and analyzed using the mean score (M) method. The mean score (M) for each factor was computed using the following formulae (Siegel and Castellan, 1988).

$$MS = \frac{\sum (f X_s)}{N} \dots\dots\dots \text{Equation 3-1}$$

Where $\sum = 1 \text{ to } 5$

MS = mean score

f = frequency of response to each rating (1-5) for each factor

s = score given to each factor by the respondents, ranging from 1 (Strongly Agree) to 5 (Strongly Disagree); and

N = Number of responses to that factor

In case of occurrence of a tie, the criterion for adoption was obtained based on the percentage of respondents strongly agreeing to the identified constraint.

3.7 Model development

The conceptual model for integrated urban infrastructure development was developed based on systems thinking theory developed in the 1950s. The model adopts the systems of systems viewpoint, where all role players in infrastructure development are

supposed to see the linkages and interactions between elements that comprise a whole infrastructure system (Ejigu, 2007).

Based on the research findings and data analysis, a model for planning, delivery and management of urban infrastructure was developed. The model was constructed with the aim of defining urban planning, delivery and management processes for infrastructure over the entire project life cycle. The model adopts a visual graphical method of demonstrating relationships between urban design process activities, software applications, information collaborations activities, sustainable aspects inputs, integrated infrastructure organization resources, outputs and outcomes. It could be used as a planning, delivery and management tool for infrastructure projects to conduct activities and information through the urban design process intended to produce specific and desirable results in the physical urban environment.

The information gathered through literature review, interviews and questionnaire surveys was analyzed to provide the basis for proposals to improve and effectively plan, delivery and management infrastructure projects through the use of a conceptual model. In preparing the urban integrated infrastructure model, the flow chart approach was found desirable as it is easy to understand and explain relationship, showing how steps in a process fit together. The outcome framework is a useful tool for communicating how the processes related to each other and for clearly documenting how a particular function is performed and fits in the overall framework.

3.8 Ethical considerations

According to (Caruana, 2015) there are ethical issues that one needs to consider when carrying out research such as this one. A lack of consideration for this may ultimately lead the researcher to face conflicting values and beliefs that may affect the objectivity of the researcher and ultimately the validity of the research process itself.

In order to address ethical considerations, the following measures were put in place during the study.

- a. Confidentiality and privacy

The participants in all surveys were assured of their privacy and anonymity. Throughout the study, the names of the respondents were not disclosed in accordance to

the assurance given at the data collection stage.

b. Use of appropriate language

The use of offensive, discriminatory or other unacceptable language was avoided. The questions in both the interview and questionnaire survey were constructed in an appropriate language.

c. Acknowledgements of works of other authors

All work of other authors was acknowledged and referenced appropriately.

d. Dissemination of findings.

All the findings of the research were disseminated objectively without concealing any information.

e. Maintenance of the highest level of objectivity

The information was gathered through literature review, interviews and the questionnaire

3.9 Summary

In this chapter, the methodology used to carry out the research has been presented and described how the results are to be used in designing the conceptual framework for integrated urban infrastructure development. It also described the characteristic of the research sample and the method of analysis that was employed.

The next chapter presents the research findings, data analysis and a discussion of the results. A proposed conceptual framework for integrated urban infrastructure development for Zambia is presented.

CHAPTER 4: RESEARCH FINDINGS, ANALYSIS AND DISCUSSION

4.1 Introduction

The previous chapter described the methodology adopted for carrying out the research and methods used to collect the data. This chapter presents the research findings and data analysis, then a proposed conceptual framework for integrated urban infrastructure development for Zambia is presented. Finally, a discussion of the research findings is presented.

4.2 Interview data and analysis

Structured interviews were conducted between March 2018 and July 2018. The interviews were preliminary in nature and 18 experts working for infrastructure organizations in Zambia were targeted. The interviewees were sampled purposefully to ensure that various views from stakeholders in government organizations and agencies mandated to provide critical infrastructure services were incorporated. One executive officer from each organization firm was targeted. The inclusion criteria used to establish that interviewees are experts was; firstly, academic qualifications in the fields relevant to infrastructure development. These include a bachelor's degree in architecture, civil engineering, town planning, transportation and logistics. Secondly, at least 10 years' experience in infrastructure development services. The purpose was to obtain an in-depth understanding of how various stakeholders in Zambia view, conduct and understand integrated approach to sustainable infrastructure planning, delivery and management. Despite the organizations and agencies targeted were national, the interviewees were based in the capital city, Lusaka.

The analysis of interview data was done by 'thematic classification' to enable in-depth comparison and classification of challenges and possible solutions to sustainable urban infrastructure planning, delivery and management among organizations/agencies in infrastructure provision.

4.2.1 Respondents profile

Out of 18 targeted professionals, 15 participated in the interviews. 3 interviewees couldn't make it for the interview due to other commitments. Out of the 15 interviewees

who participated, ten had over 15 years of experience in the organization, while five had between ten to 15 years of experience. It is noteworthy that all experts held management positions within their organizations. The profile of targeted respondents included 3 Chief executive Officers (CEOs), 3 Senior Management, 5 Middle-level management and 4 Junior management level. Out of these, 9 interviewees worked for public sector organizations and 6 worked for private sector organizations. The organizations and agencies targeted had a long history of involvement in urban infrastructure provision for over 20 years in Zambia. This provided an assurance of reasonable professional experience in the execution of public infrastructure projects.

4.2.2 Impact of integrated approaches to infrastructure development

The first objective of the interviews was to assess the impact of integrated approaches to urban infrastructure planning, delivery and management, whether or not there was an improvement in the delivery process compared to the use of traditional methods. The question was fairly broad and provided interviewees with the opportunity to begin their answer broadly and break it down towards a concise opinion.

Though some of the interviewees expressed concern that it was too early to notice the impact of integrated approaches to urban infrastructure development in Zambia, all respondents highlighted a number of ways in which the integrated approach to urban infrastructure development has great potential to the delivery of sustainable urban infrastructure. Interview responses on the impact of the integrated approaches were grouped in the following highlighted areas:

i. Improved levels of services – integrated approaches have improved the levels of services in urban infrastructure provisions through shared objectives.

ii. Economic benefits – integrated infrastructure projects have created more employment on a large scale since they integrate other range services related to infrastructure provisions such as; internet, food catering services, security and businesses.

iii. Increase infrastructure volumes – the efficient implementation within time, cost and desirable quality has resulted in an increase in the volumes of infrastructure delivery.

iv. Cost savings – The effective planning for financial resources through identifying synergies at planning stage among organizations and agencies, saved sums of money for rework on excavations and related works to infrastructure deliver.

Some interviewees stated that a framework that would help them integrate and evaluate their infrastructure development performance would have a great impact on the survival of the infrastructure organizations and well-being of the city. The framework would promote stronger coordination practices, capacity building, continuous knowledge sharing and improvement. Interviewees stated that the benefits of the integrated infrastructure development framework to infrastructure planning, delivery and management within organizations include:

- i. promotion of new concepts and ideas such as ‘systems thinking’ to understanding interdependencies to infrastructure;
- ii. enhancement of individual continuous professional development,
- iii. benchmarking of organization/agencies and the basis of comparing the organizations performance; and
- iv. development of workable methods to sort out shared drawing preparations problems through software usage applications such as AutoCAD, Google Earth©, ArchGIS©

However, some interviewees argued that the Zambian infrastructure organizations were not yet ready for integrated approaches of planning, delivery and management of infrastructure because of the existing gap between country’s developmental standing and that of the world at large.

4.2.3 Integrated infrastructure development processes

The second objective of the questions was to find out the ingredients and processes that could enhance integrated urban infrastructure approaches. The responses varied widely and were grouped into five key factors for urban infrastructure identified from the literature review in Chapter 2. The key factors include methodology factor, urban design principles and practices, policy factor, institutional factor and substantive factor.

i. Methodological factor

The questions of methodological factors of integrated infrastructure development explored the integration of tools and software applications that could enhance the understanding of the complexity of infrastructure planning, delivery and management. All the interviewees confirmed that software applications were an important ingredient for urban success planning and sustainability. Despite having a variety of software applications for infrastructure planning, challenges of effective information sharing among organizations increased due to non-compatibility of the software applications. Eight of interviewees indicated that their organizations used tools such as Computer-Aided Design (CAD), while four interviewees indicated that they use Geographical Information Systems (GIS) and Building Information Modelling (BIM). The interviewees were not aware of software applications that could be used to integrate planning for urban infrastructure that is compatible with other organizations except their own organizations.

ii. Policy integration factor

As was the case with methodological factors, the interviewees confirmed that policy factors integration is an important ingredient that enables efficient delivery and disciplined infrastructure delivery.

iii. Design principles and practices factor

Questions on the benefits of design principles and practices in integrated urban infrastructure development were asked. The responses were put in common groups highlighting the benefits. Interviewees agreed that the ingredients regarding design principles and practices in urban are: enhanced accountability, reduced project delivery time, cost savings, economic benefits, innovation, budget and risk-sharing.

iv. Institutional factors

Some interviewees stated that institutional or organizational factors are key drivers to the success of urban infrastructure integration framework for urban areas. Interviewees stated that institutional factors provide adequate collaborative behaviour to promote sustainability principles. Also, the attainment of shared objectives could improve among infrastructure organizations/agencies due to the sharing of information relevant among organizations and agencies in urban infrastructure service delivered.

v. Substantive factor

The respondents stated that a lack of co-ordination at the planning stage of infrastructure among organizations leads to rework, disruption and damage of urban infrastructure. All the experts confirmed that integrated approaches to infrastructure development could positively contribute to the delivery of infrastructure project duration and reduction of project cost-overruns in urban areas.

4.2.4 Challenges to the implementation of integrated approaches in Zambia

Third and final objective of the questions were aimed at obtaining the challenges affecting the implementation of integrated approaches in urban areas of Zambia were posed. Table 4–1 presents responses that highlight the challenges (interviewees account) with their possible solutions and key success factor so as to enhance decision making in urban infrastructure planning, delivery and management.

Table 4-1: Summary of interview responses

<u>S/No</u>	<u>Type of Code</u>	<u>Challenge (interviewees' account)</u>	<u>Extracted code</u>	<u>Possible solution and key factor</u>
1.	Conceptual code	Infrastructure information is crucial to developers of infrastructure because it highlights the critical information, such as the right cable or conduit size, location and depth to lay new infrastructure cables.	Organizations lack infrastructure information from other organizations and agencies undertaking infrastructure development.	Develop policies that guide and regulate information sharing among organizations. Key factor: Policy factor.
2.	Participant perspective code	Methods to integrate this information are not well documented to be followed by practitioners and yield sustainable results.	Lack of appropriate legislation to engage critical organizations in the early stages of an infrastructure projects.	There is need to involve all organizations in infrastructure provision from early stages of infrastructure projects. Key factors: Methodology, principles and practices factors.
3.	Conceptual code	Procedures and processes seem scattered and are not religiously followed by all organizations delivering infrastructures and improved regularly	Lack of practical collaborative behaviour among organizations in infrastructure development.	There is need to integrate infrastructure planning, delivery and management guidelines and procedures for organizations. Key factor: Urban design principles and practices.

4.	Experts perspective code	Underground electrical cables, water/sewer lines and telecommunications are punctured or ripped by excavations due to poor coordination of shared objectives to deliver infrastructure without harming other infrastructures.		Developing the capacity in methodologies that assist integrate planning procedures among organizations in infrastructure development. Key factor: Policy and methodology factors.
5.	Setting code	Software applications such as AutoCAD, IBM and GIS would assist several infrastructure organization see other infrastructures off the computer screen easily and make a decision of undertaking new infrastructure in any given location	Absence of shared value and revenue sharing formulae	There is need to simplify methodologies for planning through software applications that can integrate a variety of organizations' needs. Key factors: Methodologies and Institutional factors.
6.	Experts characteristic code	Poorly coordinated site investigations before new infrastructure excavations commence, but waiting for other organizations/agencies results in delay in project time delivery and hence project budget overruns	Inconsistent of application evaluation tools such as cost benefit analysis for all organizations at an early stages of infrastructure planning	There is need to integrate and coordinate organizations early in an infrastructure project. Key factor: Principles and practices.

7.	Experts perspective code	Silo based policies that have set-up individual organizations have rigid procedures to share or receive important infrastructure information with other organizations	Lack of shared success objectives in infrastructure development.	There is need to ease information sharing among organizations. Key factors: Policies and Methodologies.
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The summary of challenges affecting the implementation of integrated urban infrastructure development include: organizations lack of infrastructure information from other organizations and agencies undertaking infrastructure development, lack of practical collaborative behaviour among organizations in infrastructure development, inconsistent collaboration when setting urban infrastructure objectives, lack of appropriate legislation to engage critical organizations in the early stages of infrastructure projects, absence of shared value and revenue sharing formulae and inconsistent application of evaluation tools such as cost-benefit analysis for all organizations at an early stage of infrastructure planning.

4.3 Questionnaire Survey

4.3.1 Profile of respondents

Respondents from organizations and agencies listed on the (IDC) which provide critical urban infrastructure; railways, roads, water and sewerage, telecommunication and electricity. The data obtained indicate that 3 were Chief executive Officers (CEOs), 22 Senior Management, 10 Middle-level management and 6 Junior management level. The respondents’ years of experience in infrastructure development ranging from 0 to 10 years with over 50 per cent having had more than 5 years of experience. The level of exposure and experience exhibited by the respondents suggested that a fairly high degree of reliability could be derived from the study findings.

4.3.2 Statistical analysis

The questionnaire was aimed at establishing common ingredients to the key factors of integrated infrastructure development; methodology, institutional, principles and practices, policy and substantive factors identified from the literature and confirmed during interviews were compiled and evaluated in the questionnaire survey. The number of questionnaires distributed was 40 (100%) rate, 36 (90%) questionnaires were received. Then, 1 (3%) questionnaire was spoilt, and 3 (7%) of the questionnaires were not received. The sample was representative of organizations providing infrastructure in Zambia.

The characterization and ranking of the ingredients were obtained using the mean score (MS). To determine the ranking for each indicator using the five-point Likert scale, one (1) was assigned strongly agree and five (5) was 'Strongly disagree'. The factor rankings were then arranged in descending order of importance. The formulae for calculating the mean score is stated in Equation 3-1 on page 52.

The Mann Whitney U test, generating p values, was used to determine whether or not there was a significant difference between the mean ranks for the ingredients to integrated infrastructure development. A p -value lower than 0.05 showed that there was a difference in perceptions among the organizations' respondents regarding the identified key factors (Siegel and Castellan, 1988).

4.3.3 Ingredients of urban integrated infrastructure development

The respondents were asked to rate the possible ingredients of integrated urban infrastructure development on a Likert scale of 1 to 5. A total of 22 ingredients obtained from the literature review and preliminary interviews was adopted for this study. The ingredients to the key factors of integrated infrastructure development obtained from the literature review and confirmed in the interview was distributed as follows: nine ingredients for principles and practices factors, four ingredients for methodological factors, two for policy factor, four for institutional factor and three for a substantive factor. The list was as presented in Annexure 2. The descriptive statistics for the different ingredients of integrated urban infrastructure development are presented in Table 4-2.

Table 4-2: Descriptive statistics of integrated urban infrastructure development

S/N	Key factor	Indicator(s)	MEAN SCORE	VARIANCE	P Value
1.	Design principles and processes factor	1. Working without urban design principles in a city erodes organization infrastructure development performances	1.944	1.254	0.026
		2. Practicing urban infrastructure design in an environment without integrated guidelines forces stakeholders to act according to what is best for them than what is best for the whole city	2.056	1.254	0.020
		3. Collaboration is a key enabler which is supposed to be embraced between organizations	1.833	1.114	0.033
		4. Promoting practices and principles that encourage organizations to coordinate which leads to a willingness to adopt a coordinative behavior	1.886	0.987	0.00001
		5. Lack of communication among organizations in infrastructure development hinders opportunities for innovation	1.889	1.187	0.030
		6. Having key organizations operate as equals, is essential to urban infrastructure development	2.417	1.450	0.007
		7. Guidelines with defined relationships among key stakeholders to infrastructure supports coordination and consensus-based decisions.	2.028	0.999	0.02

		8. Concepts and ideas such as ‘systems thinking’ and synergy concepts assists to understand interdependencies of infrastructure	2.083	0.936	0.019
		9. A lack of local sustainable design concepts hinders adherence to implementation of international and regional sustainable principles in infrastructure development	2.028	1.171	0.023
2.	Methodological factor	1. The use of Geographical Information Systems (GIS) can coordinate infrastructure plans more effectively	1.806	0.961	0.030
		2. The use of GIS can help gain more time by enhancing collaboration and information sharing	1.833	1.000	0.033
		3. Building Information Modeling (BIM) can increase opportunities for alternative sustainable designs among infrastructure agencies/organizations	1.861	1.037	0.031
		4. A variety of software applications and tools used to develop and represent infrastructure has increased the lack of developing integrated infrastructure maps	2.5	1.800	0.006
3.	Policy integration factor	1. Guidelines or policies having mechanisms for coordination among infrastructure	2.556	1.797	0.005

		organizations enables efficiency and audit of infrastructure			
		2. Variety of organizational cultural values has increased isolation of infrastructure development policies	3.500	1.171	0.0002
4.	Institutional factor	1. Intensified integrated planning among organizations before construction increases the chances of objectives success for infrastructure provision	2.028	0.999	0.023
		2. Attainment of shared objectives improves among infrastructure organizations/institutions due to inter-dependent nature of infrastructure	2.111	1.016	0.017
		3. Working together among infrastructure agencies/organizations at planning stages offers greater chances for innovative solutions	1.889	0.959	0.03
		4. Agencies/institutions infrastructure budgets and spending habits improves with constant planning engagements with other agencies/institutions	2.056	1.083	0.02
5.	Substantive factor	1. Lack of coordination among agencies/organizations leads to duplication of infrastructure activities	2.167	1.571	0.015
		2. Public health problems increase without careful and joint	2.028	1.056	0.03

		development of objectives and goals			
		3. A framework for urban development with urban infrastructure design principles at city level can deliver infrastructure development successfully in the Zambian construction industry.	1.611	0.587	0.045

4.3.4 Analysis of design principles and practice ingredients

Nine ingredients for design principles and practices ranked by the respondents were compared. The ingredients were later evaluated to determine their relative importance as perceived by the public and private sector respondents in urban infrastructure development of Zambia. Factors with MS values less than 3.500 were considered to be significant. This was based on the interpretation that the factors had an over 75 per cent chance of success in infrastructure project delivery. For this reason, MS values less more than 3.500 were eliminated. All nine ingredients remained on the list.

The results in Figure 4-2 indicate that success ingredients for design principles and practices of urban infrastructure delivery projects in Zambia were: working without urban design principles in a city erodes organization infrastructure development performances, practising urban infrastructure design in an environment without integrated guidelines forces stakeholders to act according to what is best for them than what is best for the whole city, collaboration is a key enabler which is supposed to be embraced between organizations, promoting practices and principles that encourage organizations to coordinate which leads to a willingness to adopt a coordinative behaviour, having key organizations operate as equals is essential to urban infrastructure development, guidelines with defined relationships among key stakeholders to infrastructures supports coordination and consensus-based decisions, concepts and ideas such as ‘systems thinking’ and synergy concepts assists to understand

interdependencies of infrastructure and lack of local sustainable design concepts hinder adherence to the implementation of international and regional sustainable principles in infrastructure development. It was established that all 9 ingredients were statistically significant at $p < 0.05$. The statistical results are presented in Table 4-2.

4.3.5 Analysis of methodological ingredients

The ranked ingredients for Methodology factor by respondents were compared. The ingredients were evaluated to determine their relative importance as perceived by the public and private sector respondents in urban infrastructure development of Zambia. Methodology ingredients with MS values less than 3.500 were considered to be significant. All the four ingredients remained on the list. The results in Figure 4-2 indicate that success ingredients for methodology factor for urban infrastructure delivery in Zambia were: the use of Geographical Information Systems (GIS) can coordinate infrastructure plans more effectively, the use of GIS can help gain more time by enhancing collaboration and information sharing, Building Information Modeling (BIM) can increase opportunities for alternative sustainable designs among infrastructure agencies/organizations and a variety of software applications and tools used to develop and represent infrastructure has increased the lack of developing integrated infrastructure maps. It was established that all 4 ingredients were statistically significant at $p < 0.05$. The statistical results are presented in Table 4-2.

4.3.6 Analysis of policy ingredients

Two ingredients for policy factor in urban infrastructure development by respondents were compared. Policy ingredients were MS values greater than 3.500 were considered to be significant. It was established that 1 out of the 2 indicators was found to have a mean score of less than 3.50 and this was considered to be significant. This was based on the interpretation that the indicator had an over 75 per cent chance of success in infrastructure project delivery. For this reason, ingredients with MS value more than 3.50 were eliminated. The statistical results are presented in Table 4-2.

4.3.7 Analysis of institutional ingredients

The four ingredients for Institutional factor in urban infrastructure development by

respondents from the public and private sectors were compared. The ingredients were evaluated to determine their relative importance as perceived by the respondents in the public and private sectors. It was established that all the four ingredients were found to have a mean score of less than 3.50 and this was considered to be significant. All the four ingredients remained on the list.

The results in Figure 4-2 indicate that success ingredients for the institutional factor of urban infrastructure delivery projects in Zambia were: intensified integrated planning among organizations before construction increases the chances of objectives success for infrastructure provision, attainment of shared objectives improves among infrastructure organizations and agencies due to the inter-dependent nature of infrastructure, working together among infrastructure organizations and agencies at planning stages offers greater chances for innovative solutions and organizations and agencies infrastructure budgets and spending habits improves with constant planning engagements with other organizations. It was established that all four ingredients were statistically significant at $p < 0.05$. The statistical test results are presented in Table 4-2.

4.3.8 Analysis of substantive ingredients

The three ranked ingredients for Substantive factor by respondents were compared. The ingredients were evaluated to determine their relative importance as perceived by the respondents in the urban infrastructure development of Zambia. It was established that all the three ingredients were found to have a mean score of less than 3.50 and this was considered to be significant. All the four ingredients remained on the list.

The results in Figure 4-2 indicate that ingredients for substantive factor in urban infrastructure development in Zambia were: a lack of effective coordination among organizations and agencies in infrastructure delivery leads to duplication of infrastructure activities, public health problems increase without careful and joint infrastructure development of objectives and goals and finally a framework for urban development with urban infrastructure design principles at the city level can deliver infrastructure development successfully in the Zambian construction industry. It was

established that all three ingredients were statistically significant at $p < 0.05$. The statistical results are presented in Table 4-2.

4.4 Interpretations of the findings

The data from the interviews and questionnaire survey were analyzed. Using structured interviews and questionnaire survey on key ingredients of urban infrastructure key ingredients was established. The key ingredients were grouped into five categories which are: methodology, policy ingredients, urban principles and practices, institutional and substantive ingredients for integrated infrastructure planning, delivery and management for Zambia.

i. Methodology ingredients

The Computer-Aided Design (CAD), Geographical Information System (GIS) and Building Information Modelling software applications were considered to be significant to urban infrastructure planning, delivery and management in Zambia. Although these software applications are used in individual organizations for a specific service such as water supply networks, they have the potential to integrate more information from other infrastructure organizations. (Batty, Dodge, Jiang, and Smith, 1998) noted that the opportunities provided by computer technology software applications have not been fully utilized in the urban infrastructure design process.

The software applications have been used as inputs to the proposed framework for integrated urban infrastructure development for Zambia.

ii. Urban design principles and practices

The benefits of innovation, budget and risk sharing, economic benefits, sustainable practices were unique to urban design principles and practices in urban infrastructure planning, delivery and management. Further, guidelines and practices with defined relationships among key stakeholders to infrastructure development support coordination and consensus-based decisions. Sarabi, Han, Romme, De-Vries, and Laura (2019) noted that the prevailing regulations have been developed from single sector infrastructure as the main, or only available, option to address given urban infrastructure challenges, thereby restricting integrated innovations to infrastructure

development. Results show strong acceptance to concepts and ideas of ‘systems thinking’ and synergy concepts employed in urban design processes could enhance the understanding of the interdependent nature of infrastructure development.

iii. Policy ingredients

The strong agreement to policy factor as a key enabler to infrastructure development tends to show the appreciation of discipline and accountability among organizations carrying out infrastructure development in urban areas. The key ingredient to policy factor is to have policies with mechanisms for coordination with other infrastructure organizations which enables efficiency and audit of infrastructure development in urban areas. This is further necessitated by feedback loops to ensure policies address current infrastructure problems and future needs. According to Head (2008), very rarely are organizations or agencies providing infrastructure looking at developing policies that enable the integration of policies and procedures for efficient urban infrastructure delivery.

iv. Intuitional ingredients

The attainment of shared objectives in urban infrastructure development improves among infrastructure organizations and agencies due to the inter-dependent nature of infrastructure. However, organizations and agencies need to clearly clarify the duties and responsibilities of personnel within departments of the organization so that the overall input and role of any organization in the urban infrastructure development is known. This offers greater chances for innovative solutions to infrastructure development and organizations/agencies infrastructure budgets and spending habits improves with the common objective and constant planning engagements with other organizations.

v. Substantive ingredients

The lack of effective coordination among organizations and agencies in infrastructure delivery leads to duplication of infrastructure activities such as excavation works for underground cable installation. This is attributed to a lack of integrated coordination at the planning stage for urban infrastructure. It was noted by Blizzard (2011) that almost all infrastructure planning and delivery were either individual field design or remained

largely uncoordinated and its own guidelines unclear. The urban infrastructure development can be managed effectively if integrated planning is conducted through the urban design process and it is coordinated with among organizations while maintaining their individualities.

These key ingredients were used as inputs to the proposed conceptual framework for integrated urban infrastructure development.

4.5 Integrated framework for planning, delivery and management of urban infrastructure development for Zambia

The results from the qualitative approach and quantitative approach presented in this study, are used in proposing the conceptual framework for integrated urban infrastructure development in Zambia. The framework development was based on the need for a tool that is workable and adaptable to sustainable urban infrastructure development. The proposed framework utilized the policy direction of the 7NDP of Zambia that calls for tackling infrastructure development through integrated approaches among all sectors implementing infrastructure projects.

4.5.1 Development of the urban infrastructure framework

The proposed integrated urban infrastructure framework was based on systems thinking theory developed in the 1950s. One of the core challenges to the systems thinking approach in integrated urban infrastructure planning approaches is the lack of recognizing the role played by different organizations involved in urban infrastructure development. The framework developed in this study proposes to express the essential features of organizational role in the urban design process and software applications support in integrated urban infrastructure planning, delivery and management process in Zambia.

The urban design process framework developed by Batty, Dodge, Jiang, and Smith (1998) for carrying out planning and implementation of urban infrastructure development places emphasis on showing how computer technologies and software could support the planning, delivery and management of infrastructure in sequence with the urban design process. Finally, it highlights the relevance of incorporating

critical information obtained from social, economic, functional, behavioural and environmental factors. However, there is no well-defined process of synthesizing these requirements into a whole infrastructure system.

Another framework developed by Hawkesworth (2015) relies upon the engagement of a wide selection of stakeholders into the urban design processes to enable them to understand infrastructure development as a whole infrastructure system of the urban built environment. Generically, it involves identifying infrastructure organizations for collaboration and coordination on one side and on the other side, develop interdependency planning and management practice through the urban design process, in a context-dependent on the development learning process. However, it does not highlight how the integration of computer information technologies and software applications could be integrated into the urban design infrastructure system. Further, key sustainable categories; economic, social and environment have not been given consideration within the frameworks, making it difficult for stakeholders to appreciate the outcomes.

While there are shortcomings, it is also important to appreciate the frameworks developed by Hawskeworth (2015) and Batty, Dodge, Jiang, and Smith (1998), as they have provided basic guidelines and processes in the delivery of urban design development processes.

The foregoing issues constitute the missing links in the integrated urban infrastructure design frameworks. The proposed urban infrastructure framework for Zambia was intended to fill the gap of missing areas. The proposed framework consists of the identified additions besides the generic one as depicted in Figure 4-3.

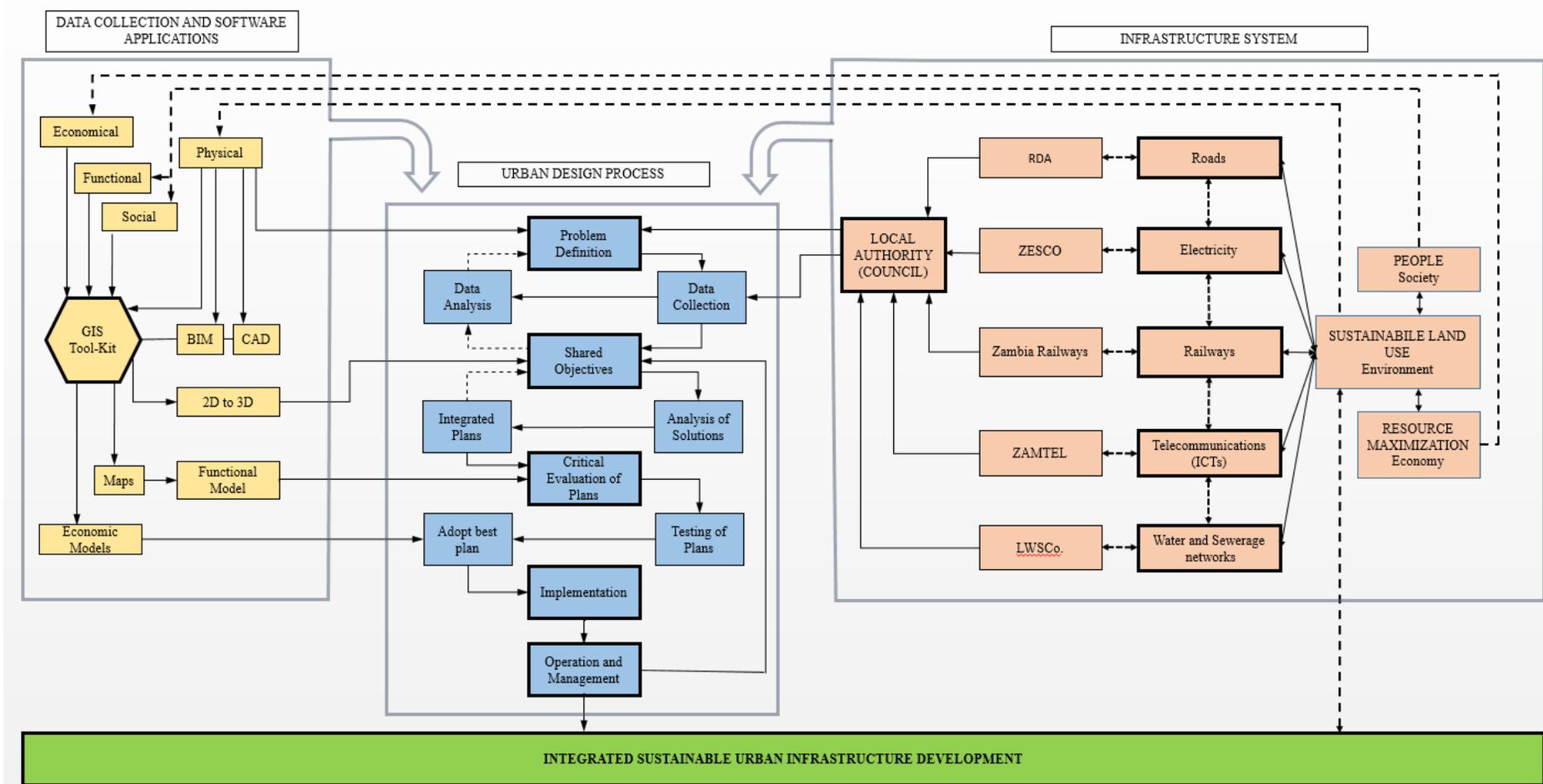


Figure 4-1: Proposed conceptual framework for integrated urban infrastructure development for Zambia

4.5.2 Processes in the proposed conceptual framework

1. Urban Design Process

The design process for infrastructure development shall be a continuous process of planning, delivering and managing infrastructure within spaces and places for people, thereby creating sustainable cities. Therefore, there's an urgent need for municipalities to build and other implementing agencies so as to facilitate integrate infrastructure service delivery. The urban infrastructure development design process stages include: problem definition, shared objectives, critical evaluation of plans, implementation, operation and management.

i. Problem definition

This is when decision-makers define the problem and appraise the situation. During this stage, organizations are assembled, the project site and its context are assessed through data collection. This is carried should be carried out in a variety of ways such as physical features from software applications, site survey, valuation of surrounding areas and spaces dimensions of wayleaves.

ii. Shared objectives

Here decision-makers are designing objectives that will cater for all stakeholders. There is need to integrate and coordinate organizations early in infrastructure development stages. Data from the variety objectives received from organizations is further analyzed and integrated plans are generated. The integrated plan should be checked whether it meets the objective. To enhance decision making among shared objectives and prepared integrated plans, 2D and 3D maps or models should come from a GIS tool kit.

iii. Critical evaluation of adopted plan

The integrated urban infrastructure plan should be critically evaluated. This will enable decision-makers to improve infrastructure service delivery at all levels. This option should be tested before the best plan is adopted. This should be carried out with consultation from all stakeholders and support information for decision making should be obtained from economic models generated by GIS Tool-Kit. The economic model should provide guidance on the economic benefits to the public that infrastructure will prove.

iv. Implementation

At this stage, the decision-makers implement the selected option plan through the construction process. Once the infrastructure is built, it should be monitored and managed during the operational period. During this period, the infrastructure should be checked with a feedback loop to meet shared objectives within the urban infrastructure design process.

2. Urban design data collection and software applications

The integrated urban infrastructure development frameworks should establish a system that would effectively support infrastructure decision making by urban practitioners through the urban design process. This system should be focused on integrating a variety of information for infrastructure into software applications that should be easy to be used by all stakeholders.

i. Inputs

Information about infrastructure in an urban infrastructure system is received from infrastructure systems and clustered into economic, social, physical and functional information of data collection and software support applications.

ii. Analysis software

The GIS software stores, manipulate and analyze physical, social, functional and economic data of the city. Urban practitioners can then use the spatial query and mapping functions of GIS to analyze the existing infrastructure situation in the city. Through map overlay analysis, GIS can help to identify areas of conflict of land development with the environment.

The BIM software should enable urban practitioner's assess and manage buildings contained in urban areas. The objective of this system is to model the real world and present the entirety of infrastructure into the design process for decision making. This integrated information should include data about specific territories and individual buildings in the city so that the presented information makes it easy to plan, deliver and manage urban infrastructure.

Whereas the computer-aided design (CAD) presents 2d or 3d capabilities added to GIS thereby capturing essential information that aims at supporting the decision process through visual 3ds.

iii. Output

The 2D or 3D models, maps and functional models to support shared objectives, integrated plans and adopting the best plans accordingly.

3. Infrastructure system

i. Organizations

The identified organizations carrying out critical infrastructure development in urban areas should share benefits by combining knowledge, skills and physical assets. Further, ease access to information and failed approaches to infrastructure delivery are exchanged. Organizations use collaborations to expand and improve their core competencies.

ii. Integrated infrastructure

The critical infrastructure identified; railway, roads, telecommunications, water and sewer networks should be planned, delivered and managed successfully with each given consideration within parameters of universal access, connect competitive places, ecological modernizations and new self-sufficiency (Cirolia and Rode, 2019).

iii. Sustainable category

The sustainability categories; society, environment and economy in an infrastructure system should consider relationships between sustainability outcomes in planning, delivery and management of infrastructure. The information is collected and is fed into software applications for easy presentation and comparison.

iv. Integrator

The local authority takes the lead role as an integrator of organizations in infrastructure planning, delivery and management. They also take the lead in proposing innovative solutions for their cities. The role as system integrator is to exploit the technological capabilities which reside in other firms and use them to deliver, finance, maintain and support other infrastructure within the infrastructure system.

4.6 Discussion

In the problem formulation of this study, it was noted that if the new urban infrastructure is not built to match the increasing urban population, failures due to high demands in power supply, inadequate water/sewer services and lack of proper transportation problems could occur more frequently resulting in loss of revenue, low economic growth and low productivity in cities. Based on the applications and interpretations that integrated approach to infrastructure development, opportunities through the establishment of key factors that enable sustainable urban infrastructure planning, delivery, management in urban cities become alive.

4.6.1 Benefits of integrated urban infrastructure development

The findings of the interviews in Section 4.2.3 showed that integrated approaches improve the levels of services in urban infrastructure provisions through shared objectives. The findings of this study tend to agree to the assertion that, collaborative planning to infrastructure development generates commitment to commonly accepted objectives and goals, thereby fostering focused behaviour to improved infrastructure delivery services (Margerum, 2002).

While a strong case for infrastructure development is clear, there is a danger that poorly planned and built infrastructure will be a hazard to society especially due to increased service demand on existing infrastructure resulting from urbanization and natural disaster events occur (Pant, Thacker, and Hall, 2017).

Infrastructure continues to be the foundation upon which prosperous economies and societies are built and function (iBUILD, 2018). Recent studies have claimed that integrated practices in infrastructure development throughout the life cycle of infrastructure, minimizes loss of capital investments in infrastructure, cost and time overruns in infrastructure development (McLean, 2017). This viewpoint seems to agree with the findings of this study in which economic benefits were identified from integrated infrastructure projects that employ human labour on a large scale since they require a wide range of services such as internet connectivity, food catering services, security and transport services.

This supports the notion pointed out by Schinale, Schneidmesser and Dorre, (2015), where they assert that the success of urban infrastructure development could be obtained by allowing efficient integrated planning and delivery approaches that tend to significantly reduce rework of implemented projects, thereby assure value for money from infrastructure investments. Promoting practices and principles that encourage organizations to coordinate, lead to a willingness to adopt a coordinative behaviour in the delivery of infrastructure services. The results tend to agree more with the assertions of (Pant, Thacker, and Hall, 2017) in which similarities to service flows that occur in coordination between different infrastructure, tend to reinforce the functional dependencies between physical and social behaviour in urban infrastructure development.

4.6.2 Factors and ingredients of urban infrastructure development

The findings in Section 4.3 shows that the ability to monitor and evaluate integrated urban infrastructure planning, delivery and management performance of a city is critical for its long-term success. The success factors and ingredients are therefore required so as to assess progress, devise improvements and compare one's own situation to that of a different organizations strategy for successful sustainable urban infrastructure development (Abdulgader and Aina, 2005).

The Zambian organizations and agencies mandated to provide urban infrastructure were identified on the need to propose a conceptual integrated urban infrastructure development framework for planning, delivery and management of urban infrastructure. These factors include urban planning and practices, methodology factors, substantive factors, institutional factors and substantive factors. Studies by other scholars have however shown that planning and implementation of urban infrastructure development places emphasis on methodology factor which shows how computer technologies and software can be able to show value in the planning, delivery and management of infrastructure in sequence with the urban design process. It is also important to make sure the activities are aligned with the shared objectives and urban principles and practices to improve the urban challenges innovatively (Radu and Popescul, 2016)

Collaborative planning to infrastructure development is being advocated for by planning academics and practitioners as a new paradigm for planning practice, because of the value created to commonly accepted objectives and goals (Margerum, 2002). However, the interrelations and collaborations among infrastructure organizations could potentially increase the risk of infrastructure failure due to fragmented or separated infrastructure development cause confusion about who is the owner, who should operate and maintain the infrastructure in the long-term as the infrastructure system increases in complexity (Zimmerman and Restrepo, 2006). The framework proposed in this study provides a linkage between the effective collaboration through computer technologies tools and infrastructure system which includes organizations integrated into the urban design process. This was based on the understanding that it is the infrastructure system that highlights the field or infrastructure sector regarding integrated planning, delivery and management for urban infrastructure.

4.7 Summary of the chapter

The chapter presented the research findings of the study in line with the objectives. The integrated urban framework was presented in this chapter. The key factors of urban infrastructure development which include; methodology factors, urban principles and practices factors, policy factors, institutional factor and substantive factors, key ingredients to the factors were established. The discussion of the research findings in comparison to other scholars was presented. The next chapter presents conclusions, limitations, and recommendations of the study.

CHAPTER 5: CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1 Introduction

In the previous chapter, an integrated sustainable urban infrastructure framework was developed and described data collection and analysis. The discussion of the findings of this research in relation to what other scholars have established was presented too. In addition, the conceptual framework was developed and validated. This chapter highlights the conclusions drawn from the analysis of results from the questionnaire survey, structured interviews and the framework validation exercise. Then limitations regarding the study and opportunities for further research are presented. Finally, recommendations directed at improving infrastructure planning, delivery and management of urban infrastructure development are stated.

5.2 Conclusions

The objectives of the study were met successfully. Through this study, the benefits of integrated sustainable urban infrastructure development were established. It was established that the infrastructure planning and delivery organizations were not yet ready for integrated approaches of planning, delivery and management of infrastructure because of the existing gap between country's developmental standing and that of the world at large. It was also noted that despite the presence of approaches and systems including those in 7NDP for guiding the development of urban infrastructure, they appear not to integrate planning, delivery and management of infrastructure development. Hence the Zambian Government embarked on structural reforms such as integrated approaches development across development sectors of the country to enhance infrastructure project planning and delivery.

Challenges to integrated sustainable urban infrastructure development were identified. The study established that organizations lack of infrastructure information from other organizations and agencies undertaking infrastructure development, lack of practical collaborative behaviour among organizations in infrastructure development, inconsistent collaboration when setting urban infrastructure objectives, lack of appropriate legislation to engage critical organizations in the early stages of

infrastructure projects, absence of shared value and revenue sharing formulae and inconsistent application of evaluation tools such as cost-benefit analysis for all organizations at an early stage of infrastructure planning.

Using the key success factors of integrated urban infrastructure development: methodology, institutional, policy, principles and practices and substantive factors, the ingredients for integrated sustainable urban infrastructure development were identified.

The key ingredients of Methodological factor were identified. These include:

- i. the use of Geographical Information Systems (GIS) can coordinate infrastructure plans more effectively,
- ii. the use of GIS can help gain more time by enhancing collaboration and information sharing,
- iii. Building Information Modeling (BIM) can increase opportunities for alternative sustainable designs among infrastructure agencies/organizations; and
- iv. variety of software applications and tools used to develop and represent infrastructure has increased the lack of developing integrated infrastructure maps.

On the other hand, the ingredients of urban design practices and principles that were identified include among others:

- i. collaboration is a key enabler which is supposed to be embraced among organizations,
- ii. promoting practices and principles that encourage organizations to coordinate which leads to a willingness to adopt a coordinative behaviour,
- iii. having key organizations operate as equals is essential to urban infrastructure development,
- iv. concepts and ideas such as ‘systems thinking’ and synergy concepts assist to understand interdependencies of infrastructure; and
- v. lack of local sustainable design concepts hinders adherence to implementation of the international and regional sustainable principle

The ingredient for policy factor was identified to policies with mechanisms for coordination with other infrastructure organizations which enables efficiency and audit of infrastructure development in urban areas.

The key ingredients for institutional factor were identified to include:

- i. intensified integrated planning among organizations before construction increases the chances of objectives success for infrastructure development,
- ii. attainment of shared urban infrastructure objectives among organizations improves organizations performance,
- iii. working together among infrastructure organizations and agencies at planning stages offers greater chances for innovative solutions; and
- iv. infrastructure budgets and spending habits improves with constant planning engagements with other organizations.

On the other hand, the ingredients of substantive factor that were identified include:

- i. urban development carried out with urban infrastructure design principles at the city level can deliver infrastructure development successfully in the Zambian construction industry.
- ii. public health problems increase without careful and joint infrastructure development of objectives and goals, and
- iii. ineffective coordination among organizations and agencies in infrastructure delivery leads to duplication of infrastructure activities,

The conceptual integrated sustainable urban infrastructure development framework was developed based on the survey result, integrated urban design process (Batty, Dodge, Jiang, and Smith, 1998). The purpose and operations of the framework were also prescribed. The functionality and usefulness of framework were validated by the shortcomings identified in urban infrastructure design process frameworks ([Hawskeworth, 2015], [Batty, Dodge, Jiang, and Smith, 1998] and [Munasinghe, in Pearce, 1999]). It was deduced from validation that the conceptual framework for integrated urban infrastructure development would help improve the effectiveness and efficiency in infrastructure planning, delivery and management in Zambia.

5.3 Limitations

This study should be considered with some limitations as it focused on urban infrastructure development at the urban level. Although it has been designed for the effective delivery of planning, delivery and management and improves the quality of communication between the public and the urban design professionals, the integrated urban infrastructure development framework has several limitations.

The first limitation is the types of drawing software required for exchange and support of for urban design process. Although the drawing computer software's types as constructed for this research enhances the flow of information for urban design, the computer drawing software does not support all the information exchange required for the collaborative infrastructure urban design process. Figure 4-3 shows the types of computer drawing software used by the proposed integrated sustainable infrastructure development framework for his research.

The second limitation is the technical limitation of the integrated urban sustainable infrastructure development framework proposed in this study is the way that the integrator organization is represented within the urban infrastructure system. Different urban infrastructure projects could have different integrators or lead organizations might have other challenges that are different from the ones highlighted in this study.

Furthermore, the proposed integrated sustainable infrastructure framework presents casual relationships between urban design process, computer software presentation and infrastructure system and that of anticipated integrated sustainable infrastructure development outcomes. The framework does not take the place of performance indicators within an integrated infrastructure development context. Relevant performance indicators or criteria must be developed for each infrastructure project.

5.4 Contributions to the research

Through the study, the integrated urban sustainable infrastructure development key factors, processes, tools and methods used in integrated sustainable infrastructure planning, delivery and management among organizations identified. The ingredients to enhance the planning, delivery and management of urban infrastructure development among organizations were established.

A conceptual that integrates urban infrastructure planning, delivery and management among organizations was developed through this study. In particular, three key spheres were integrated in the integrated urban infrastructure development conceptual framework. The categories include the integrated urban infrastructure design process, computer support software applications and infrastructure systems. The study established that it is possible to optimize the urban design process, computer software application and infrastructure system for sustainable urban development. This new-found knowledge opens the frontiers of enhanced performance of urban planning, delivery and management of infrastructure among organizations.

5.5 Recommendations

A number of aspects have been identified from the study that could yield useful results for both academic research and practical applications to enhance the adoption of integrated approaches to the implementation of integrated sustainable urban infrastructure development within organizations delivering infrastructure. It was noted among urban practitioners in infrastructure planning, delivery and management that there is a tendency to treat infrastructure as a linear object and in isolation from other infrastructure. However, with increasing urban challenges of urbanization, uncertainty, climatic changes and durability of the infrastructure systems among organizations and the general public, the consequences of this tendency could be worse.

The recommendations include:

- i. Further development on the use of integrated urban infrastructure development framework at the national scale,
- ii. Further studies on computer technologies and software applications that support integrated urban planning and delivery,

- iii. Further studies on the ingredients that could enhance organizations performance in infrastructure delivery,
- iv. organizations need to employ holistic approaches to new circumstances and acquire knowledge from different sectors in setting objectives and making decisions so that they address environmental, economic and social concerns once and for all; and
- v. relevant regulatory professional bodies such as Engineering Institute of Zambia (EIZ), Zambia Institute of Architects (ZIA), Zambia Institute of Planners (ZIP), National Council for Construction (NCC)and Association for Consulting Engineers in Zambia (ACEZ), should consider incorporating integrated planning, delivery and management of infrastructures in their curricular for infrastructure-related academic and professional programs.

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ANNEXURE 1 – Interview Guide

1. To what extent could co-ordination with other related infrastructure agencies in infrastructure delivery improve effectiveness of infrastructure delivery?
2. Could integrated design principles and methodological factors assist in delivering sustainable infrastructure among organizations?
3. Do infrastructure organizations have provisions within respective policies for sharing of critical infrastructure information that enable effective infrastructure delivery among organizations?
4. What comprises integrated infrastructure system development for organizations delivering infrastructure?
5. To what extent could round-table planning, delivery and management of urban infrastructure result in disciplined spending habits among institutional/organizations sharing the objectives of infrastructure?
6. State your opinion on the present condition of your organization co-ordination with other related infrastructure companies regarding infrastructure planning, delivery and management?
7. Explain the current methods or aspects guiding urban infrastructure planning, delivery and management of new and existing infrastructure?
8. Do you have a master plan for infrastructure development as an organization? What social, economic or environmental challenges do are incurred when developing it?
9. Are software applications such as CAD, GIS, BIM employed in planning infrastructure? Are these enabling infrastructure development? Are there any other being used in the organization?
10. Could you state the importance of infrastructure institutions coordinating their planning, delivering and management of infrastructure with regards to the organizational benefits, user client's benefits and economic benefit?
11. What future objectives and key factors has the organization set which are related to coordination of planning, delivering and management?
12. Could you highlight major problems prevailing in the city as a result of uncoordinated approach to planning, delivering and management of infrastructure?
13. Are there any efforts made to introduce integrated approaches for infrastructure planning, delivery and management (operation and maintenance)?

31st July 2018

The University of Zambia

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Dear Sir/Madam,

QUESTIONNAIRE SURVEY: AN INTEGRATED APPROACH TO SUSTAINABLE URBAN INFRASTRUCTURE DEVELOPMENT.

I am a Masters’ Degree candidate in Project Management at the University of Zambia. I am undertaking a research on the topic “An integrated approach to sustainable infrastructure urban infrastructure development.”

The study seeks to establish a workable framework for integrated approach and coordination to planning, delivering and management of infrastructure in urban areas within infrastructure agencies and institutions mandated to provide infrastructure. The results obtained from the study will contribute the development of a framework that can be used for the following purposes:

By practitioners/experts – to efficiently plan, deliver and manage infrastructure with established processes and procedures.

Firms/organizations – to ensure sustainability in delivery of infrastructure development.

Attached to this letter is a questionnaire and based on your experience in the construction industry and infrastructure development, you are requested to spare your valuable time to complete it. Please answer all questions. All information gathered will be used only for purpose of the research with strict confidentiality.

Your assistance and cooperation is highly appreciated.

Yours faithfully,

Chilando E. Musanda
Masters’ Candidate

ANNEXURE 2 – Questionnaire

Section A. General Information

1. Which institution/parastatal company do you work for?

- a. ZAMTEL
- b. ZESCO
- c. LWSCo
- d. TAZARA
- e. RDA
- f. MUNINCIPLE COUNCIL

Other please specify.....

2. What is your Profession?

- a. Quality surveyors
- b. Engineers
- c. Architects
- d. Project managers
- e. Town Planner

Others please specify.....

3. What position do you hold in your organization?

- a. Project manager
- b. Construction manager
- c. Engineer
- d. Planning Engineer
- e. Town planner

Other please specify.....

4. What position level are you within your organization?

- a. Chief Executive Officer
- b. Senior level management
- c. Middle level management
- d. Junior level management
- e. Employee

5. How many years of experience do you have within the construction industry?
 - a. <5 years
 - b. 5-10 years
 - c. 10-15 years
 - d. 15-20 years
 - e. >20 years

SECTION B: Urban infrastructure design principles and practices

Key: Strongly Agree = 1; Agree = 2; Unsure = 3; Disagree = 4;

Strongly Disagree = 5

<u>No.</u>	<u>Questions</u>	1	2	3	4	5
1	Working without urban design principles in a city erodes institutions/organization infrastructure development performances.					
2	Practicing urban infrastructure design in an environment without integrated guidelines forces stakeholders to act according to what is best for them than what is best for the whole city.					
3	Collaboration is a key enabler which is supposed to be embraced between agencies/organizations					
4	Promoting practices and principles that encourage institutions/organizations to coordinate lead to a willingness to adopt a coordinative behavior.					
5	Lack of communication among agencies/organizations in infrastructure development hinders opportunities for innovation.					

6	Having key agencies/organizations operate as equals, is essential to urban infrastructure development.					
7	Guidelines with defined relationships among key stakeholders to infrastructures supports coordination and consensus-based decisions.					
8	Concepts and ideas such as 'systems thinking' and synergy concepts assists to understand interdependencies of Infrastructure.					
9	A lack of local sustainable design concepts hinders adherence to implementation of international and regional sustainable principles in infrastructure development.					

SECTION C: Methodology aspects of urban infrastructure development

Framework.

Key: Strongly Agree = 1; Agree = 2; Unsure = 3; Disagree = 4;

Strongly Disagree = 5

<u>No.</u>	<u>Questions</u>	1	2	3	4	5
10.	The use of Geographical Information Systems (GIS) can coordinate infrastructure plans more effectively.					
11.	The use of GIS can help gain more time by enhancing collaboration and information sharing.					
12.	Building Information Modeling (BIM) can increase opportunities for alternative sustainable designs among infrastructure agencies/organizations.					
13.	A variety of software applications and tools used to develop and represent infrastructure has increased the lack of developing integrated infrastructure maps.					

SECTION D: Policy aspects of urban infrastructure development framework

Key: Strongly Agree = 1; Agree = 2; Unsure = 3; Disagree = 4;

Strongly Disagree = 5

<u>No.</u>	<u>Questions</u>	1	2	3	4	5
14.	Guidelines or polices having mechanisms for coordination among infrastructure agencies/organizations enables efficiency and audit of infrastructures.					
15.	Variety of cultural values has increased isolation of infrastructure development policies.					

SECTION E: Institutional aspects of urban infrastructure development framework.

Key: Strongly Agree = 1; Agree = 2; Unsure = 3; Disagree = 4;

Strongly Disagree = 5

No.	Questions	1	2	3	4	5
16.	Infrastructure Agencies/Organizations intensified integrated planning before construction increases the chances of objectives success.					
17.	Attainment of shared objectives improves among infrastructure organizations/institutions due to inter-dependent nature of infrastructure.					
18.	Working together among infrastructure agencies/organizations at planning stages offers greater chances for innovative solutions.					
19.	Agencies/institutions infrastructure budgets and spending habits improves with constant planning engagements with other agencies/institutions.					

SECTION F: Substantive aspects of urban infrastructure development framework.

Key: Strongly Agree = 1; Agree = 2; Unsure = 3; Disagree = 4;

Strongly Disagree = 5

No.	Questions	1	2	3	4	5
20.	Lack of coordination among agencies/organizations leads to duplication of infrastructure activities.					
21.	Public health problems increase without careful and joint development of objectives and goals.					
22.	A framework for urban development with urban infrastructure design principles at city level can deliver infrastructure development successfully in the <i>Zambian</i> construction industry.?					

ANNEXURE 3 – Submitted journal paper under review



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10 April 2019

The Directorate of Research and Graduate Studies
University of Zambia
P. O. Box 32379, Lusaka
Zambia.

Dear Professor H. M. Sichingabula,

Submission Acknowledgement – Paper 733

I hereby acknowledge that Chilando Exter Musanda submitted a manuscript entitled “Key factors of an integrated approach to sustainable urban infrastructure development among infrastructure organizations/agencies” to the Journal of Construction Business and Management.

The paper is currently under review. The Editorial decision on the manuscript will be communicated to the author after the review process.

Please do not hesitate to contact me on +27 21 650 2049 or via email if you have any queries or concerns.

Yours sincerely,

Abimbola Windapo, PhD

Editor, Journal of Construction Business and Management

cc:

1. Dr Erastus Mwanaumo – Assistant Dean Postgraduate Studies, School of Engineering, University of Zambia
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