SOCIAL AND ECONOMIC IMPACT OF INNOVATIVE HOUSING CONSTRUCTION TECHNOLOGIES IN SLUM UPGRADING PROGRAMMES: CASE OF MATHARE VALLEY, NAIROBI

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Social and Economic Impact of Innovative Housing Construction Technologies in Slum Upgrading Programmes: Case of Mathare Valley, Nairobi

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DECLARATION

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

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This thesis has been submitted for examination with our approval as the University Supervisors.

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DEDICATION

This work is dedicated to my family for affording me conducive environment during my studies.

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OPERATIONAL DEFINITIONS

Slum is generally defined as a contiguous settlement where the inhabitants are characterized as having inadequate housing and basic services. A slum is often not recognized and addressed by the public authorities as an integral or equal part of the city" (Caldeira 1996 quoted in UN-HABITAT 2003, p.10).

Slum upgrading is a process of intervention for economic, organizational and environmental improvement to an existing human settlement undertaken collectively among citizens, community groups, governments (national/local) and any other development partners. (Syagga, 2011).

Innovation is defined as the actual use of nontrivial changing and improvement of a process, product or system that is novel to the institution developing the change (Freeman, 1989). It may involve changing equipment, human resources, working methods or a combination of these (OECD, 1997).

Technology the application of scientific knowledge to the practical aims of human life, to the change and manipulate of the human environment (https://www.britannica.com/technology/technology

Construction technologies refer to the methods and processes used in the construction of buildings and other structures. Construction materials refer to the various materials and substances used in the construction of buildings and other structures (Tylor, 2000; Dogne & Choudhary, 2014).

Social Impact Assessment is the process of analyzing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment (International Association of Assessment, 2003).

Economic impact assessment is the process of analysing the changes in economic aspects such as employment, income, levels of business activity or monetary value additions within a society resulting from a intervention such as a project or program (International Association Of Assessment, 2003).

Post Occupancy Evaluation is the last of phase of construction project process cycle. It involves the systematic assessment of the performance of buildings in use, from the perspective of the people who use them. It assesses how well buildings match users' needs, and identifies ways to improve building design, performance and fitness for purpose.

ABSTRACT

Adequate housing is a universal integral component of human rights. Intensified rural-urban migration has increased the demand for housing in urban centers resulting in acute shortages. To address this, attempts have been made to apply innovative products and processes to facilitate the provision of affordable housing. Kenya has in the past adopted innovative construction practices in slum upgrading using cost-effective locally available building materials and construction techniques. These include stabilized earth blocks and sisal/cement roofing sheets among others. However, the impact of these innovative practices has not been adequately evaluated. This post upgrade study evaluated the physical outcomes, social and economic impact of innovative housing construction technologies in the Mathare Valley slum in Nairobi city and suggested a guiding framework for slum upgrading using the technologies.This study used exploratory and descriptive research designs. Stratified random sampling technique was used to sample 384 households of a low-cost housing project in Mathare Valley. Construction authorities were purposively sampled. Research instruments included semi-structured questionnaires and interview guides. A pilot study, validity, and reliability tests ensured the quality of the study. The study adhered to ethical considerations. Descriptive and inferential statistics were computed using Statistical Package for Social Sciences (SPSS) version 21.The outcome of the slum upgrading process was significantly positive with improved houses and community. The significant social impact included the construction of communal facilities; assurance of security of tenure to slum residents; and retained frameworks of establishments. The significant economic impact included employment; affordable and durable. However, the process led to the displacement of some residents; and had no effect on rent. The slum upgrading process positively impacted the dwellers' social and economic wellbeing.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

The provision of affordable housing has been a global challenge. This can be attributed to the cost of resources such as land, construction materials, and financing. The challenges are further compounded by the incremental demand for shelter, especially in urban areas due to rural-urban migration. The Universal Declaration of Human Rights underscored adequate housing as an integral component of human rights (United Nations, 1948). This has been sustained by subsequent declarations and covenants like the 1992 Earth Summit in Rio (Brazil) when the housing blueprint on sustainable construction was inaugurated under Agenda 21 and the Habitat Agenda.

Lack of adequate housing has led to the proliferation of slums in major developing countries cities. Slums are characterized by inadequate access to safe water; inadequate access to sanitation and other infrastructure; poor structural quality of housing; overcrowding; and insecure residential status (UN-Habitat, 2008). Every seventh person worldwide lives in an informal urban settlement, summing up to 850 million people globally. In some megacities of low and middle-income countries, almost 80% of the total population resides in slums (WHO, 2019). Globally, urbanization is escalating and 1.5 billion people may be living in slums by 2025. Three-quarters of the world's population is expected to reside in urban areas by 2050, with urbanization in developing countries projected to be the most significant (WHO, 2019). These factual projections illustrate that immediate action is demanded for preparedness for the potential impacts.

The purpose of slum upgrading is to provide decent housing or to improve existing ones (Diang'a, 2012). Essentially, it involves integrating low-income slum dwellers living in informal settlements into the main city infrastructure. This means that they have the opportunity to access education, health care, employment, and other basic services. It involves the physical improvement of housing units, new construction, or entire resettlement.

According to the Department of Trade and Industry in Britain, as quoted by Freitas (2007), innovation has long been recognized for its contribution to national economic growth, competitiveness, and higher living standards and is at the heart of the modern knowledge-based economy. It enables individuals, governments, industries, and organizations to successfully exploit novel ideas, products, and processes. Some of the major challenges facing the construction industry are the need to reduce the cost of construction and meet the rising demand for dwelling houses. This is done by providing dwellings that are socially acceptable, economically sustainable, and environmentally friendly. Innovative practices that focus on the products and processes used in construction, therefore, need to be employed as much as possible.

According to David (2014), effective innovation in construction is encouraged as it contributes to the development of alternative building materials, processes, and designs that enable the reduction of construction costs and in effect promote the provision of low-cost housing. According to DTI (2007), innovation in the construction of low-cost housing can take several forms including product innovation (changes in the products/services) that a construction firm employs, and process innovation (changes in the ways in which the building designs are created and delivered).

As with other developing nations, Kenya is faced with the need for better housing facilities for low-income groups. Access to affordable housing is central to Kenya’s development blueprint as outlined in Vision 2030. This explains why the government has made affordable housing a priority item in the Big Four development agenda from 2018 (Mutinda, 2020). The provision of decent housing is still a challenge in Kenya due to the continuous population growth and demand for low-cost housing that cannot be effectively addressed by the current conventional construction methods. David (2014) acknowledges that in order to meet the accelerating demand for housing and to improve the living conditions in informal settlements, various organizations have been involved in using innovative practices in slum upgrading projects. In Kenya, building materials contribute almost 70% of the total cost of construction (Mutinda, 2020). It is, therefore, prudent that innovative cheaper practices focus on building materials such as stabilized earth blocks, sisal cement roofing sheets, rammed earth floors, cross-laminated timber, translucent concrete, and reinforced concrete, among others. Also, it is critical to understand their performance and consequences in terms of their impact on the economy and society. The Kenyan government produces approximately 50,000 dwelling units per year as compared to 250,000 units demanded (KNBS, 2019). Affordable housing was the fourth pillar in the Kenya government's economic recovery agenda for 2018. This housing strategy targets government employees generally and other formally employed persons who can afford credit or mortgages. The housing strategy excludes informal settlement dwellers due to low incomes and lack of formal or permanent employment. These people can only afford accommodation in slums which are characterized by various innovative construction technologies and whose physical and socio-economic impacts are inadequately documented.

Some government housing interventions in Nairobi have made use of innovative construction materials and techniques like stabilized soil blocks and sisal/cement roofing sheets like in the Mathare 4A slum upgrading project (Diang'a, 2012). However, the adoption of these materials and construction techniques has faced numerous challenges at physical, social, and economic levels.

1.2 Statement of the Problem

Slum upgrading projects in Nairobi have been employing innovative construction technologies to enhance sustainability, quality, and safety in low-cost housing. However, the use of these innovative practices in housing have been accompanied by a range of post-occupancy challenges that warrant investigation. These include physical deterioration of upgraded structures, social resistance, and economic constraint, as observed in previous studies (Mwangi, 2013). The challenges not only increase maintenance costs but also impact on the functional performance of the housing units. In addition, there are growing concerns that the use of innovative construction practices may lead to unaffordable housing for low-income residents, potentially exacerbating housing inequality (Huchzermeyer, 2008). Despite the significant attention given to innovative construction practices in academic research, a considerable gap exists regarding the specific impact of the use of innovative technologies on low-cost housing in slum upgrading projects. The study sought to fill the gap of knowledge on the social and economic impact of innovative construction technologies in low-cost housing which is lacking in most of the research work.

1.3 Aim and Purpose of the Study

The aim of the study was to assess the physical and social and economic influence of innovative construction technologies with a view to guiding the planning, design, and implementation of low-cost housing projects. This post upgrade occupancy study on upgraded Mathare 4A slum assessed the outcomes and social and economic impact that are associated with the use of innovative construction technologies. The purpose of the study was to highlight how innovative construction technologies impacted the physical and socio-economic aspects of slum upgrading.

1.4 Objectives of the Study

The main objective of this study was to assess the impact of innovative construction technologies in slum upgrading in Mathare valley, Nairobi.

1.4.1 Specific Objectives

1. To determine the effect of innovative construction technologies in slum upgrading in Nairobi County
2. To establish the social impact of innovative construction technologies in slum upgrading in Nairobi County
3. To establish the economic impact of innovative construction technologies slum upgrading in Nairobi County
4. To develop a framework for use of innovative construction technologies in informal settlements

1.4.2 Research Questions

1. What is the effect of innovative construction technologies in slum upgrading in Nairobi County?
2. What is the social impact of innovative construction technologies in slum upgrading in Nairobi County?
3. What is the economic impact of innovative construction technologies slum upgrading in Nairobi County?
4. What constitutes an effective framework for use of innovative construction technologies in informal settlements?

1.5 Scope of the Study

The study focused on the physical and social and economic impact of innovative construction technologies in the upgraded Mathare Valley, area 4A. The outcome of the study informed the development of a guiding framework for future slum upgrading initiatives.

1.6 Significance of the Study

In a bid to promote the development of the country, the government instituted strategies such as the upgrading of slums to provide better housing to the slum dwellers. The aim was to meet the economic and social pillars of the Sustainable Development Goals as well as Kenya’s Vision 2030. The information from this study may assist the government and other policymakers in determining strategic and effective measures to institute slum upgrading and generally low-cost housing projects.

The findings may also provide information to the construction sector stakeholders on issues pertaining to effective and sustainable application of innovative construction practices and technologies. The construction industry continues to seek to improve competitiveness, user’s satisfaction, sustainability, quality, and safety of the built environment. This has inspired extensive research on innovative practices. However, the impact of such practices on the target population has not been adequately assessed. A study on the social and economic impact of innovative construction techniques may therefore inform stakeholders on issues that may promote the effective use of innovative materials, techniques, and processes. The information from the study may also form the basis for literature for other researchers and academicians wishing to carry out studies in the same field in Sub-Saharan Africa.

1.7 Justification

International organizations such as UN-HABITAT have advocated the provision of adequate and affordable shelter to improve living conditions and livelihoods in informal settlements such as the Mathare slums. The Kenya government through its agencies has initiated programs in support of the foregoing considering the rapid urbanization and proliferation of informal settlements in urban areas. Affordable housing is one of the big four development agenda items that the Kenya government has pledged to accomplish. Its achievement will also contribute to attaining the Sustainable Development Goals and the Vision 2030. Assessment of the post-habitation impact of innovative construction technologies is therefore critical to guide physical development policies in the future.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a review of literature from books, official government documents, journals, articles, theses, and working reports. The literature review in this study is appraised under the following sub-thematic areas: slum upgrading, projects process, case studies, policies and legislations, innovative construction practices. Also covered is social and economici impact, challenges, past innovation frameworks, theoretical underpinnings and conceptual framework.

2.2 Slum Upgrading

Slum upgrading programs are significant because they aim to improve the living conditions and livelihoods of slum dwellers. According to Winrso (2022) and Mesplé-Somps et al. (2021), these programs focus on physical improvements such as infrastructure, access to basic services, and tenure security. They also incorporate social concerns through participatory planning and aim to improve the quality of life of slum dwellers (Sinha, 2021). However, the impact evaluations of these programs are limited, and their effects on employment and income are mixed (Ghanam & El-Deep, 2021). Despite this, Núñez Collado and Wang (2020) argue that slum upgrading programs have shown some positive outcomes, such as the development of self-employed activities and improvements in access to basic services. Additionally, slum upgrading can contribute to climate change adaptation and mitigation efforts by enhancing infrastructure and policies in informal settlements (Núñez Collado & Wang, 2020). Overall, slum upgrading programs play a crucial role in addressing the challenges faced by slum dwellers and promoting sustainable development in disadvantaged areas.

Slum upgrading programmes aim to improve the living conditions of slum residents by providing access to basic services such as clean water, sanitation, and better housing (Agayi, & Serdaroğlu Sağ, 2020). These programmes also address the social and economic challenges faced by slum communities, promoting social justice and inclusivity. However, the success of these programmes depends on factors such as community participation, systemic approaches, and consideration of the diverse needs of residents. According to Aditya et al. (2020), the lack of participatory programmes and systemic approaches can hinder the effectiveness of slum upgrading solutions. Additionally, interventions that fail to consider the social diversity of slum residents may result in the non-use or minimal use of delivered projects (Ceppi et al., 2020). Therefore, it is crucial for slum upgrading programmes to acknowledge the diverse needs of residents and involve them in project identification, planning, and implementation (Yeboah et al., 2021).

Slums are characterized by inadequate housing, lack of basic amenities, and limited access to essential services. By upgrading these settlements, governments and organizations can create an environment that promotes social inclusion, economic development, and overall well-being. Meléndez Fuentes and Pintor Pirzkall (2020) argue that conventional approaches to the slum question have not been successful in achieving solid results, but evidence shows that comprehensive and inclusive slum upgrading programs in Latin America have the potential to lead to more sustainable and comprehensive outcomes. Agayi and Serdaroğlu Sağ (2020) observed that the first phase of KENSUP project implementation in Kenya was successful. However, the relocation caused social and economic disruption to residents. These programs can contribute to human development by providing better living conditions and opportunities for slum dwellers. However, the success of slum upgrading programs depends on factors such as community involvement in project identification and implementation, as well as the existence of specific laws and policies on urban regeneration.

Innovative construction practices have emerged as an effective means to address the challenges faced in slum upgrading projects. These include innovative materials, technologies, and processes that are used to transform slums into sustainable and resilient communities. According to Meredith and MacDonald (2017), innovative construction materials used for slum upgrading include bio-fuel ash cellular lightweight (BFA-CLW) bricks and expanded polystyrene geofoam (EPGF) as an insulator. These materials have been analyzed for their energy efficiency and cost-effectiveness in controlling peak cooling load demand in high-temperature climatic zones (Frigione & Aguiar, 2020). Ralegaonkar et al.(2017) observe that the use of BFA-CLW bricks and EPGF as an insulator has shown promising results in achieving energy efficiency in a sustainable manner. These materials have the potential to improve the quality of housing for urban slum dwellers in developing countries (Meredith et al., 2021). Additionally, there are efforts to develop smart materials that can provide efficient alternatives to conventional construction materials and improve energy efficiency in buildings (Cronin, 2012). These smart materials aim to upgrade, repair, and protect existing infrastructures, contributing to sustainable development

Stabilized soil bricks, also known as compressed earth blocks (CEBs) or compressed stabilised earth blocks (CSEBs), are eco-friendly building materials used for construction. They are made by compressing a mixture of soil, sand, stabilizers, and water to create solid blocks that can be used for various construction purposes. Saidi et al. (2018) observe that stabilized soil bricks have been investigated as innovative construction materials in slum upgrading. Various studies have explored the use of different stabilizers, such as cement, lime, fly ash, and binder obtained from calcined laterite and phosphoric acid, to improve the properties of soil bricks (Corbin, 2017; James & Saraswathy, 2020; Mimboe et al., 2020; Ronoh et al., 2015). These stabilizers have been found to enhance the compressive strength and water resistance of the bricks, making them suitable for construction purposes. Additionally, the use of stabilizers can reduce the cost of producing stabilized bricks. However, the hygrothermal properties of the bricks may be affected by the addition of stabilizers (Bruno et al., 2020). Further research is therefore needed to optimize the use of stabilizers and assess the long-term performance of stabilized soil bricks in slum upgrading projects.

Innovative construction technologies used in slum upgrading include among others integrated Building Information Modeling (BIM) and Monitoring and Evaluation (M&E) systems (Abanda et al., 2021). BIM technology allows for the creation and management of digital representations of physical and functional characteristics of buildings. In slum upgrading, BIM helps optimize the design, construction, and operation of buildings, ensuring efficiency and minimizing errors. Additionally, an automated heuristic-based planning model has been proposed to prioritize upgrading phases and select suitable construction methods for accelerated service delivery in slum areas (Bahi et al., 2016). Machine learning algorithms, such as support vector machine (SVM) and random forest (RF), combined with remote sensing imagery, have shown promise in mapping slums for monitoring and upgrading purposes (Leonita et al., 2018). Binale (2011) observes that bio-centres, a technology developed by Umande Trust, have been used to improve access to basic urban services in slums, with successful implementation in Nairobi and Kisumu. It involves capacity building achieved through trainings. The community is trained on innovative approaches such as removing mud from shoes before entering the toilet and ensuring that the facilities have a door rack. To improve energy efficiency and reduce environmental impact, slum upgrading projects are incorporating green building technologies. These include solar panels for renewable energy generation, rainwater harvesting systems, and efficient insulation for climate control. The implementation of smart infrastructure systems, such as smart grids and sensor networks, enables efficient management of resources in slum upgrading projects (Meredith & MacDonald, 2017). These technologies optimize energy usage, water management, and waste disposal, leading to improved living conditions.

Innovative construction processes used in slum upgrading include participatory and community-based approaches (Shelby, 2021). According to Meredith and MacDonald (2017), a hybrid approach that combines community engagement with the resources of governments and large agencies has been effective in slum upgrading projects. Slum upgrading projects often involve community engagement to ensure the needs and aspirations of the residents are considered. Participatory planning and design processes enable the community to actively participate in decision-making and contribute to the design of their own living spaces. According to Chaudhuri (2017), the use of adaptive management models and promoting community involvement has shown success in building community engagement and achieving development outcomes. Instead of demolishing and rebuilding slums, incremental housing approaches focus on gradual improvements. This involves upgrading existing structures incrementally, allowing residents to remain in their homes during the upgrading process. Stakeholder management and participation processes have been found to increase the success of slum upgrading projects (Meredith et al., 2021). Innovative construction practices in slum upgrading often involve collaborations between governments, non-governmental organizations, private sector entities, and the local community. These partnerships bring together diverse expertise, resources, and funding to implement sustainable and effective slum upgrading projects. Adequate stakeholder analysis, efficient participation, and effective information and communication are therefore key factors for successful slum upgrading (Flinck, 2016). The use of innovative materials, technologies, and processes has improved the efficiency, affordability, and environmental sustainability of slum upgrading projects. By embracing these practices, urban areas can create better living conditions for the urban poor and promote inclusive and resilient cities.

2.3 Concept of Slum Upgrading

Scholars have different perspectives on the definition and characteristics of slums. Taubenböck and Kraff (2014) use remotely sensed data to identify physical features of slums, such as building density and height, that can be used to define slum areas. Nuissl and Heinrichs (2013) highlight the complexity and variety of slums worldwide and the different approaches to defining, assessing, and solving the problems associated with them. Marx et al. (2013) focus on the economic aspects of slums, describing them as densely populated urban areas with poor-quality housing and inadequate public services. Abubakar et al. (2017) proposes a dynamic framework, the Slum Property Map, that organizes the multidimensional and relational properties of slums (cultural, social, economic, environmental) into a relationship map to guide intervention and management of local assets. Overall, they suggest that slums are complex and multifaceted phenomena that require a nuanced understanding of their physical, economic, and social characteristics to effectively address the challenges they pose. From their different perspectives, we can see that slums are urban areas characterized by substandard housing, inadequate access to basic services, and a lack of proper infrastructure.

Slum areas are often inhabited by marginalized populations, living in poverty and facing various socio-economic challenges (Kondapi et al., 2019). Taubenböck and Kraff (2014) define slum as densely populated areas within cities that lack essential amenities and exhibit inadequate living conditions. These areas are typically characterized by the presence of makeshift shelters, overcrowding, and unhygienic environments. According to Ranguelova et al. (2019), many slum dwellers live in makeshift structures made from scrap materials such as corrugated metal sheets, tarpaulins, or wooden planks. Slums are known for their high population density, with limited living space available for each household (Safitri et al., 2020). Due to the lack of affordable housing options, slum dwellers often live in cramped conditions, sharing small living spaces with multiple family members. Aggrey-Korsah and Oppong (2013) observe that slums are typically marked by a lack of access to basic amenities such as clean water, sanitation facilities, electricity, and healthcare services. Limited or non-existent infrastructure in slums hinders the provision of these essential services to residents.

Slums are predominantly inhabited by people living in poverty (Kondapi et al., 2019). According to Mahabir et al. (2016), the lack of formal employment opportunities often leads to the proliferation of informal economies within slums, where residents engage in low-paying jobs in the informal sector to sustain their livelihoods. Slum dwellers often face social exclusion and marginalization, with limited access to education, healthcare, and other social services (Hemati et al., 2019). Discrimination and stigmatization further exacerbate the challenges faced by slum communities. Slums are prone to environmental hazards such as poor waste management, pollution, and inadequate drainage systems. These factors contribute to unsanitary living conditions, increasing the risk of diseases and health issues among residents. Slums often emerge as a result of rapid urbanization, rural-urban migration, and insufficient urban planning.

Slums represent a significant urban challenge, reflecting the complex interplay of socio-economic, environmental, and political factors (Rivera-Padilla, 2021). They are prevalent in developing countries, particularly in less developed countries of Asia and Africa. The characteristics of slums encompass substandard housing, overcrowding, inadequate access to basic services, poverty, social marginalization, and environmental hazards. Efforts to address slum conditions require comprehensive urban planning, provision of basic services, and initiatives aimed at poverty alleviation and social inclusion. Demolishing slums in productive areas can have negative effects on welfare and labour productivity, while eliminating formal housing distortions can increase welfare and labour productivity.

Informal settlements, also known as slums or favelas in parts of Latin America, are unplanned, densely populated, and neglected areas within cities where living conditions are extremely poor (Diang'a, 2012). Slum upgrading involves improving both the physical and social environments. To allocate financial investments effectively, one must recognize the connections between the underlying issues and the interactions among different stakeholders to achieve holistic success. Projects demonstrate that tri-sector partnerships, including the state, private, and voluntary sectors, must collaborate to overcome slum upgrading challenges (TEDx, 2013).

While the mentioned parties show commitment, the urgent needs of individual slum dwellers and local communities must also be considered. To achieve long-term success in slum upgrading, enduring and strategic planning must address all financial, institutional, and regulatory decisions to a significant extent. The key issue in urban development and slum upgrading is related to the increasing number of urban residents and how housing and infrastructure services can be financed for future urban generations (UN-Habitat, 2014).

Slum upgrading is complex and multifaceted, as it requires addressing several interconnected components in both the physical and social environment. These components entail significantly different financial implications, including housing, water, sanitation, roads, footpaths, storm drainage, telephones, waste collection, schools, medical centers, and other services like social integration buildings, public spaces, peacebuilding, and poverty reduction programs. The primary concern remains extensive poverty despite rapid economic growth in most developing countries. Particularly in urban poverty, the lack of well-paid employment is the most significant factor. Considering the issues and challenges mentioned above, it is evident that conventional sources of finance will not be sufficient to meet the projected requirements for urban infrastructure and housing (UNCHS, 1996).

Urbanization and slum modernization rely heavily on the increasing number of city residents and how they will be financed in future urban eras. The redesigning of slums is complex and intricate due to several interconnected environmental and social factors. Financial implications include infrastructure components like housing, water, sanitation, streets, and pathways, storm drainage, electricity, and public telephones, as well as administrative components like waste collection, schools, and medical centers; and other services such as social integration structures, public spaces, peacebuilding, and poverty reduction programs. There are several notable aspects. Despite rapid and semi-rapid economic growth in many developing nations, widespread poverty remains a significant challenge. Urban poverty is greatly affected by the lack of well-paying employment. Given the issues and challenges, it can be inferred that conventional funding sources will not suffice to meet the projected requirements for urban infrastructure and housing (UNCHS, 1996).

According to WHO (2019), slums are home to 828 million people, accounting for around one-third of the world's urban population. In some developing cities, the slum population can reach 80%. Current slums are characterized by informal economies, social exclusion, poor housing, and underdevelopment. The smart, productive cities of the future can transform these areas into vibrant neighbourhoods that are fully integrated into urban design and management systems. Slums are expected to increase in the coming years. UN Millennium Goal Number 7 (specifically 7D) on the improvement of slum dwellers' living conditions, along with several UN post-2015 Sustainable Development Goals (SDGs), are also attempting to address this complex issue (Walnycki, 2013).

Low-cost housing benefits low-income households with limited economic means. The construction industry, like many others, prioritizes economic gains, making less profitable work unattractive to contractors. However, the main hindrance to appropriate building technology is the lack of sufficient political support. Development is hampered by institutional services, outdated planning regulations, and limited social acceptance. Slum-dwellers may face constraints due to inadequate access to credit, quality control, and equipment.

Namayi (2013) reported that some government housing campaigns in Nairobi utilize SSBs, for example, in Mathare and Kibera. Authorities have approved the construction, provided machines for SSB production, and advised on construction methods and quality controls implemented by government officers. While public buildings, such as schools, are constructed with SSBs, baked bricks are still widely used.

The right to adequate housing is universally recognized and protected at the international level and in over one hundred national constitutions worldwide. There is no doubt that it is valid for everyone (Lemonnier, 2013). The Universal Declaration of Human Rights of 1948 recognizes the right to adequate housing as an essential component of the right to a reasonable standard of living (Ouda, 2009). This has been further reaffirmed by subsequent international instruments, including the International Covenant on Economic, Social, and Cultural Rights of 1966, the Istanbul Declaration and Habitat Agenda of 1996, and the Declaration on Cities and Other Human Settlements in the New Millennium of 2001. In all these instruments, housing is understood in the broader context of the shelter fabric and the living environment (Smith, Fressoli & Thomas, 2014).

2.3.1 Objectives and Principles of Slum Upgrading Programmes

Slum upgrading programs aim to improve the living conditions of residents in informal settlements. Jones (2012) argues that slum upgrading initiatives are often driven by neoliberal principles, with a focus on financialization and private property. Corburn and Sverdlik (2017) highlight the potential for slum upgrading to improve health equity, but notes that few evaluations capture the multiple health benefits of upgrading. Brakarz and Jaitman (2013) proposes a methodological approach for evaluating slum upgrading programs, which involves assessing outcomes related to housing, neighbourhood, and individual. Muchadenyika and Waiswa (2018) emphasize the importance of policy, politics, and leadership in slum upgrading, arguing that policies should evolve gradually over time, party-politics can undermine slum upgrading programs, and leadership at the city level is crucial for inclusive municipal governance and development.

Slum upgrading programmes play a crucial role in addressing the challenges faced by informal settlements and promoting sustainable urban development. These programmes strive to improve the living conditions of slum dwellers, enhance their access to basic services, and create inclusive and resilient cities. Olthuis et al. (2015) argue that slum upgrading projects should be more location-specific and offer flexible yet customized solutions that build upon local knowledge to account for the dynamic and diverse nature of slums. Muraguri (2011) discusses two Kenyan government initiatives in slum upgrading, the Kenya Slum Upgrading Programme (KENSUP) and the Kenya Informal Settlement Improvement Project (KISIP), and presents their objectives, strategies, and components. Their objectives included community organization and mobilization, shelter improvement, security of tenure or residential security, housing development and improvement, preparation of city/town development strategic and land use master plans, provision of physical infrastructure, provision of social infrastructure, provision of secure tenure and residential security, environmental and solid waste management, employment and income generation, addressing issues of HIV/AIDS, and conflict prevention and management in the targeted informal settlements. The main principles of KENSUP are decentralization, sustainability, democratisation and empowerment, transparency and accountability, resource mobilization, secure tenure, expansion and up-scaling, partnerships and networking.

Turley et al. (2013) review the effects of slum upgrading strategies on health and socio-economic outcomes and concludes that there is a high risk of bias within the included studies, heterogeneity, and evidence gaps that prevent firm conclusions on the effect of slum upgrading strategies on health and socio-economic wellbeing. Bhan (2013) also reviews the effects of slum upgrading strategies on health and socio-economic outcomes and finds reductions in communicable diseases, particularly incidence of diarrhoea, but mixed findings for parasitic infections and social and economic outcomes. The authors collectively suggest that slum upgrading programmes should be location-specific, flexible, and customized to account for the dynamic and diverse nature of slums, and that rigorous studies with longer follow-ups are needed to allow firm conclusions to be drawn on the impact of slum upgrading strategies on health and socio-economic outcomes.

Literature shows that the primary objective of slum upgrading programmes is to improve the living conditions of slum dwellers (Jones, 2012; Corburn & Sverdlik, 2017; Brakarz & Jaitman, 2013; Muchadenyika & Waiswa, 2018). This includes upgrading housing structures, providing access to clean water and sanitation facilities, and enhancing the overall quality of life for residents. Slum upgrading programmes also aim to ensure that residents have access to basic services such as electricity, healthcare, education, and transportation. By improving access to these services, the programmes contribute to reducing inequalities and promoting social inclusion. Slum upgrading programmes seek to promote socio-economic development within informal settlements. This involves providing opportunities for income generation, skill development, and entrepreneurship, which can help uplift slum dwellers out of poverty and create sustainable livelihoods. Another objective of slum upgrading programmes is to foster social cohesion within informal settlements. By promoting community participation, empowering local stakeholders, and creating spaces for interaction, these programmes aim to build trust, solidarity, and a sense of belonging among residents.

Literature shows that slum upgrading programmes adopt a participatory approach, involving slum dwellers, community-based organizations, and other stakeholders in the decision-making process (Olthuis et al., 2015; Muraguri, 2011; Turley et al., 2013; Bhan, 2013). This ensures that the programmes address the specific needs and aspirations of the residents and promote ownership and sustainability. Slum upgrading programmes prioritize inclusivity and gender sensitivity, recognizing the unique challenges faced by different groups within informal settlements. These programmes strive to ensure equal access to resources, services, and opportunities for all residents, regardless of their gender, age, or social background. Slum upgrading programmes try to align with the principles of sustainable urban development. They aim to create environmentally sustainable and resilient cities by promoting energy efficiency, waste management, green spaces, and climate change adaptation measures within informal settlements. Slum upgrading programmes require collaboration among various sectors, including government agencies, non-governmental organizations, private sector entities, and community-based organizations. This multi-sectoral approach ensures the pooling of resources, expertise, and knowledge to effectively address the complex challenges of slum upgrading.

2.3.2 Key stakeholders involved in slum upgrading initiatives

There are several key stakeholders involved in slum upgrading initiatives. Muchadenyika and Waiswa (2018) argue that policy makers, politicians, slum dwellers, and government officials are all important stakeholders in slum upgrading. Flinck (2017) emphasizes the importance of community participation in slum upgrading projects, and suggests that community members are key stakeholders. Corburn and Sverdlik (2017) argue that slum upgrading can have multiple health benefits, and suggests that health professionals should be involved as stakeholders in slum upgrading initiatives.

Doe et al. (2020) suggest that the sustainability of slum upgrading interventions depends on the involvement of low-income households as stakeholders. Overall, a wide range of stakeholders, including policy makers, politicians, community members, health professionals, community organizations, government officials, private sector actors and low-income households, are involved in slum upgrading initiatives. These stakeholders play a crucial role in slum upgrading initiatives. Understanding the key stakeholders involved in these initiatives is essential for effective planning, implementation, and sustainability. Government authorities, NGOs, CBOs, international donors, private sector, and slum dwellers are key stakeholders in slum upgrading. They play vital roles in policies, funding, community engagement, and sustainable solutions. Collaboration is crucial for success.

2.3.3 Project Process

The construction process refers to the sequence of activities that build on one another culminating in a composite whole finished production of the intended function. The process involves six stages that include need, planning, design, construction, operation and maintenance, and retirement (Haplin & Woodhead, 1998).

PHASE	DESCRIPTION
NEED	A need for a facility is identified by the owner
PLANNING	Initial feasibility and cost projections are developed The decision to proceed with conceptual design is made and a design professional is retained
DESIGN	Development of the conceptual design and scope of work with an approximate estimate of cost Decision to proceed with the development of final design documents
CONSTRUCTION	Construction of the facility The facility is available for occupancy and utilization Complex projects need a period of testing, commonly used in industrial projects (project start-up)
OPERATION & MAINTENANCE	The facility operates and is maintained during a specified service life
RETIREMENT	The facility is disposed of if appropriate or maintained in perpetuity

Figure 2.1: The Construction Project Process

Source (Haplin & Woodhead, 1998)

As per the preceding framework, construction projects commence with need identification (Haplin & Woodhead, 1998). This initial phase involves the project owner identifying the problem or opportunity that requires a facility solution. The owner also assesses the project's feasibility and cost. Planning constitutes the second phase, wherein the owner engages a design professional to define the project scope, schedule, budget, and quality requirements. Site investigations and environmental assessments are also conducted by design professionals. The third phase is the design stage, during which the design professional develops the conceptual design of the facility and seeks the owner's approval to proceed with the detailed design (Zavadskas, Vilutien, Turskis, & Aparauskas, 2014).

Construction documents, specifications, and bid packages are prepared by design professionals. Construction marks the fourth phase, with the owner selecting a contractor to build the facility based on the design documents. The contractor is responsible for quality control and safety inspections during construction. The fifth phase comprises operation and maintenance, during which the owner occupies and utilizes the facility as intended. Regular maintenance and repairs are performed to keep the facility in good condition. The sixth phase is retirement, where the owner decides to discontinue using the facility due to obsolescence, deterioration, or changing needs. Renewing or revitalizing the facility may be considered to extend its service life (Eastman, 2018).

2.3.4 Case Studies of Slum Upgrading

A slum is an urban area with substandard housing and squalor, now synonymous with informal settlements (Huchzermeyer, 2004). These settlements are becoming prominent manifestations of urban poverty in developing cities. In china, Yantai’s slum upgrading projects improved over 430 residential properties' external walls and re-roofed around 280 buildings to protect against harsh weather and reduce energy consumption. However, in Nairobi City County, upgrading focuses on individual areas like Kibera and Mathare Slums instead of multiple slums simultaneously like the Yantai. Unfortunately, insufficient attention is given to the external walls and roofs of residential buildings in Kenyan projects, impacting the housing deprivation assessment and slum household definition. Addressing housing durability is essential for meaningful change (UN-Habitat, Housing and Urban Upgrading in Yantai, China, 2008).

In Brazil, the government intervened in the housing sector in the second half of the twentieth century, coinciding with increased urbanization (Magalhaes, 2016). Before this, policies were minimal, and poor housing mainly consisted of high-density tenement housing known as cortiços with poor living conditions (Brakarz & Eduan, 2004). The Favela-Bairro Program, initiated in 1994, improved living conditions in

Rio de Janeiro's slums by investing in urban infrastructure, services, and social inclusion (UN-HABITAT, 2003). Investments focused on accessibility, housing, income generation, and crime prevention. The program's success was attributed to its multi-sectoral approach, strong local government capacity, and active community involvement (Perlman, 2010). Community policing units also improved security and business opportunities.

Hague (2004) described Colombia's national housing policy evolving through three stages: first, state involvement in housing supply during rapid urbanization in the 1950s-1970s; second, local integration into territorial development planning and adoption of a market approach after decentralization in 1991; and third, a comprehensive land production mechanism called Macroproyecto (Forester, 1999).

Nigeria's Makoko community, with SERAC and USI, developed an urban renewal plan through a participatory process, involving diverse stakeholders (George, 2008). Neighborhood management facilitated direct citizen participation, balancing top-down and bottom-up approaches, leading to the Waterfront Regeneration Plan (Ambe-Uva, 2013). This approach enhanced inclusion, representation, and legitimacy in policymaking. The dire living conditions in Nigeria's Makoko community prompted representatives to propose a regeneration plan to the Lagos State Governor. Collaborating with Social and Economic Rights Action Centre (SERAC) and Urban Spaces Innovation (USI), the community formed a working group of professionals to consider various perspectives (George, 2008). They involved citizens, neighborhood managers, traditional rulers, and various stakeholders, ensuring diversity and inclusivity (Okedele, 2008). Neighborhood management aimed for direct citizen participation, balancing top-down and bottom-up approaches, resulting in the Waterfront Regeneration Plan (Ambe-Uva, 2013). This participatory model enhances representation, accountability, and legitimacy, benefiting citizens' quality of life (Warren, 2009). The plan integrates land use, housing, tourism, and economic development.

Kenya Slum Upgrading Programme (KENSUP) is a collaborative effort by the Kenyan government, civil society partners, and local communities to improve the lives of people in slums (Muraguri, 2011). The Government of Kenya executes and manages the programme while the Ministry of Housing and NHC implement it by involving the civil society partners, participating local communities and the private sector. It focuses on providing security of tenure, infrastructure, and economic opportunities. Implementation is nationwide, emphasizing decentralization, sustainability, transparency, and empowerment. The Settlement Executive Committee connects the community to government decisions. KENSUP's actions include community organization, housing development, infrastructure provision, waste management, skill development, and HIV/AIDS awareness. Its main objectives are conflict prevention, slum improvement, and curbing slum expansion.

The Kenya Informal Settlement Improvement Project (KISIP) is a government-led initiative partnered with the World Bank, AFD, and SIDA (Muraguri, 2011). It is an initiative started by the Government in collaboration with the World Bank, the French Agency for Development (AFD) and the Swedish International Development Agency (SIDA). KISIP focusses on improving living conditions in existing informal settlements by investing in infrastructure and strengthening tenure security. It also supports the Government of Kenya in planning for future urban growth in a manner that prevents the emergence of new slums. The goal is to eliminate slums and promote affordable housing in Kenya's cities. Through KISIP, the government provides technical assistance to county governments in investing by infrastructure investing and service delivery.

2.3.5 Policies, Legislations, Organizations and Blue Prints

Since 1963, the Kenyan government has made efforts to tackle housing challenges, including policies and the establishment of bodies such as the National Housing Corporation (NHC) and Housing Finance Company (Otiso, 2005). NHC was established by an Act of Parliament Cap 117 and has completed about 43,000 units though the target was 150,000 units. Housing Finance Company of Kenya also known as Housing Finance (HF), is a mortgage finance provider for low-cost housing programes and is the only mortgage company regulated by the Central Bank of Kenya. The company was established in November 1965, to promote a savings culture and home ownership among the citizens of newly independent. Although HF offers mortgage facilities for prospective house owners, its repayment rates are out of reach for most citizens hence not fully supportive of the objective of providing adequate and affordable shelter to all its citizens. (Masibo & Majimbo, 2018).

Kenya's Sessional Paper No. 5 of 1966-1967 was the first housing policy aiming to provide adequate shelter and a healthy environment at a low cost. It emphasized on eradicating slums and promoting self-help initiatives. However, forcefully displacing slum residents violated human rights and didn't solve the issue. People relocated to other slums or remote areas with no services or income sources. The policy called for better coordination and studying of local building materials and techniques to reduce costs. Despite efforts, the slum problem wave never abated due to ineffective relocation strategies. Sessional Paper No. 3 of 2004 replaced Paper No. 5 of 1966/67, aiming to improve housing conditions and address the housing shortage in Kenya's cities. The goal was to provide affordable and healthy housing for all socio-economic groups, reducing slums and informal settlements. The policy focused on creating sustainable human communities with decent living conditions for everyone (Olima & Majimbo, 2015).

Local physical development plans, under Act 286 of 1996, advocate the development of adequate infrastructure and zones for public use, utilities, commercial, industrial, residential, and recreational areas. The Physical Planning Act sets public rules and regulations to standardize physical planning, supported by a handbook with guidelines and standards. Local authorities have the power to control land use and development, approving or denying applications based on compliance with development rules. These strict requirements and building codes have increased housing costs, transforming low-cost units into unaffordable high-cost housing (Mugenda & Oluoch, 2016).

The Environmental Management and Conservation Act (EMCA) of 1999 grants Kenyan citizens the right to a clean environment. Any growth project that may harm the environment must undergo an Environmental Impact Assessment (EIA). The EIA process results in Environmental Management Plans to address impacts and improve the environment. Projects causing irreversible damage to the atmosphere are not allowed. EMCA affects slum upgrading and redevelopment due to its mandatory nature in housing projects. It emphasizes the need for a clean environment, supporting the improvement of slum living conditions through redevelopment. Housing developers considered EMCA the most stringent legislation before the Built Environmental Bill in 2011 (Olima & Majimbo, 2015).

The National Urban Development Policy (2012) aims for safe, well-run, and sustainable urban areas in Kenya, aligning with national development goals. It focuses on sustainable urban growth through good governance and improved infrastructure and services. To ensure sufficient housing infrastructure, the policy urges the National and County governments to strengthen urban authorities, allocate more budget, and provide incentives for private sector involvement. Collaboration between the governments is essential for successful low-cost housing programs in cities (Nyakundi, 2015). The Housing Act (1990 Revised 2012) mandates the National Housing Corporation (NHC) to provide affordable housing through a Housing Fund. NHC can also offer loans for land purchase and home construction. The Urban Areas and Cities (Amendment) Act (2019) allows for the governance and management of urban areas, enabling slum upgrading and redevelopment through integrated municipal plans for sustainable urban settlements (Government of Kenya, 2019). The County Government Act (2012) requires urban areas to develop land use plans, building and zoning plans, and allocate recreational areas and public services to guide and control housing development in the counties.

UN-Habitat is a global UN agency focused on improving urban growth and development. It works in seven priority areas, including housing and slum upgrading. It partners with KENSUP for upgrading and redevelopment projects in various Kenyan cities, promoting sustainable human settlements. Shelter Afrique provides housing finance solutions and guidance to developers across Africa. Their focus is on middle to high-income brackets and not low-income housing (Orinda & Manase, 2017).

The Constitution guarantees the right to a home, stating that everyone has the right to accessible, spacious, and clean housing (Republic of Kenya, 2009). However, there are no specific laws for its implementation, so housing developers rely on various policies and laws. While the constitution doesn't mention slum upgrading directly, it promotes sustainable human settlements and the right to decent living conditions and sanitation. The Vision 2030 plan aims to improve city planning, provide affordable housing, and boost the housing sector (Government of Kenya, 2007). Key measures include upgrading slums, enhancing local government's land management, setting up housing technology centres, establishing a secondary mortgage finance company, and streamlining housing development approvals (Nyabuti, 2013).

2.4 Innovative Construction Practices

2.4.1 Definition of innovative construction practices

In the dynamic and ever-evolving field of construction, innovative practices play a vital role in enhancing efficiency, productivity, and sustainability. There are different perspectives on innovative construction practices. Ozorhon et al. (2016) propose a framework for analysing construction innovation, identifying six components: drivers, barriers, enablers, inputs, project-level benefits, and firm-level benefits. They suggest that the innovation decision is governed by those factors specified as the drivers. Iranmanesh et al. (2015) investigate the association between construction firms' characteristics and their level of innovative practices implementation, finding that old and big firms with non-public clients exercise more innovation creation practices, while young and small firms with public clients implement more innovation practices. Xue et al. (2014) provide a critical review of construction innovation, identifying collaboration, culture, innovation process, and drivers as critical factors to improve the performance of construction innovation. Bakrunov and Vasliyeva (2022) focus on the innovation approaches to providing construction companies with financial resources, defining the type of innovations occurring in the sphere of financing and crediting of construction companies as improving innovations or modification, aimed at the improvement of service while preserving the main functions and principles of the services rendering.

Innovation in construction is a multidimensional and dynamic process that involves generating and adopting new ideas and technologies. Ozorhon et al. (2009) propose a project lifecycle approach to investigate the ways in which innovation occurs in a construction project setting and the dynamics between project and firm level innovation. Gambatese and Hallowell (2011) identify three necessary components of innovation: idea generation, opportunity, and diffusion, and highlights the importance of practices and processes that encourage and facilitate innovative changes. Kulatunga et al. (2006) emphasizes the need to identify the prevailing nature of construction innovation with reference to enabling and disabling factors and ways to improve the performance of construction to address stakeholder needs. Harty (2005) argues that successful innovation requires consideration of the social and organizational contexts in which it is located, and that unbounded innovations require an approach to understand and facilitate the interactions both within a range of actors and between the actors and technological artifacts.

Overall, innovation in construction involves generating and adopting new ideas and technologies, and that understanding the innovation process, how innovation can be enhanced, and how it can be measured are key steps to managing and enhancing innovation in the construction industry. Innovative construction practices involve a range of factors, including drivers, barriers, enablers, inputs, project-level benefits, firm-level benefits, collaboration, culture, innovation process, and financial resources. From the different perspectives by scholars, innovative construction practices can be defined as the implementation of novel techniques, methods, technologies, and materials within the construction industry. These practices aim to improve efficiency, reduce costs, minimize environmental impact, enhance safety, and promote sustainable development. By embracing innovation, construction professionals can overcome traditional limitations and achieve higher standards in project execution and delivery.

2.4.2 Categories of Innovative Construction Practices

Different perspectives exist on the categories of innovative construction practices. Yusof et al. (2014) discuss innovation adoption and innovation creation. They argue that different skills, resources, and cultures are needed to encourage each innovation. They found that construction participants in Malaysia are categorized as innovation adopters. Gambatese and Hallowell (2011) identified three necessary components of innovation in construction: idea generation, opportunity, and diffusion. To optimize each aspect, various practices are employed, involving support and commitment from the owner/client and upper management, integration and diversity within the workforce and project team. Implementing these practices enhances innovation by fostering improved communication among team members, integrating design and construction disciplines, creating more efficient designs, finding unique approaches to work, and sharing knowledge gained from experiences. Ultimately, this innovation leads to successful projects that surpass cost, quality, schedule, and safety objectives. Akintoye et al. (2012) presented a collection of literature on construction innovation and process improvement, covering topics such as change management, technology, and supply chain management. The text presents three main themes of construction innovation: Theory and Practice, Process Drivers, and Future Technologies. It raises various questions, such as: What makes construction innovation unique in theory and practice? What are the key drivers of construction innovation? What factors are necessary to support and implement future construction technologies?

Davidson (2013) emphasizes a comprehensive approach to construction innovation, considering its effects on stakeholders and requiring organizational changes. Lim and Ofori (2007) classify innovations into three categories: those valued by consumers, cost-reducing for contractors, and providing intangible benefits and competitive advantage. Bessant (2006) observes widespread innovation in the construction industry, covering technological and organizational advancements. Bachas (2006) details past construction innovations, categorized into organizational, managerial, and technological interventions. The authors overall suggest classifying innovative practices based on stakeholder impact, benefits, and required intervention levels.

Koebel (2008) suggests that innovation in developing nations focuses on incremental or sustained improvements, like better building materials in Kenya. Stabilized soil blocks are used in Mathare Valley to upgrade slums cost-effectively (Diang’a, 2012). These blocks combine earth, water, and a small amount of cement to create strong elements like blocks, tiles, and foundations (Andabati, 2010). Using stabilised soil blocks and concrete floor waffles can save up to 50% of building costs, but adoption is limited due to traditional construction techniques that do not support innovative materials. To fully benefit, innovative construction methods are needed alongside innovative materials (Kvarnstrom, 2013).

Construction techniques refer to the methods and processes used in the construction of buildings and other structures. Construction materials refer to the various materials and substances used in the construction of buildings and other structures (Tylor, 2000; Dogne & Choudhary, 2014). Despite their numerous advantages over conventional procedures, novel materials and techniques have received hardly any attention. Construction uses numerous alternatives to conventional building materials. These materials include stabilized soil walling blocks, sisal cement roofing sheets, stabilized compacted earth floors, lean concrete elements, expanded polystyrene wall cores, and recycled composites. Cost, ease of production, availability of basic materials, and social acceptance influence innovative building technologies dissemination and adoption. However, conventional building materials such as concrete and quarry stones continue to dominate the market and are ineffective for low-income households. Locally produced building materials, such as stabilized soil blocks (SSBs), can have an abundant supply of raw materials, generate more employment opportunities, require skills that are readily obtainable, and are more economical and environmentally sustainable (Kvarnstrom, 2014).

Concrete's strength, compactness, and ductility have reached previously unimaginable levels due to tremendous technological advancements in recent years. Due to these improved material properties, the strength and durability of concrete structures are greatly enhanced; their weight and dimensions are reduced, expanding the use of concrete as a structural material, and despite the increased material costs, overall economy is possible, with positive effects on sustainability as well (Madurwar, Ralegaonkar, & Mandavgane, 2013). Similar developments are occurring in reinforced materials, such as high-strength steel and fiber-reinforced polymers, and in the way they are combined with concrete to create high-performance structures. Developments in materials and equipment, as well as novel ideas, have resulted in innovative construction techniques, reducing costs and construction time, and enabling the use of concrete in extreme construction or environmental conditions (Pacheco, 2014).

The literature on innovation distinguishes "product innovations" from "process innovations." Product innovations involve new or improved labor and products, while process innovations enhance the methods of delivering these labor and products (Reichstein & Saltzman, 2006). Product development in the manufacturing industry is less frequent due to the unique characteristics and limited-service life of many structural components, affecting inventory levels and manufacturers' motivation to change processes (Gann, 1994). Process improvements in development can reduce ongoing expenses by decreasing creation time or material waste (Gann, 1994).

Process development involves enhancing cycle developments, such as new or improved tools and equipment that directly impact product delivery (Reichstein & Saltzman, 2006). The construction industry faces obstacles to innovation, including various principles, industry discontinuity, business cycles, and risk avoidance, making it hesitant to adopt innovations (Hass, Rose, & Gerbb, 1997). Prior research has focused on elucidating the causes of slow progress in the industry, exploring the propensity of individuals or organizations to adopt innovations and the factors influencing adopters' capacity to do so (Attwell, 1992; Taylor & Levvit, 2004).

From the foregoing discussion, categories of innovative construction practices can therefore be broadly classified into three main areas: materials, technologies, and processes. Each of these categories encompasses various advancements and breakthroughs that have revolutionized the construction industry.

2.4.3 Examples of innovative construction practices

Slum upgrading programs have been instrumental in improving the living conditions of people residing in informal settlements. To effectively address the challenges faced by slum dwellers, innovative construction practices have been implemented to provide sustainable and affordable housing solutions. Bamigboye et al. (2019)

examined various innovative materials, such as nanotechnology, mineral admixture, glass, plastic, biological materials, and wood, contributing significantly to the growth of construction innovations.

The use of sisal in the construction industry offers several advantages. Sisal-cement roofing sheets reduce cracking and internal forces in concrete, allowing for weight savings in comparison to conventional concrete. It maintains crack width below 100m even when loaded beyond the elastic limit and does not corrode at its interface with concrete, making it suitable for structures where corrosion avoidance is crucial (Muraguri, 2011). Sisal-fiber reinforced concrete enhances tensile and bending strength, ductility, and crack resistance, resulting in increased impact strength and toughness (Gram & Skarendahl, 1978). However, it should be noted that exposure to alkaline solutions can affect the strength of sisal and coconut fibers (Tohelo et al., 2000). Ismail (2007) found that the tensile strength of natural fiber-reinforced cement-based composites increases by approximately 53% as the fiber volume fraction increases, while the compressive strength decreases.

Meredith and MacDonald (2017) observed that a hybrid approach that engages the community while mobilizing the resources of governments and large agencies overcame limitations of community-based organizations in slum upgrading programs in Kibera, Kenya. Huchzermeyer (2008) discusses the challenges of slum upgrading in Nairobi, highlighting the need to address market distortions to prevent displacement of slum residents. El-Anwar and Aziz (2014) propose an integrated urban-construction planning framework for slum upgrading projects that incorporates participatory upgrading and aims to maximize the benefits of upgrading projects. However, they do not provide specific examples of innovative construction processes used in slum upgrading programs. Overall, literature shows that innovative construction processes have been used in slum upgrading programs to improve the physical infrastructure and living conditions of slum dwellers, but effective monitoring and community engagement are critical to ensure successful implementation and maintenance of interventions.

Gebremariam et al. (2020) discussed the development of large-scale technologies for recycling end-of-life concrete waste into coarse, fine, and ultrafine particles, which can be used to produce concrete with comparable mechanical properties to natural aggregates. Kurtis (2015) reviewed developments in expanding the use of supplementary cementitious materials, alternative cements and binder technologies, and developing alternative reinforcement options, which have the potential to transform the ways in which infrastructure is specified, designed, and constructed. Scrivener and Kirkpatrick (2008) discussed innovations in concrete technology, including high and ultra-high-performance concrete and self-consolidating concrete, and the importance of sustainability as a driver for future innovations. Overall, innovative construction technologies can be used to improve the quality of housing and infrastructure in slum upgrading programs, and that there is ongoing research and development in this area.

Bredenoord and Kulshreshtha (2023) highlight the use of compressed stabilized earth blocks (CSEB) and interlocking stabilized soil blocks (ISSB) in participatory social housing projects in Africa, Asia, and Latin America. Kwan et al. (2017) examine the engineering properties of stabilized soil blocks using different stabilizers, including cement, slaked lime, bitumen emulsion, and calcium silicate. Ali et al. (2017) present a technique for building low-cost housing in Egypt using compressed stabilized earth building bricks. Olaleye and Ibitoye (2023) assess architects' response to the adoption of ISSBs as an alternative building material for housing projects in Southwest Nigeria.

Earth blocks are a cost-effective construction option as they utilize widely available soil (Adam & Agib, 2001). Soil is suitable for many building components, consuming only about 1% of the energy required for cement concrete. Earth blocks require minimal specialized equipment, making them less expensive and readily available. However, production costs should not be the only consideration; expensive additives and transportation costs affect the overall expense. Properly compressed and stabilized earth blocks do not need external renderings, reducing labor and mortar requirements. Various tools and equipment can be locally used to make earth blocks, such as the CINVA-RAM machine (Nam & Tatum, 2004).

Compressed Stabilized Earth Blocks (CSEB) face two main challenges: durability and compressive strength. Water weakens CSEB, reducing block strength (Guettala et al., 2014). There's a need to develop cost-effective and eco-friendly alternatives to address these concerns. Past research has explored adding materials like sand, fly ash, and quarry dust to enhance compressive strength, but not significantly durability. Many failures reported in different countries are related to the durability of CSEB. Previous research established the optimal clay and silt content for compressive strength, but not for durability (Nagaraj, Sravan, Arun & Jagadish, 2014).

Both stabilized soil blocks and sisal-cement roofing have been successfully used in slum upgrading programs. These innovative construction practices offer sustainable and cost-effective solutions for improving housing conditions in slum areas. By utilizing local resources and promoting environmentally friendly techniques, these practices not only provide better housing options but also contribute to the overall development and upliftment of slum communities. Overall, stabilized soil blocks and sisal-cement roofing are cost-effective and sustainable building materials that can be used in slum upgrading programs.

2.5 Social Impact of Innovative Construction Practices

2.5.1 Improved housing quality and living conditions

Social impact refers to the long-term effects or changes to individuals or communities arising from interventions, activities by development sectors or organizations. The impact can be positive, negative planned or unforeseen. Impact assessment findings can be used to improve activities, interventions while gathering information for use in future enterprises.

Literature suggests that slum upgrading interventions can have positive effects on health and living conditions, but there are challenges to achieving sustainability and measuring the impact of interventions. Henson et al. (2020) found that physical slum upgrading interventions in Latin America improved quality of life and reduced communicable improved ease of transportation and safety. However, Doe et al.

(2020) found that conventional urban upgrading interventions may not be sustainable in low-income neighbourhoods. Doe et al. (2020) argue that slum upgrading can promote health equity, but few evaluations capture the multiple health benefits of upgrading. Turley et al. (2013) found that the effect of slum upgrading on health and socio-economic outcomes is unclear due to a high risk of bias and heterogeneity in the studies. Overall, the authors suggest that slum upgrading interventions can improve living conditions and health outcomes, but more research is needed to understand the impact of interventions and how to achieve sustainability.

The social impact of innovative construction practices in slum upgrading programmes is evident through the improved housing quality and living conditions experienced by slum residents (Henson et al., 2020; Corburn & Sverdlik, 2017). These practices provide safer, more functional, and aesthetically pleasing housing units, promoting health, well-being, and a sense of community among residents. By addressing the basic needs and aspirations of slum dwellers, innovative construction practices contribute to the overall social development and empowerment of marginalized communities.

2.5.2 Enhancing community participation and empowerment

Literature suggests that community participation and empowerment are important for successful slum upgrading programs. Mehrolhasani et al. (2021) found that residents' participation in expressing problems and solutions was the most effective intervention for community empowerment. However, they noted that community empowerment for health promotion in urban slums still faces challenges. Muchadenyika (2015) highlighted the importance of inclusive municipal governance and community partnerships in tackling city challenges. Harare Slum Upgrading Programme sought to change the story of evictions, fear and misery for the urban poor in Zimbabwean cities. This was to be achieved through creating and strengthening municipal and community partnerships to tackle city challenges in an inclusive manner. Rigon (2014) cautioned that elite capture can undermine the outcomes of development projects and that participation needs careful management and external agency to achieve genuine social transformation. The author observed that community and democratic participation are still an essential component of current mainstream development interventions. However, elite capture seriously undermines the outcomes of development projects. Baker and McClain (2009) explored the challenges and opportunities for scaling up private sector participation in slum upgrading activities, including financing of incremental housing solutions. Overall, community participation and empowerment, along with inclusive governance and partnerships, are key to successful slum upgrading programs.

The social impact of innovative construction practices in slum upgrading programmes extends beyond improved housing conditions, extending to enhanced community agency, pride, and the pursuit of sustainable development (Mehrolhasani et al., 2021; Muchadenyika, 2015). Innovative construction practices in slum upgrading programmes enhance community participation and empowerment by incorporating participatory design, promoting skill development, fostering collective action, and contributing to social transformation. By involving residents in the construction process and decision-making, these practices empower communities to shape their living environment, build social cohesion, and develop leadership capacities.

2.5.3 Impact on social cohesion and community development

Literature suggests that slum upgrading programs can have positive effects on social cohesion and community development. Mitra et al. (2017) found that slum upgrading interventions can reduce conflict, crime, insecurity, and flood risks, and subsequently strengthen resilience in highly dense and complex urban environments, if they include processes that build the social contract, build bridging social capital between ethnic groups, and integrate different sectoral interventions. Patel (2013) argues that successful outcomes of slum upgrades are intrinsically tied to the manner in which the upgrade process is implemented. Meredith et al. (2021) describe a successful slum upgrading initiative in Kibera, Nairobi, that relied heavily on community engagement to build trust, encourage active participation, and define community concerns.

Boonyabancha (2005) describes an ambitious national slum and squatter upgrading program launched by the Thai government in 2003 and implemented through the Community Organizations Development Institute (CODI), which seeks to "go to scale" by supporting thousands of community-driven initiatives within citywide programs designed and managed by urban poor networks working in partnership with local actors. Overall, slum upgrading programs can have positive effects on social cohesion and community development if they involve community engagement, build social capital, and integrate different sectoral interventions. By enhancing social cohesion and community development, innovative construction practices contribute to creating vibrant, inclusive, and resilient communities. These practices empower individuals, strengthen social relationships, and improve living conditions, laying the foundation for sustainable social development and positive community transformation in slum upgrading programmes.

2.5.4 Health and Well-Being Benefits for Slum Residents

Literature suggests that slum upgrading programmes can have positive health and well-being benefits for slum residents, but the evidence is limited and mixed. Henson et al. (2020) found that physical environment slum upgrading interventions in LMICs can improve quality of life and communicable diseases, but the effects may vary by regional context and intervention scope. Corburn and Sverdlik (2017) argue that slum upgrading should be viewed as a key strategy to promote health, equitable development, and reduce climate change vulnerabilities, but few evaluations capture the multiple health benefits of upgrading. Turley et al. (2013) found that slum upgrading may reduce the incidence of diarrhea diseases and water-related expenditure, but there is a high risk of bias within the included studies, heterogeneity, and evidence gaps. Bhan (2013) also found reductions in communicable diseases, particularly incidence of diarrhea, but rigorous studies with a low risk of bias and longer follow-ups are needed to allow firm conclusions to be drawn on the impact of slum upgrading strategies.

Slum upgrading programs can improve health and well-being benefits for slum residents. Mitra et al. (2017) found that slum upgrading interventions can reduce conflict, crime, insecurity, and flood risks, and subsequently strengthen resilience in highly dense and complex urban environments, if they include processes that build the social contract, build bridging social capital between ethnic groups, and integrate different sectoral interventions. Lilford et al. (2017) argues that slum health should be promoted as a topic of enquiry alongside poverty and health, and that census tracts should be designated slum or non-slum to inform local policy and research studies. Overall, while slum upgrading programmes have the potential to improve health and well-being benefits for slum residents, more research is needed to understand the specific interventions that work and for whom.

2.6 Economic Impact of Innovative Construction Practices

2.6.1 Cost-Effectiveness and Affordability of Innovative Construction Practices

Economic impact relates to the changes in monetary aspects such as employment, income, levels of business activity or value addition within a society or community resulting from an intervention such as a project or program. Innovative construction practices in slum upgrading programmes have significant economic implications, particularly in terms of cost-effectiveness and affordability. innovative construction practices often offer cost-effective solutions compared to traditional construction methods. By utilizing locally available and affordable materials, such as recycled materials or alternative construction techniques, costs can be significantly reduced. This cost-effectiveness is particularly important in slum upgrading programmes, where limited financial resources are a common challenge. Innovative practices can help reduce construction costs through various means. For example, prefabrication techniques enable faster and more efficient construction, minimizing labour costs and construction time. Additionally, the use of sustainable and durable materials can reduce maintenance and repair expenses in the long run.

The affordability of housing is a key concern in slum upgrading programmes. Innovative construction practices can provide affordable housing options for slum dwellers by utilizing cost-effective materials and technologies (Flinck, 2016; Aggrey-Korsah & Oppong (2013)). These practices offer opportunities to address the housing needs of low-income communities and ensure that the upgraded housing remains within their financial means. Innovative construction practices can contribute to local economic development. By utilizing locally available materials and engaging local labor, these practices stimulate economic activities within the community. They create employment opportunities for local workers, contractors, and suppliers, thereby improving the economic well-being of the community and reducing dependency on external resources.

Innovative construction practices have the potential to enable sustainable income generation for slum dwellers. For example, training and capacity-building programs in construction skills can empower community members to become self-employed or engage in income-generating activities related to construction (Mehrolhasani et al., 2021). This enhances their economic resilience and reduces dependence on informal and low-paying jobs. The implementation of innovative construction practices can have multiplier effects on the economy (Hemati et al., 2019). It stimulates demand for construction-related goods and services, such as building materials, equipment, and transportation. This increased economic activity can generate additional jobs and income opportunities beyond the construction sector, benefiting the local economy as a whole.

According to Kurtis (2015), innovative construction practices offer the potential for long-term financial sustainability in slum upgrading programmes. By reducing construction and maintenance costs, these practices contribute to the economic viability and sustainability of the upgraded housing. This, in turn, allows for the allocation of financial resources towards other development priorities, such as social services, infrastructure, and community development. To maximize the economic impact of innovative construction practices, it is important to address potential challenges and barriers (Rivera-Padilla, 2021). These may include initial investment costs, skill gaps among local workers, and limited access to finance. Collaboration with microfinance institutions, development agencies, and private sector entities can help enhance affordability and access to funding.

2.6.2 Employment Generation and Local Economic Development

Innovative construction practices in slum upgrading programmes not only bring about social benefits but also have a significant economic impact, particularly in terms of employment generation and local economic development. According to Mesplé-Somps (2021), innovative construction practices create employment opportunities at various stages of the construction process. The adoption of new technologies and materials often requires skilled labour, providing job opportunities for local communities. This includes roles in construction, project management, engineering, architecture, and related services. Increased employment opportunities can reduce unemployment rates, enhance income levels, and alleviate poverty among slum residents.

The implementation of innovative construction practices necessitates the development of specialized skills (Mesplé-Somps et al., 2021). Training programs and capacity-building initiatives can equip local residents with the knowledge and expertise needed to engage in construction-related activities. Skill development contributes to the human capital of the community, enhancing employability and fostering economic self-sufficiency. Innovative construction practices can stimulate local economic development by promoting local sourcing of materials and services (Marx et al., 2013). Utilizing locally available materials and engaging local suppliers and contractors supports local businesses and creates economic linkages within the community. This multiplier effect boosts the local economy by circulating money within the community and creating additional employment opportunities in related industries.

The implementation of innovative construction practices contributes to the overall development of the construction industry in the region. This includes advancements in construction techniques, improved building standards, and the transfer of knowledge and skills (Yeboah et al., 2021). A thriving construction industry attracts investments, stimulates economic growth, and enhances the long-term sustainability of the local economy. To maximize the economic impact of innovative construction practices, it is essential to ensure local participation, capacity building, and the integration of local businesses into the supply chain (Muchadenyika, 2015). Collaborative efforts between government agencies, private sector entities, and community organizations can promote inclusive economic development, ensuring that the benefits of innovative construction practices are shared among all stakeholders. Furthermore, fostering partnerships with regional and international actors, such as development agencies, donors, and investors, can unlock additional resources, expertise, and market opportunities. These collaborations can support the scaling up of innovative construction practices, facilitate technology transfer, and attract investment for sustainable economic growth.

2.6.3 Potential for Sustainable Income Generation for Slum Dwellers

Innovative construction practices in slum upgrading programmes not only contribute to improved housing conditions but also have the potential to generate sustainable income opportunities for slum dwellers (Núñez Collado & Wang, 2020). By empowering individuals and communities economically, these practices can alleviate poverty and enhance the overall economic well-being of slum residents. Innovative construction practices often require a skilled and unskilled labour force, creating employment opportunities for slum dwellers. By involving local residents in construction projects, these practices contribute to job creation and income generation within the community (Ghanam & El-Deep, 2021). The demand for labour in construction activities stimulates the local economy and provides a source of income for individuals who may have previously been unemployed or engaged in informal, low-income work. Poverty reduction has not been significantly achieved in Mathare after the upgrade (Diang'a, 2012).

According to Agayi and Serdaroğlu Sağ (2020), innovative construction practices can facilitate the establishment and growth of microenterprises and small businesses within slum areas. Local entrepreneurs may seize opportunities to provide construction-related services, such as masonry, carpentry, or supply of construction materials. This entrepreneurial activity not only generates income for individuals but also contributes to the development of the local economy and the emergence of a more vibrant business ecosystem. The implementation of innovative construction practices often involves training and capacity-building programs. These initiatives equip slum dwellers with construction-related skills, improving their employability and income-earning potential (Baker & McClain, 2009). By providing training opportunities, residents can acquire specialized skills and qualifications that enable them to access higher-paying jobs in the construction sector or start their own construction-related businesses.

Innovative construction practices create opportunities for income diversification among slum dwellers (Bhan, 2013). By engaging in construction-related activities, individuals can supplement their existing sources of income or transition from informal, low-income occupations to more sustainable livelihood options. Income diversification reduces the vulnerability of slum dwellers to economic shocks and enhances their overall financial stability. The implementation of innovative construction practices can stimulate local economic linkages and value chains (El-Anwar & Aziz, 2014). This includes the procurement of construction materials from local suppliers, the engagement of local transport services for logistics, and the utilization of locally available resources. Such linkages create multiplier effects, generating economic opportunities beyond the construction sector and benefiting various stakeholders within the local economy.

Upgraded housing resulting from innovative construction practices can increase property values within slum areas (Cronin, 2012). As property values rise, slum dwellers may benefit from increased equity and improved access to credit and financial services. This creates opportunities for asset creation and wealth accumulation, providing a foundation for long-term economic stability and mobility. Flinck (2016) argues that to fully realize the potential for sustainable income generation, it is essential to address challenges and barriers such as limited access to finance, inadequate infrastructure, and regulatory constraints. Governments, in collaboration with development partners and microfinance institutions, can provide targeted financial support, including access to affordable credit and microloans, to enable slum dwellers to invest in income-generating activities related to innovative construction practices.

2.6.4 Economic Multiplier Effects in the Construction Sector

Innovative construction practices in slum upgrading programmes not only have direct economic impacts but can also generate multiplier effects within the construction sector and the broader economy (Ghanam & El-Deep, 2021). These multiplier effects create a ripple effect of economic benefits, stimulating growth, employment, and income generation. Innovative construction practices often require specialized skills and labour, leading to increased employment opportunities within the construction sector (Hemati et al., 2019). As the demand for innovative practices grows, more workers are needed, including architects, engineers, skilled craftsmen, and laborers. This expansion of employment helps reduce unemployment rates, particularly in areas with high levels of poverty and informal employment.

The implementation of innovative construction practices requires the procurement of materials, equipment, and services, creating opportunities for local suppliers and businesses (Kondapi et al., 2019). This stimulates economic activities along the construction supply chain, benefiting suppliers of construction materials, transport providers, equipment rental companies, and other related industries. The increased demand for construction materials can also drive the growth of local manufacturing and production sectors. The economic multiplier effects extend beyond the construction sector. As construction activities increase, it leads to additional spending on goods and services in the local economy. Workers' incomes are spent on housing, food, transportation, and other necessities, contributing to the growth of local businesses and service sectors. This increased economic activity can have a positive impact on the overall development and prosperity of the community (Marx et al., 2013).

Meredith et al. (2021) observed that successful implementation of innovative construction practices attracts both public and private investments. The construction of upgraded housing and infrastructure improves the attractiveness of the area for further investments, such as commercial developments, tourism, and business expansion. This, in turn, creates additional employment opportunities and stimulates economic growth in the long term. Innovative construction practices require specialized skills and knowledge. As workers gain experience in these practices, their skills become more valuable, leading to enhanced human capital within the construction sector. The development of skilled workers contributes to a more productive workforce, supporting economic growth and competitiveness (Mesplé-Somps et al., 2021).

The implementation of innovative construction practices promotes technological advancement within the construction sector (Winarso, 2022). This can drive innovation, research, and development activities, leading to the creation of new technologies, building materials, and construction techniques. Technological advancements not only improve efficiency and productivity but also create opportunities for entrepreneurship and new business ventures. The economic multiplier effects of innovative construction practices have the potential to alleviate poverty and improve income levels within the community. The creation of jobs and increased economic activities provide opportunities for individuals and households to generate income, leading to improved living standards and economic well-being.

By leveraging the economic multiplier effects in the construction sector, innovative construction practices in slum upgrading programmes can contribute to sustainable economic development and poverty reduction (Xue et al., 2014). However, it is important to ensure that the benefits are distributed equitably and that the local community is actively involved and engaged in the economic activities generated by these practices. This requires appropriate policies, capacity building, and coordination among stakeholders to maximize the positive economic impacts and create a more inclusive and resilient local economy.

2.6.5 Economic Feasibility and Long-Term Financial Sustainability

Innovative construction practices in slum upgrading programmes have the potential to generate significant economic impacts at various levels. The economic feasibility and long-term financial sustainability of these practices are critical considerations for their successful implementation. One of the key advantages of innovative construction practices is their potential to reduce construction costs. By utilizing locally available and affordable materials, adopting efficient construction technologies, and streamlining construction processes, innovative practices can lower the overall cost of slum upgrading projects. This cost-effectiveness enhances the affordability of housing for both residents and implementing agencies, making the projects financially viable.

The long-term financial sustainability of innovative construction practices is crucial for their wider implementation and scalability. Projects that demonstrate financial viability, such as through cost savings, efficient resource utilization, and revenue generation, are more likely to attract sustained funding and support from stakeholders and investors. The replicability of successful innovative practices in different slum contexts enhances their long-term impact and financial sustainability. Collaboration between public and private sectors, as well as the involvement of development finance institutions, can contribute to the economic viability of innovative construction practices. Public-private partnerships can leverage private sector expertise, resources, and financing to ensure the successful implementation and long-term sustainability of slum upgrading projects.

To ensure the economic feasibility and long-term financial sustainability of innovative construction practices, it is important to establish robust financial management systems, including transparent budgeting, cost monitoring, and revenue-generating mechanisms. Long-term planning, cost projections, and risk assessments should be integrated into project implementation. Additionally, capacity-building efforts for local communities and stakeholders can enhance financial literacy and entrepreneurial skills, enabling them to actively participate in income-generating activities and contribute to the financial sustainability of the projects. By considering the economic feasibility and long-term financial sustainability of innovative construction practices, slum upgrading programmes can create positive economic impacts that promote self-reliance, economic growth, and poverty reduction within the community.

2.7 Past Innovation Construction Frameworks

2.7.1 Dynamic Framework of Innovative Construction Organization

According to Motawa, Price and Sher (1998), the framework on Figure 2. 2 shows how innovation is introduced and managed in a construction organization. They defined innovation as "the creation and implementation of new processes, products, services and methods of delivery which result in significant improvements in outcomes efficiency, effectiveness or quality" (Motawa *et al.*, 1998). The framework consists of three main sections: Innovation driving forces, Construction Organization, and Consensus process. Innovation driving forces are the factors that motivate the organization to innovate, such as market demand, competition, technology, regulation, etcetera. They lead to the creation of new ideas that can improve the performance of the organization. However, these ideas may face barriers such as resistance to change, lack of resources, organizational culture, etc. that hinder their implementation.

Construction Organization is the internal environment of the organization that consists of its strategy, structure and projects. The strategy defines the vision, mission, goals and objectives of the organization. The structure determines how the organization is organized, coordinated and controlled. The projects are the specific activities that the organization undertakes to deliver its products or services. These three elements interact with the new ideas and influence their acceptance or rejection.

Consensus process is the process of building agreement among the stakeholders of the organization on whether to implement the new ideas or not. It involves an initial decision to accept or reject the ideas based on their feasibility, suitability and desirability. If the ideas are accepted, they move to the implementation process where they are executed and evaluated. If they are rejected, they are either discarded or modified and resubmitted for another decision.

The framework suggests that innovation is incremental, meaning that it occurs through a series of small changes rather than radical transformations1. It also implies that innovation is dynamic, meaning that it is influenced by both external and internal factors that change over time1. Therefore, the organization needs to be flexible and adaptable to respond to these changes and foster a culture of innovation. Figure 2.1 shows the dynamic framework of innovative construction organization by Motawa *et al.* (1998).

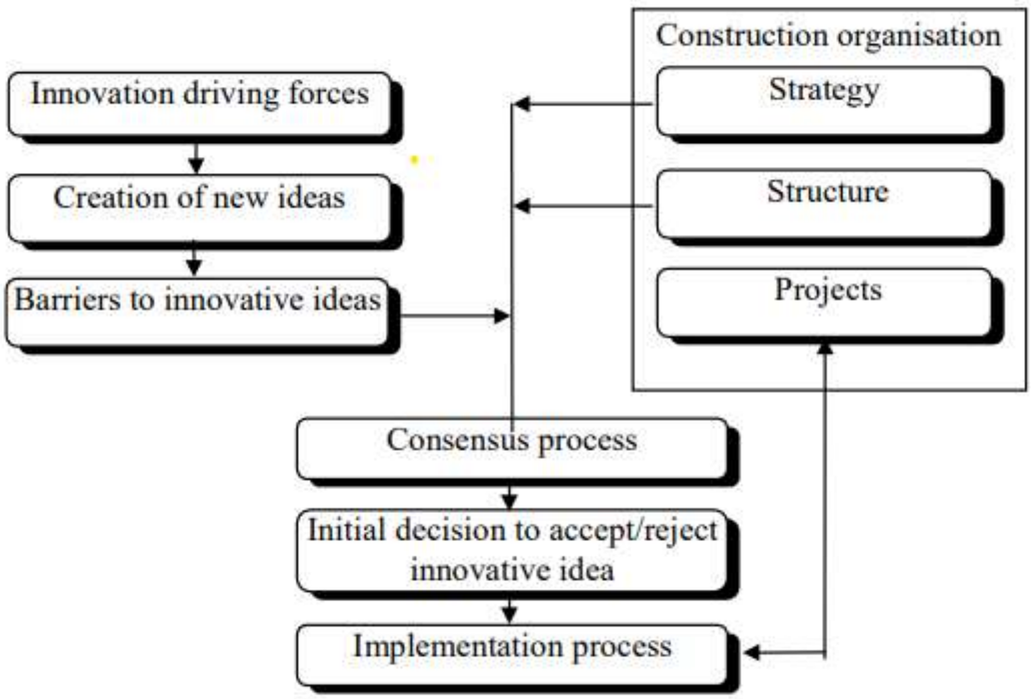


Figure 2.2: Dynamic Framework of Innovative Construction Organization

Source: Motawa *et al.* (1998)

2.7.2 Technology and Knowledge Fusion for Construction Industry

Yamazaki (2004) developed technology and knowledge fusion for construction industry. The manufacturing industry contributes significantly in construction technology and knowledge through prefabrication, industrialization, modularization, automation, mechanization, and computerization. The fusion of prefabrication, automation, construction, and information technologies are seen to transform the construction industry. It has led to emergence of new construction system. Figure 2.2

shows the conceptual view of technology and knowledge fusion for construction industry.

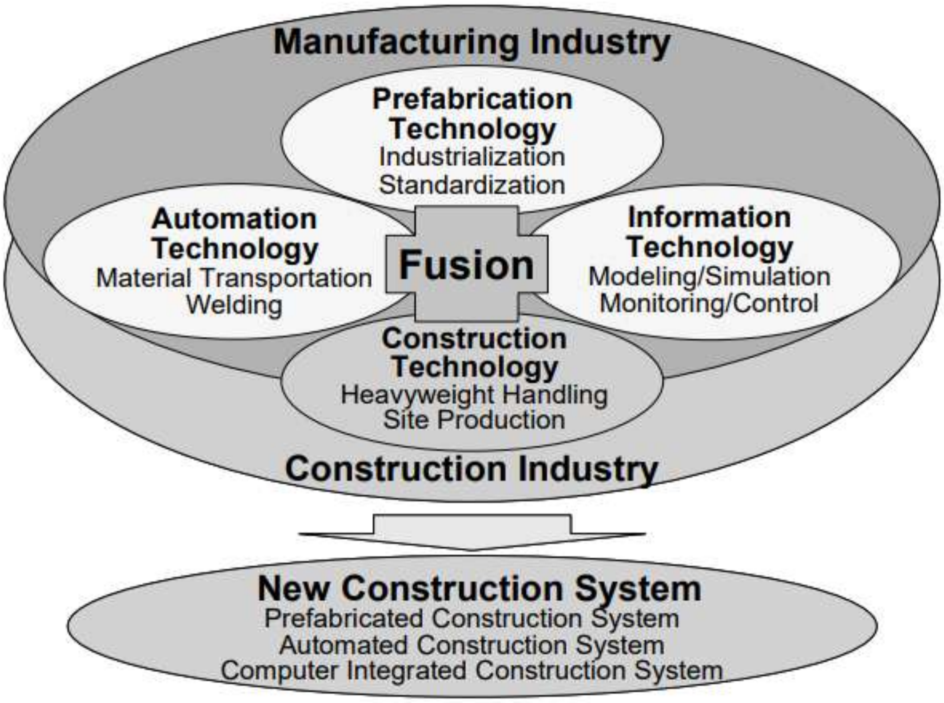


Figure 2.3: Technology and Knowledge Fusion for Construction Industry

Source: Yamazaki (2004)

Yamazaki (2004) explores how the manufacturing and construction industries can collaborate to create innovative, efficient, and sustainable construction systems. Manufacturing expertise includes prefabrication, industrialization, automation, material science, and welding. The construction industry excels in new construction systems, prefabricated and automated construction systems, and computer-integrated construction systems. Both industries can share knowledge in construction technology, heavyweight site handling, modelling/simulation, and monitoring/control. Such collaboration can lead to improved quality, cost-effectiveness, and productivity in construction projects.

2.7.3 Future Directions of Construction Technologies

Yamazaki (2004) added two elements that will inform technology and knowledge for construction industry in the future. These include new material technology and environment preservation technology. The emerging new construction will comprise of new production system and new business system. Figure 2.3 shows future directions of construction technologies.

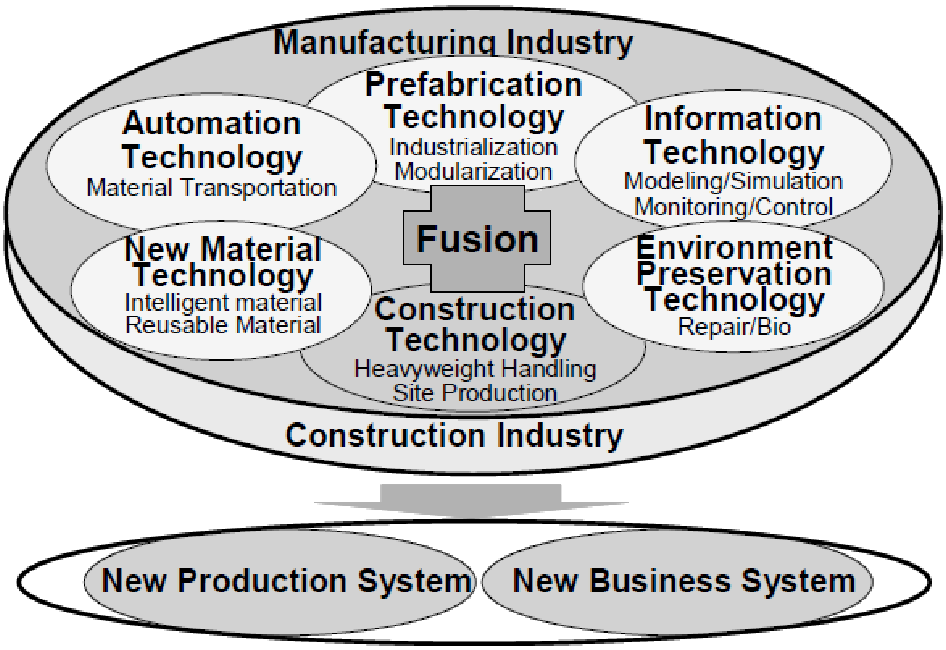


Figure 2.4: Future Directions of Construction Technologies

Source: Yamazaki (2004)

Yamazaki (2004) demonstrates the synergy achieved by combining various technologies to innovate solutions in manufacturing and construction. The crux lies in the significance of new material technology and environment preservation technology, as they shape the future of these industries. New material technology entails developing materials that surpass existing ones in performance, durability, functionality, and sustainability. Environment preservation technology focuses on implementing measures to reduce the environmental impact of manufacturing and construction processes. This encompasses energy efficiency, waste management, pollution control, and resource conservation.

Furthermore, Yamazaki (2004) illustrates the integration of these elements with other technologies like automation, information technology, modelling/simulation, monitoring/control, repair/bio, heavyweight handling, and site production. This seamless amalgamation enhances productivity, quality, safety, and cost-effectiveness in manufacturing and construction. As a result, Yamazaki (2004) proposes that this fusion could lead to novel production and business systems. The new production systems facilitate more efficient and adaptable production of goods and services, such as prefabrication, industrialization, and material transportation. On the other hand, new business systems create fresh value propositions and competitive advantages for the manufacturing and construction industries. These encompass customer satisfaction, innovation, and social responsibility.

2.7.4 Innovation Value Chain Model

Hansen and Birkinshaw (2007) developed innovation value chain at the firm level. It comprises of idea generation, conversion, and diffusion stages. The idea generation stage entails activities that take place in-house within units, collaborations across units, and collaboration with parties outside firm. The conversion stage involves selection and development. It is in this stage that screening and funding takes place. It also sees the transformation from the idea to first result. The next and final stage is diffusion which entails dissemination across the firm. Figure 2.4 shows the innovation value chain model.

	IDEA GENERATION			CONVERSION		DIFFUSION
	In-house	Cross-pollination	External	Selection	Development	Spread
	Creation within a unit	Collaboration across units	Collaboration with parties outside the firm	Screening and initial funding	Movement from idea to first result	Dissemination across the organisation
Key questions	Do people in our unit create good ideas on their own?	Do we create good ideas by working across the company?	Do we source enough good ideas from outside the firm?	Are we good at screening and funding new ideas?	Are we good at turning ideas into viable products, businesses, and best practices?	Are we good at diffusing developed ideas across the company?
Key performance indicators	Number of high-quality ideas generated within a unit.	Number of high-quality ideas generated across units.	Number of high-quality ideas generated from outside the firm.	Percentage of all ideas generated that end up being selected and funded.	Percentage of funded ideas that lead to revenues; number of months to first sale.	Percentage of penetration in desired markets, customer groups; number of months to full diffusion.

Figure 2.5: Innovation Value Chain Model

Source: Hansen and Birkinshaw (2007)

According to Hansen and Birkinshaw (2007), the innovation value chain presents a framework to evaluate innovation performance in three phases: idea generation, conversion, and diffusion. Each phase contains two or three essential tasks for successful innovation. In-house involves generating ideas within firm units or functions, requiring creativity, experimentation, and problem-solving by employees. Cross-pollination entails generating ideas across different units or functions, necessitating collaboration, knowledge sharing, and integration of diverse perspectives. External involves generating ideas from external sources like customers, suppliers, partners, or competitors, necessitating scanning, networking, and open innovation practices. Selection involves choosing the best ideas from the pool of generated ideas, requiring evaluation, prioritization, and alignment with the firm's strategy and goals. Development involves transforming selected ideas into prototypes, products, or services, requiring testing, refinement, and iteration. Screening and initial funding refer to allocating resources and support for idea development, involving budgeting, sponsorship, and governance of innovation projects. Movement from idea to first result entails delivering the first tangible outcome of the innovation process, involving execution, launch, and feedback. Spread involves spreading developed ideas within the firm, requiring adoption, adaptation, and scaling of innovation outputs. Dissemination involves spreading developed ideas outside the firm, involving marketing, distribution, and commercialization of innovation outputs.

2.7.5 Framework for Analyzing Innovation in Construction

The innovation analysis framework for construction by Ozorhon, Abbott, Aouad, and Powell (2010) adopt a project lifecycle approach. Its purpose is to comprehend the contributions of various actors in promoting innovation across the stages of a construction project. Built upon Hansen and Birkinshaw's (2007) innovation value chain model, this framework categorizes the innovation process into three phases: idea generation, conversion, and diffusion. When applied to the construction context, it identifies the drivers and hindrances to innovation at each phase. The framework also furnishes a set of indicators to measure innovation performance. Figure 2.6 shows the framework for analyzing innovation in construction.

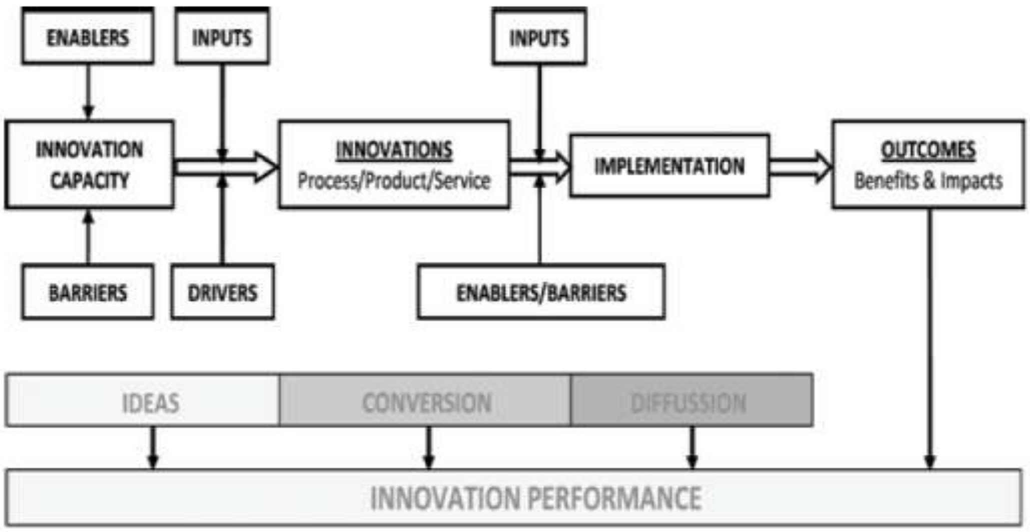


Figure 2.6: Framework for Analyzing Innovation in Construction

Source: Ozorhon, Abbott, Aouad, and Powell (2010)

The diagram illustrates the attainment of innovation performance through three stages: idea generation, innovation conversion, and diffusion into the market or society. Each stage involves distinct factors that either facilitate or impede the innovation process, including knowledge, investment, capacity, inputs, implementation, and outcomes. Furthermore, the diagram implies that the innovation outcomes can loop back into the idea generation stage, establishing a cycle of continuous improvement.

Past frameworks and models on innovation in construction seem to emphasize on the processes, products and technology and downplayed the socio-economic aspects that determined innovation in construction. They also seem to have evolved with time from basic ideas implemented by organizations to encompassing many and complex elements determined by diverse players in the construction and related industries. This necessitated review of innovation practices (technologies, materials, and processes) in the lens of socio-economic aspects that inform use of innovation in construction projects such as slum upgrading.

2.8 Challenges to Implementation of Innovative Construction Practices

2.8.1 Technical Constraints and Skill Gaps

Innovative construction practices in slum upgrading programmes are often hindered by various challenges and barriers. Among these, technical constraints and skill gaps pose significant obstacles to the successful implementation of innovative practices (Kishan et al., 2022). Implementation of innovative construction practices requires a certain level of technical expertise and knowledge. However, in many cases, implementing agencies and local communities may lack the necessary technical skills and capacity to effectively utilize these practices (Rigon, 2014; Meredith et al., 2021). Limited understanding of innovative technologies, design principles, and construction techniques can impede their proper implementation. Addressing these challenges and barriers requires building the technical capacity of construction workers, local artisans, and community members through training and education programs.

Collaborative efforts between government agencies, non-governmental organizations, academia, and private sector entities can bridge the skill gaps and technical constraints. According to Meredith et al. (2021), partnerships can facilitate the transfer of knowledge, provide technical support, and encourage the exchange of best practices. By addressing technical constraints and skill gaps, stakeholders can overcome barriers to the implementation of innovative construction practices in slum upgrading programmes. This, in turn, can enhance the effectiveness, sustainability, and long-term impact of these practices, leading to improved housing conditions and better quality of life for slum dwellers.

2.8.2 Institutional and Regulatory Challenges

According to Van der Molen (2015), the implementation of innovative construction practices in slum upgrading programmes is often hindered by various institutional and regulatory challenges. These challenges can significantly impact the successful implementation and scalability of innovative practices. Existing building codes and regulations, for example, may not adequately accommodate or support the use of innovative construction practices (Van der Molen, 2015). These codes often prioritize traditional construction methods and materials, making it difficult for innovative practices to gain acceptance and compliance. Revising and updating building codes to incorporate and encourage the use of innovative practices is essential to facilitate their implementation.

The bureaucratic processes involved in obtaining approvals and permits for construction projects can be time-consuming and cumbersome (Udo-Udoma, 2014). The complexity of these processes can pose challenges for innovative practices that may not fit within the traditional approval frameworks. According to Akintoye et al. (2012), streamlining and simplifying approval processes, establishing dedicated review mechanisms for innovative practices, and providing clear guidelines can facilitate their implementation. Addressing institutional and regulatory challenges requires a multi-faceted approach that involves policy reforms, capacity-building initiatives, and stakeholder engagement. Engaging relevant government agencies, policymakers, regulatory bodies, and industry professionals in dialogue and collaborative efforts can drive the necessary changes (Udo-Udoma, 2014; Akintoye et al., 2012). Moreover, fostering a culture of innovation, providing incentives for adopting innovative practices, and establishing monitoring and evaluation mechanisms can help overcome these challenges and promote the wider implementation of innovative construction practices in slum upgrading programmes.

2.8.3 Financial Barriers and Resource Limitations

Iweka and Adebayo (2015) noted that the implementation of innovative construction practices in slum upgrading programmes faces various challenges, particularly in relation to financial barriers and resource limitations. These challenges can hinder the widespread implementation and scalability of innovative practices. One of the major challenges is the limited access to capital and financial resources for implementing innovative construction practices (Mahabir et al., 2016). Slum upgrading programmes often operate under tight budgets, making it challenging to allocate sufficient funds for the implementation of innovative practices. Limited access to loans, grants, and other sources of funding further restricts the financial feasibility of implementing these practices.

According to Russo et al. (2023), implementation of innovative construction practices may require higher upfront costs compared to conventional methods. The initial investment required for acquiring new technologies, training construction workers, and procuring specialized materials can pose financial constraints. This can be particularly challenging for slum upgrading programmes operating within limited budgets and resource-constrained environments. Fonbeyin (2020) noted that inadequate financing mechanisms specific to innovative construction practices can hinder their implementation. Limited availability of loans, grants, and financial support tailored to these practices creates barriers for implementing agencies and slum dwellers who seek to upgrade their housing. The absence of financial products and incentives designed to promote innovative practices restricts their scalability and sustainability.

Addressing financial challenges and barriers requires engaging with financial institutions and development partners to create dedicated funding mechanisms for innovative construction practices that can alleviate financial barriers (Meredith et al., 2021). Governments and implementing agencies should invest in training programs to enhance technical capacity and foster a skilled workforce. Strengthening supply chains, promoting local production of innovative materials, and exploring partnerships with private sector entities can help overcome procurement challenges (Iweka & Adebayo, 2015). Additionally, integrating long-term financial planning, including maintenance and operational costs, into project design and implementation is crucial for ensuring the sustainability of innovative construction practices. By addressing financial barriers and resource limitations, stakeholders can promote the wider implementation and scalability of innovative construction practices, ultimately enhancing the effectiveness and sustainability of slum upgrading programmes in improving housing conditions and the overall well-being of slum dwellers.

2.8.4 Social and Cultural Barriers to Change

Mahabir et al. (2019) observed that the implementation of innovative construction practices in slum upgrading programmes can face various challenges, particularly social and cultural barriers that hinder change and innovation. These barriers can impact the successful implementation and acceptance of innovative practices. Overcoming resistance to change requires effective communication, awareness campaigns, and community engagement to foster understanding and acceptance of the benefits of innovative practices (Meredith & MacDonald, 2017). Limited awareness and knowledge about innovative construction practices can hinder their implementation. Many slum residents, particularly those with low levels of education, may not be familiar with alternative construction technologies or materials. Lack of awareness can lead to misconceptions, scepticism, and a preference for familiar traditional methods. Providing information, education, and capacity-building initiatives are essential to address this barrier and promote knowledge about the benefits and feasibility of innovative practices. Chaudhuri (2017) argues that building trust and establishing reliability are critical when introducing innovative practices. Communities may be cautious about new construction technologies or materials, fearing their durability, safety, or long-term maintenance requirements.

According to Udo-Udoma (2014), addressing social and cultural barriers to change requires a comprehensive and participatory approach. Engaging with communities, involving local leaders and influencers, and fostering dialogue can help in understanding their concerns, addressing misconceptions, and promoting the benefits and relevance of innovative construction practices (Rigon, 2014). Collaboration with local cultural institutions, community-based organizations, and religious leaders can also facilitate the integration of innovative practices within the existing social and cultural context. By recognizing and addressing social and cultural barriers to change, slum upgrading programmes can create an enabling environment for the implementation of innovative construction practices. Sensitivity, inclusivity, and tailored approaches that align with local customs and values are key to fostering acceptance and ensuring the long-term success of these practices (Muchadenyika, 2015).

2.8.5 Governance and Coordination Issues in Slum Upgrading Programmes

Rigon (2014) noted that the implementation of innovative construction practices in slum upgrading programmes faces several challenges related to governance and coordination. These challenges can hinder the effective implementation and scalability of innovative practices. Slum upgrading programmes often involve multiple stakeholders, including government agencies, non-governmental organizations, community-based organizations, and private entities. However, fragmented governance structures and the lack of clear responsibilities and coordination mechanisms can impede effective decision-making and hinder the implementation of innovative construction practices. The absence of a centralized authority or coordinating body can lead to overlapping roles, duplication of efforts, and a lack of accountability.

According to Anderson and Mwelu (2013), weak institutional capacity within implementing agencies can pose a significant challenge to the implementation of innovative construction practices. Insufficient technical expertise, inadequate resources, and a lack of specialized knowledge can hinder the planning, design, and implementation of innovative projects. Building the capacity of government agencies, community organizations, and other relevant stakeholders through training, knowledge sharing, and partnerships is essential to overcome these limitations. The financial constraints faced by implementing agencies and slum communities pose a significant barrier to the implementation of innovative construction practices.

Ineffective community engagement and limited participation of slum residents in decision-making processes can hinder the successful implementation of innovative construction practices (Meredith & MacDonald, 2017). It is, therefore, crucial to involve the local community from the early stages of project planning, design, and implementation. Meredith and MacDonald, 2017) argue that community engagement builds trust, ensures that projects meet the needs and aspirations of the residents, and promotes ownership and sustainability. (Hasanawi et al. 2019) add that effective coordination among various stakeholders involved in slum upgrading programmes is essential for successful implementation of innovative construction practices. Lack of coordination can lead to fragmented efforts, conflicts of interest, and delays in project implementation. Establishing clear lines of communication, promoting collaboration, and strengthening coordination mechanisms among stakeholders can enhance the efficiency and effectiveness of the implementation process.

Addressing these governance and coordination challenges requires strong political commitment, effective leadership, and multi-stakeholder collaboration (Rigon, 2014; Meredith & MacDonald, 2017; Hasanawi et al., 2019). Strengthening governance structures, establishing clear roles and responsibilities, enhancing institutional capacity, and promoting inclusive decision-making processes are crucial for overcoming these barriers (Anderson & Mwelu, 2013). Additionally, establishing mechanisms for knowledge sharing, learning from best practices, and fostering partnerships with research institutions and international organizations can facilitate the implementation and scalability of innovative construction practices in slum upgrading programmes (Rigon, 2014).

2.9 Theoretical Framework

Four theories are discussed to inform the theoretical framework of this study. These include the participatory planning theory, sustainable livelihood approach, modernization theory, and the systems theory. The participatory planning theory focus on inclusion and technical rationality for involving all stakeholders in decision-making. The Sustainable Livelihoods Approach (SLA) aims at poverty eradication through promoting development that is sustainable not just ecologically, but also institutionally, socially and economically and to produce genuinely positive livelihood outcomes. The modernization theory emphasizes on internal social dynamics and structures in adaptation of new technologies. The goal of systems theory is to achieve optimum equifinality through a web of relationships.

2.9.1 Participatory Planning Theory

Participatory Planning Theory was advanced by Paulo Freire and Kurt Lewin in 1971. It is also known as communicative, deliberative or collaborative planning. This theory emerged as a response to the failure that planning institutions with an aim to replace the technical rationality behind hierarchical and bureaucratic planning processes towards more inclusive and democratic decision-making practices among all stakeholders (Innes & Booher, 2004). Several critics have highlighted lack of feasibility in involving all actors' interests due to lack of understanding, conflicting rationalities, and denial of differences (Connelly & Richardson, 2004). However, participatory process is key, supported and recommended by the international donor agencies in the upgrading of informal settings (Garau, Sclar, & Carolini, 2005).

The United Nations argued that what is needed towards an inclusive and sustainable urban development, is to enable cities cope with slums so that their future is safeguarded (UN HABITAT, 2011). Slums are partly as a result of inadequate government policies, ineffective urban planning and management systems. These problems can be addressed through participatory approaches that engage experts from diverse backgrounds as well as beneficiaries. This results in projects that serve the short-term and long-term needs of urban dwellers.

Participatory planning theory is also relevant in slum upgrading. For successful slum upgrading projects, the planners have to adopt inclusive approaches at all levels. The slum dwellers and their needs have to be taken into consideration to achieve the purpose of slum upgrading. Without such an approach, the slums will just move from one area to the next defeating the logic for slum upgrading projects. Slum dwellers have specific needs and have spent years creating a network that support their livelihoods. Slum upgrading disrupts this network making it critical to closely engage slum dwellers in the projects. This will create a sense of ownership and make use of resources that come with slum dwellers network. A clear understanding of the social and economic impact of slum upgrading project and those who will be mostly affected is necessary. This can only be achieved through participatory planning. Involving the entire community in the planning processes and building consensus are important. Collective community decision making and a prioritization of traditionally marginalized or vulnerable groups such as women, youths, and people living with disabilities will ensure no one is left behind in the process.

2.9.2 Sustainable Livelihood Approach

The sustainable livelihoods concept was floated by the Brundtland Commission on Environment and Development during the 1992 United Nations Conference on Environment and Development. The concept was further expanded to supporting sustainable livelihoods as a recipe for poverty eradication (Krants, 2011). Chambers and (Conway,1992) redefined the sustainable rural livelihood to include livelihoods which comprise of the competencies, access to resources and activities that individuals require to sustain their existence. Sustainable livelihood opportunities create favorable prospects for future generations (Krants, 2011). The Sustainable Livelihoods Approach (SLA) aims at promoting development that is sustainable not just ecologically, but also institutionally, socially and economically and to produce genuinely positive livelihood outcomes.

The sustainable livelihoods approach is a way to improve understanding of the livelihoods of poor people. It draws on the main factors that affect poor people's livelihoods and the typical relationships between these factors. The Sustainable Livelihoods Approach can be used in planning new development activities and in assessing the contribution that existing activities have made to sustaining livelihoods. The two key components of the SLA are a framework that helps in understanding the complexities of poverty and a set of principles to guide action to address and overcome poverty.

SLA has seven key principles that include being people-centered, holistic, dynamic, building on strengths, promoting micro-macro links, encouraging broad partnerships, and aim for sustainability. SLA begins by analyzing people's livelihoods and how they change over time. The people themselves actively participate throughout the project cycle. SLA acknowledges that people adopt many strategies to secure their livelihoods, and that many actors are involved; for example, the private sector, ministries, community-based organizations and international organizations. SLA seeks to understand the dynamic nature of livelihoods and what influences them. It builds on people's perceived strengths and opportunities rather than focusing on their problems and needs. It supports existing livelihood strategies. SLA examines the influence of policies and institutions on livelihood options and highlights the need for policies to be informed by insights from the local level and by the priorities of the poor. It counts on broad partnerships drawing on both the public and private sectors. Sustainability is important for SLA if poverty reduction is to be lasting. The sustainable theory framework therefore creates a matrix for the enhancement of livelihoods and is, therefore, though not directly, an analysis tool which allows researchers to assess individuals, households and community livelihoods from the household level. Based on these theories, the study focused on assessment of outcome, social and economic impact of an innovative construction in housing in slum upgrading Mathare Valley.

2.9.3 Modernization Theory

Modernization theory can be traced back to the ideas of Max Weber (1864-1920) and later Talcott Parsons. It seeks to explain the process of modernization within societies. Rostow developed stages of economic development from ideas of modernization theory in 1960. The scholar argued that there are five steps through which all countries must pass to become developed. These steps include traditional society, pre-conditions to take off, take off, drive to maturity, and age of high mass consumption. The theory emphasizes a focus on internal social dynamics and structures in adaptation of new technologies (Goorha, 2010).

Modernization theory was used by Frakenhoff (1967) to explain emergence of slums around or in cities. The author argues that slums are the staging area for the migrating poor who cannot afford economic life of cities. They stay in slums as they work to integrate themselves into cities in expanding economies. John Turner (1976) agreed with Frankenhoff and added that slums are both product of and vehicle for activities that are essential for modernization. Poor rural migrants initially cannot afford to buy, build or rent decent housing in cities. They opt instead for cheap, substandard structures close to their employment opportunities. These migrants are expected to enter the formal housing market or at least upgrade their dwellings as they become integrated into the urban economy and their incomes rise. However, this does not always happen. The temporary structures end up becoming their permanent houses and this leads to proliferation of slums.

Modernization theory portrays slums as a natural and temporary manifestation of market failure occasioned by dynamics of structural change in labor markets. To address slums, therefore, modernization theory recommends looking at industrialization and urbanization policies. Concentration of industries in one area without the necessary supporting infrastructure such as housing will result in more slums. In the case of Mathare Valley, many residents work in industries located in Baba Ndogo and Ruaraka in general. Urbanization without adequate and affordable infrastructure for increasing urban population will also result in slums. Many residents of Mathare Valley cannot afford to buy houses, build or rent in adjacent estates. This leaves them with no option but to stay in the slums. According to modernization theory, slum upgrading as an intervention alone is not sustainable. A multifaceted approach would solve the problem of slums and it has to start with addressing the root causes of the problem. The understanding of social and economic dynamics and structures in slums will help in choosing the right innovative construction technologies in slums upgrading.

2.9.4 Systems Theory

Systems theory originates from works of many theorists and practitioners in several disciplines. Some of them include biologist Ludwig Bertalanffy, sociologist Talcott Parsons, ecological systems by Howard Odum, organizational theory by Fritjof Capra, and study of management by Peter Senge. It is the interdisciplinary study of natural or man-made cohesive groups that are interrelated and interdependent. Each system is bound by time and space and is influenced by its environment, defined by its structure and purpose, and expressed through its functioning. If there is synergy or emergent behavior, a system can be more than its parts. Changing one part of the system will affect other parts or the whole system (Luhmann, 2013).

The goal of systems theory is to model a systems' dynamics, constraints, conditions, and elucidate principles that can be used at each level and in diverse fields to achieve optimum equifinality (Beven, 2006). Systems theory promotes dialogue between autonomous areas of study as well as within systems science. According to systems theory, all phenomena can be viewed as a web of relationships. All systems have common patterns, behaviors, and properties that an observer can use to develop deeper insight of a complex phenomenon (Luhmann, 2013).

Systems theory is relevant in understanding how slums come about and how slum upgrading projects can be successful. The slums come up as systems to support industrialization and urbanization systems in cities. This explains why slums in major cities are around or adjacent well to do suburbs or industrial areas. The unskilled or semi-skilled workers in the suburbs or industrial areas lives in the slums due to their inability to afford decent houses. The slums can be seen as systems that support suburbs and industrial areas in the cities.

With the understanding of slums as systems critical for developing suburbs and industrial areas, their upgrading can be informed by internal and external factors. The internal factors are the patterns, behaviors, and properties that define slums. These are the social and economic dynamics and structures that exist in the slums. Their disruption without consideration of these dynamics and structures may result to just a shift of the slums from one area to another. The external factors are the patterns, behaviors, and properties that define suburbs and industrial areas. Increase of suburbs and industrial areas may result in increased slums. Systems theory encourages consideration of all the social and economic dynamics and structures in slum upgrading like the Mathare Valley. This will not only ensure success of the project but also its sustainability.

2.10 Summary of Literature and Research Gaps

2.10.1 Summary of the Literature Review

The literature review explored the social and economic impact of innovative construction practices in slum upgrading programmes in Kenya. The findings highlight that innovative construction practices have the potential to bring about significant social changes. By improving access to housing, promoting participation and decision-making, fostering skills development and employment, ensuring safety and security, and enhancing social cohesion, these practices contribute to the overall well-being and empowerment of slum dwellers.

Innovative construction practices generate economic benefits at various levels. They contribute to cost-effectiveness and affordability, employment generation and local economic development, sustainable income generation, economic multiplier effects, and financial viability. By creating employment opportunities, stimulating local businesses, and reducing construction costs, these practices promote economic growth and poverty reduction within the community.

The implementation of innovative construction practices faces challenges related to fragmented governance structures, limited institutional capacity, lack of policy frameworks, limited financial resources, inadequate community engagement, and coordination issues. Addressing these challenges requires strong leadership, multi-stakeholder collaboration, policy development, capacity building, and effective coordination mechanisms.

The replicability and scalability of innovative construction practices depend on contextual adaptation, knowledge sharing and learning, local capacity building, multi-stakeholder collaboration, pilot projects and demonstration sites, financial mechanisms and support, and monitoring, evaluation, and documentation. These factors facilitate the successful replication of practices in different slum contexts, fostering sustainable and impactful slum upgrading programmes. Social and environmental sustainability should be integrated into the implementation of innovative construction practices. Policies should prioritize social inclusion and equity, environmental sustainability, capacity building and awareness, regulatory frameworks, public-private partnerships, research and knowledge sharing, and monitoring and evaluation.

Overall, the literature review emphasizes the importance of innovative construction practices in promoting social and economic development in slum communities. By addressing social and economic challenges, fostering sustainability, and addressing governance and coordination issues, these practices contribute to the creation of inclusive, resilient, and sustainable slum communities. To ensure successful implementation, it is crucial to adopt a holistic approach that integrates social, economic, and environmental considerations and involves the active participation of stakeholders at all levels.

2.10.2 Identified Research Gaps

The implementation of innovative construction practices in slum upgrading programmes holds significant potential for addressing socio-economic and environmental challenges in slum areas. However, several research gaps and areas for further investigation have been identified, indicating the need for continued research and exploration. These gaps revolve around long-term social impact, gender dynamics, economic viability, environmental sustainability, policy and governance, replicability and scalability, as well as monitoring and evaluation.

While the social impact of innovative construction practices has been explored, there is a need for longitudinal studies to assess their long-term effects on communities. Understanding how these practices contribute to sustainable social development, community cohesion, and improved quality of life over time would provide valuable insights. Further research is needed to delve deeper into the gender dynamics within slum upgrading programmes and the impact of innovative construction practices on gender equality and empowerment. Investigating the role of women in decision-making processes, economic opportunities, and community engagement would contribute to more gender-responsive approaches.

Although the economic impact of innovative construction practices has been highlighted, further investigation is required to assess their long-term financial viability and cost-effectiveness. Examining the return on investment, income-generation potential, and the economic multiplier effects of these practices would provide a clearer understanding of their sustainability. Research on the environmental impact and sustainability of innovative construction practices in slum upgrading programmes is limited. Investigating the energy efficiency, resource consumption, waste management strategies, and ecological footprint of these practices would contribute to more environmentally responsible interventions.

There is a need for in-depth research on the policy frameworks, governance structures, and regulatory mechanisms that support the implementation of innovative construction practices. Exploring the policy gaps, barriers, and effective governance models would provide guidance for policymakers and practitioners. While some best practices and lessons learned have been identified, further investigation is required to assess the replicability and scalability of innovative construction practices in different slum contexts.

There is also need for rigorous monitoring and evaluation frameworks to assess the outcomes and impacts of innovative construction practices. Developing comprehensive indicators, data collection methods, and evaluation tools would strengthen the evidence base and support evidence-based decision-making. Addressing these research gaps and further investigating these areas will contribute to a deeper understanding of the effectiveness, challenges, and opportunities associated with the implementation of innovative construction practices in slum upgrading programmes. It will also inform the development of evidence-based policies, guidelines, and strategies to promote sustainable and inclusive urban development. Continued research efforts and collaboration among researchers, practitioners, and policymakers are crucial for advancing knowledge in this field and improving the outcomes of slum upgrading initiatives.

2.10.3 Implications for Slum Upgrading Programmes in Kenya

The implementation of innovative construction practices in slum upgrading programmes in Kenya has the potential to bring about significant social, economic, and environmental transformations. This literature review has highlighted the key findings and implications related to the social and economic impacts of innovative construction practices, as well as the challenges and opportunities in their implementation. In terms of social impact, it is crucial to consider gender considerations throughout the implementation of innovative construction practices. Ensuring equal access to housing, promoting women's participation and decision-making, and addressing safety and security concerns are critical for achieving social equity and empowerment in slum communities. Additionally, initiatives that foster community development, address gender-based violence, and provide access to basic services contribute to social cohesion and well-being.

From an economic perspective, innovative construction practices offer opportunities for cost-effectiveness, employment generation, and local economic development. However, financial constraints, limited institutional capacity, and regulatory barriers can hinder their implementation. To overcome these challenges, it is essential to establish supportive policy frameworks, strengthen institutional capacity, and explore innovative financing mechanisms that make these practices financially accessible and sustainable. Furthermore, addressing governance and coordination issues is crucial for effective slum upgrading programmes. Fragmented governance structures, lack of policy frameworks, and inadequate community engagement can impede the implementation and scalability of innovative construction practices. Establishing clear roles and responsibilities, promoting multi-stakeholder collaboration, and enhancing community participation are key for successful implementation.

The replicability and scalability of innovative construction practices in different slum contexts require contextual adaptation, knowledge sharing, and local capacity building. Identifying best practices, building local expertise, and establishing pilot projects can guide the successful replication of these practices. Moreover, addressing social and environmental sustainability through inclusive policies, regulatory frameworks, and public-private partnerships is vital for the long-term impact and resilience of slum upgrading programmes.

Incorporating innovative construction practices in slum upgrading programmes in Kenya has the potential to create sustainable and inclusive communities. By considering social and economic impacts, addressing governance challenges, promoting gender considerations, and ensuring environmental sustainability, these practices can contribute to improved living conditions, economic empowerment, and environmental resilience in slum areas. Policymakers, practitioners, and stakeholders should collaborate and implement the recommended strategies to maximize the benefits of innovative construction practices and create a brighter future for slum communities in Kenya.

2.10.4 Conceptual Framework

Slum upgrading basically focuses on the construction of low-cost housing that will be affordable to the slum dwellers. The slum dwellers have challenges in affording decent housing. There are several factors that contribute to low-cost housing. The contributing factors to low-cost housing include adoption of innovative construction practices that entail innovative construction technologies and products. Innovative construction practices should lead to slum upgrading or development of low-cost housing with accompanying economic and social impact. In this study, innovative construction technologies and practices form the dependent variable while outcomes and social and economic impact form the independent variable. The relationship between the independent and the dependent variables is as shown in figure 2.7 below.

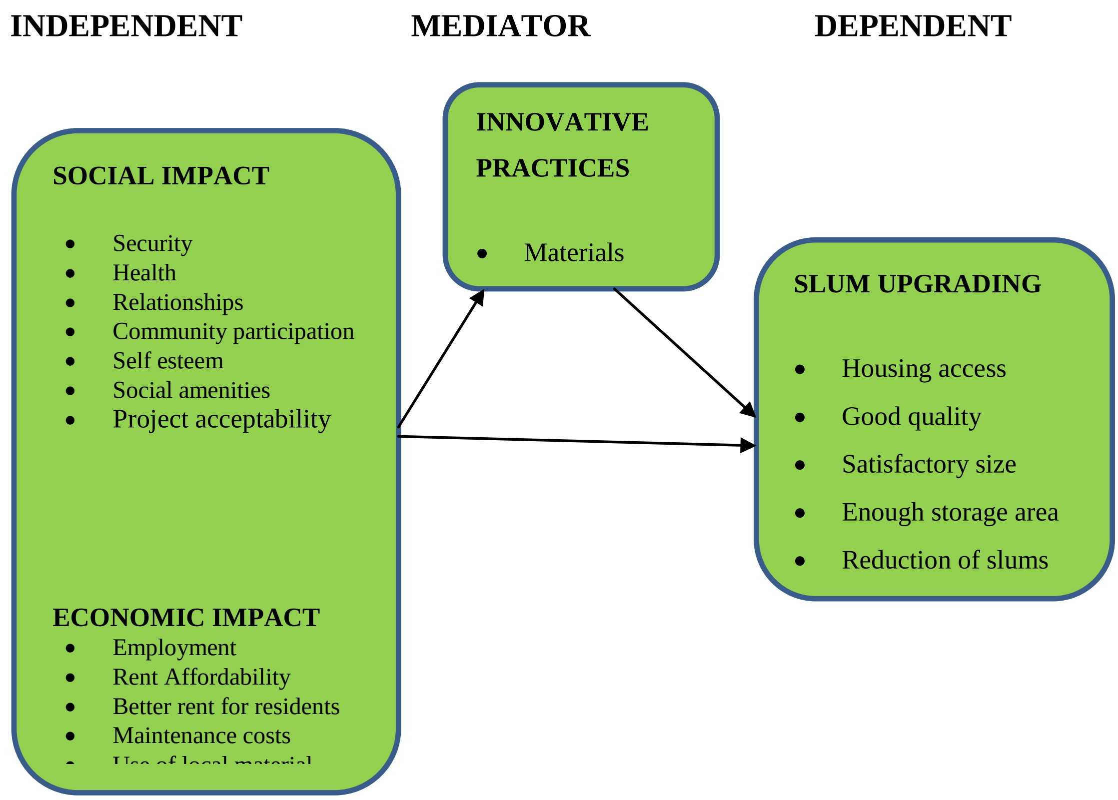


Figure 2.7: Conceptual Framework

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides a general description of the methodological approach adopted for this research. It presents the research design, target population, sample design, data collection instrument and procedures, pilot study, data analysis and ethical considerations.

3.2 Research Design

This was a post occupancy empirical evaluation that involved the systematic assessment of the performance of Mathare valley area 4A from the perspective of the slum dwellers. The study used primary data collected from the field and which informed the conclusions as related to the objectives of the study.

The study adopted descriptive research design. According to (Mugenda, A. G., & Mugenda, 2013) the design provided the framework that holds the research project together. Descriptive research design aims at establishing the current phenomena, exactly the way it is as the researcher has no control over the variables (Rahi, 2017). Particularly it minimizes interference and ensures no biasness hence more appropriate for the study. This proposed research design has been established to be ideal when data are collected to describe persons, organizations, settings, or phenomena (Creswell, 1994).

The research adopted a descriptive research design. According to (Mugenda, A. G., & Mugenda, 2013) the design provided the framework that holds the research project together. The descriptive research design aims at assessing the social and economic impact of innovative housing construction technologies in slum upgrading of Mathare Valley, Nairobi. Descriptive study allowed the researcher to have the residents of Mathare Valley explain or describe issues about innovative housing construction technologies that enabled the associations between variables to be established. According to Denvir and Millet (2003 as cited in Gona & Newton, 2015), research design provides the glue that holds the research project together. The descriptive study research design was adopted in the analysis as it identifies which parameters had the highest impact (the ones with the highest means).

The design was also preferred because it allowed unlimited collection of data and enabled comprehensive and in-depth study of the issues of the study. The descriptive designs resulted in description of data, either in words, pictures, charts, or tables and inferential statistics to indicate how the independent variables (social impact of innovative construction technologies and economic impact of innovative construction technologies) explain the change in the dependent variable (slum upgrading).

3.3 Target Population

The target population for this study was the entire Mathare Area 4A where slum upgrading project took place. The total population of study area according to 2019 Kenya Population and Housing Census was 20,733 persons in 6,973 households from which a sample was used to make inferences. Thus, the target population defined those units for which the findings of the study are meant to generalize. The study focused on the socioeconomic impact of innovative technologies used in the construction of low-cost housing in Nairobi County.

In Nairobi, the main upgraded slums include Mathare, Kibera, Pumwani, Korogocho, Majengo, among others. The researcher chose Mathare 4A as the study area because, compared to other upgraded slums, it had better planning and structuring and was extensive. It involved the Kenya government, the Catholic archdiocese of Nairobi under Amani Trust and German donors. Mathare slum is on approximately ten-acre land and has thirteen villages namely: Kosovo, Gitathuru, Village2, Mashimoni, Mabatini, No. 10, Kiamutysia, Kwa Kariuki, 4A and B, 3A, B and C.

Innovative housing construction technologies were significantly employed in Village 4A during the slum upgrade hence the justification of the study area. The study targeted the entire residents of Mathare 4A who benefited from the low-cost housing thus achieving the study objective of the outcome of innovative housing construction. The population was adequate and resourceful since the beneficiaries of the low-cost housing projects were the same who lived in the original houses before the rehabilitation project began.

3.4 Sample Design

A sample as a small proportion of an entire population, a selection from the population. Sampling is a procedure, process, or technique of choosing a sub-group from a population to participate in the study. It is the process of selecting a number of individuals for a study in such a way that the individuals selected represent the large group from which they were selected (Mugenda & Mugenda, 1999).

The researcher used simple purposeful random sampling. The rationale for this sampling technique was the homogenous nature of the population bearing the characteristics and attributes under study. Mugenda and Mugenda (1999) asserts that purposive sampling is a technique that allows a researcher to use cases that have the targeted. 6673 households with similar characteristics were targeted. The researcher then randomly selected 384 households from different groups to remove the bias.

To capture representative samples, data was collected at varying times of the day including late evenings and weekends to capture possible working household heads who would not be available during normal day times. Household heads whose houses exhibited innovative construction technologies by observation, were targeted. The interviews with slum residents were mainly conducted at the front of the houses and lasted for an average of 30 minutes by which the structured questionnaires were executed.

The researcher used Fishers (1998) formula to determine the appropriate sample size of this study. The researcher assumed 95% desired level of confidence which was equivalent to standardized normal deviation value of 1.96 and an acceptable margin of error of 5% (standard value of 0.05).

$n = Z^2pq/d^2$

Where:

n = the desired sample size (if target population is large)

z = the standard normal deviate at the required confidence level.

P = the proportion in the target population estimated to have characteristic being measured.

q = 1-p

d = the level of statistical significance set.

Assuming 50% of the population have the characteristics being measured, q=1-0.5. Assuming we desire accuracy at 0.05 level. The Z-statistic is 1.96 at this level, therefore, n= $(1.96)^2(.5)\ (.5)/(.05)^2$ =384. The sample for the study were a total of 384 household heads from Mathare Valley.

3.5 Data Collection Instrument and Procedures

The study collected primary data using both open and closed-ended questionnaires where the questions were structured according to the study objectives to capture the main themes under study. A total of 384 questionnaires were given to the household heads at random to those who benefited from Mathare Slum Upgrading projects. The questionnaires were self-administered by some respondents and researcher and assistant administered to the respondents who could not respond due to illiteracy, old age or general apathy. A questionnaire is a set of questions designed to generate the data necessary to accomplish the objectives of the research project (Creswell, 2003). Cooper and Schindler (2003) recommend the use of questionnaire in descriptive studies because self-administered studys cost less than personal interviews and researcher can contact participants who might otherwise be inaccessible.

Semi-structured questionnaires were used to obtain information from the residents. They were designed to contain both open and close-ended questions. These were preferred as respondents had the opportunity to express their views as regards positive and negative change and or experience due to the upgrade, community bond, experienced changes in the neighborhood, aspects of satisfaction regarding the dwelling's construction components, maintenance costs and other associated aspects.

3.5.1 Observations

During fieldwork, several observations were made. The researcher managed to enter several houses and documented the observed status of the upgrade slums in form of photographs. Some of the key observations include:

(a) The walls of the slum's houses have degraded by weathering with time.
(b) The residents have resorted to plastering (cement sand) to minimize the impact of degradation. The house conditions worsen during the rainy weather.
(c) Most of sisal roofing has been changed to corrugated iron sheets and some cases polyethene sheeting

3.6 Pilot Study

A pilot study serves as a trial run that allows one to identify potential problems in a study. It can involve pre-testing a research tool. Kombo and Tromp (2006) explain that the principal function of a pilot study is to increase the reliability, validity, and practicability of the questionnaire. The researcher pre-tested the questionnaire before the actual data collection. The sample for the pretest was drawn through convenience sampling.

3.6.1 Instrument Validity

The instrument validity was tested by the research supervisors who were given the instruments and then assessed them for errors and objectivity where this ensured that the content of the data collection instruments have addressed the study objectives and the data collection instrument actually measures what it is supposed to measure. According to Rohillo (2010), validity is the degree to which result obtained from the analysis of the data actually represents the phenomenon under study.

3.6.2 Instrument Reliability

Reliability refers to a measure of the degree to which research instruments yield consistent results (Mugenda, 2009). A test and re-test were conducted where randomly selected respondents were exposed to the tools of data collection. This was used to ensure the research is accurate, correct and meaningful. The questionnaire was pre-tested through a pilot test. This was done using Cronbach alpha where the Alpha values obtained were above 0.7 in all the cases indicating good internal consistency of the data collection instruments.

3.7 Data Analysis

On receipt of the completed questionnaires, the collected data was checked for errors in responses, omissions, exaggerations and biasness. All analyses were done using SPSS. For easy management and longevity of the data, it was captured in MS-Excel 2007 windows. All data was entered and verified after effective coding. Data was then scrutinized in relation to the objective of the study, otherwise with a potential abundance data; vast numbers of irrelevance summaries were produced. Checking of inconsistencies, anomalies, missing values, outliers (say data cleaning) was done in SPSS syntax. Analysis was descriptive in nature (Henning, Van Rensburg, & Smit, 2004). Descriptive statistics aimed at identifying the pattern of the data and consistency of the responses in each of the hypothesized impact of innovation construction technologies. Results were then presented in tables and graphs.

The study used two simple linear regression analysis to explain the relationship between the variables as indicated below:

Model 1	**Model 2**
$Y = \beta_0+\beta_1X_1 +€$	$Y = \beta_0+\beta_2X_2+€$
Where:	**Where**:
Y= Slum Upgrading	Y= Slum Upgrading
X_1= Social impact of innovative	X_2= Economic impact of innovative

construction technologies	construction technologies
β_1 = Coefficients of social impact of innovative construction technologies	β_2 = Coefficients of economic impact of innovative construction technologies
€ = Standard Error	€ = Standard Error

Source: Olive (2017)

3.8 Ethical Considerations

Iphofen (2016) views research ethics as the appropriateness behavior in relation to the rights of the subjects of one's study or those affected by it. They rightly point out that research ethics are inevitably affected by the broader social norms of behavior. The researcher adhered to ethical research behavior by: Seeking permission from relevant authorities to carry out the research, assuring respondents of confidentiality and privacy of data collected and upholding that confidentiality, seeking informed consent for participation in the study, assuring respondents that the results of the study were only used for academic research purpose and avoiding research plagiarism and fraud.

CHAPTER FOUR

RESULTS AND INTERPRETATIONS

4.1 Introduction

This chapter presents the results and interpretations of the study. The characteristics of the respondents sampled are presented in the first part of this chapter. The chapter also presents the results of the outcome and social and economic impact of innovative construction in slum upgrading. The findings are discussed and a guiding framework for future interventions provided.

4.2 Questionnaire Response Rate

Table 4.1 presents the questionnaire response rate for the study. The number of questionnaires returned was 324 out of the 384 intended participants, translating to a questionnaire response rate of 84%, which is sufficient for the analysis.

Table 4.1: Questionnaire Response Rate

	Frequency	Percent
Returned	324	84
Not Returned	60	16
Total	**384**	**100**

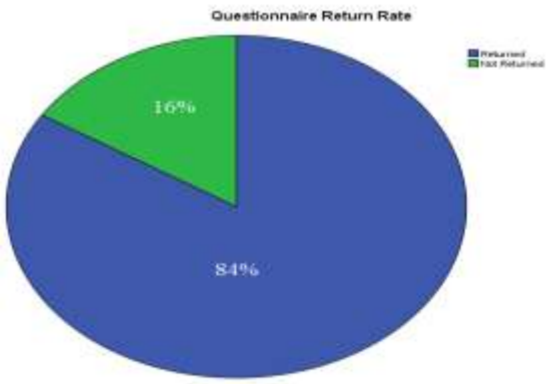


Figure 4.1: Questionnaire Return Rate

4.3 Profile of the Sampled Respondents

Table 4.2 presents the gender of the respondents who participated in the study. Majority of the respondent (63%) were males whereas 37% of the respondents were females.

Table 4.2: Respondents Gender

	Frequency	Percent
Female	121	37
Male	203	63
Total	**324**	**100**

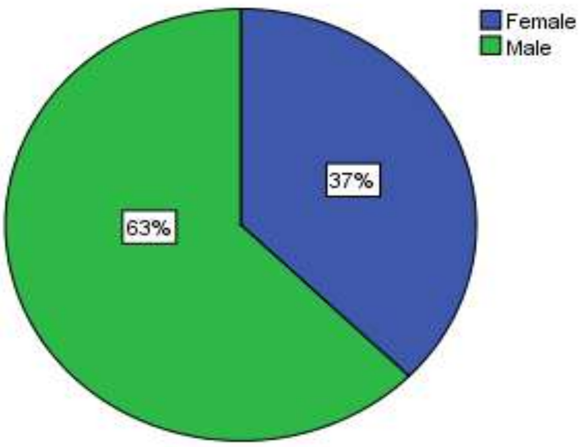


Figure 4.2: Gender of respondents

The male respondents were the majority (63%) since the study targeted the household heads. The upgrading project had considered household heads as men and women especially the widowed at its start. These findings support UN-HABITAT (2005) which found out that during slum upgrading in Kenya the list of beneficiaries was compiled from household's head who were mostly men. This suggests a negative impact depicting a gender bias.

4.3 Age of the Respondents

A significant proportion of respondents (37.7%) were aged between 30 and 49 years. Those aged between above 60 years were the minority, as shown in Table 4.3 below.

Table 4.3: Respondents Ages

	Frequency	Percent
21 - 29	90	27.8
30 - 39	122	37.7
40 - 49	96	29.6
50 - 59	11	3.4
60+	5	1.5
Total	**324**	**100.0**

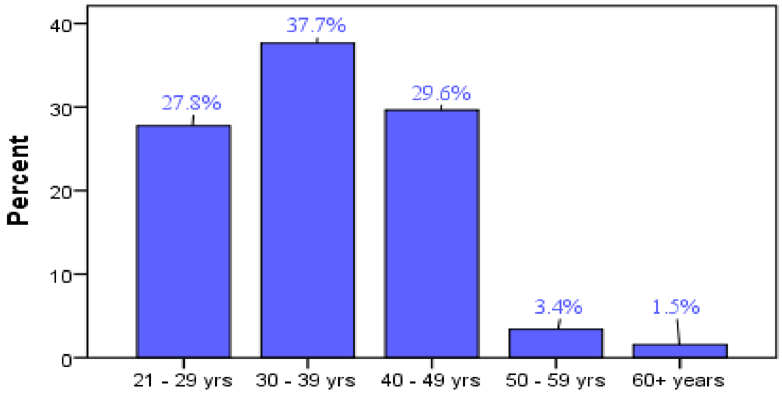


Figure 4.3: Respondents Age

These results show that the study sample was sensitive to the age of the respondents capturing opinions across all the age groups. The majority of respondents aged between 30 and 49 years were presumed to be young when the project started back in mid-1990s.

4.4 Reliability of the Data Collection Instrument

The reliability of this instrument was evaluated through Cronbach Alpha which measures the internal consistency. Cronbach Alpha value is widely used to verify the reliability of the construct. The study findings in Table 4.4 on the pilot test showed that 'Social impact of innovative construction technologies had a Cronbach's reliability alpha of 0.855, 'Economic impact of innovative construction technologies had an Alpha value of 0.792, and 'Slum Upgrading' had an Alpha value of 0.815, The pilot test showed that the scales measuring the objectives had a very high reliability and therefore no amendment on the objectives was necessary. This implied that the research instruments were adequate, objective and had reasonable internal consistency to give reliable results. Zinbarg (2005) states that an alpha coefficient of 0.70 or higher indicates that the gathered data are reliable as they have a relatively high internal consistency and can be generalized to reflect opinions of all respondents in the target population about the study problem.

Table 4.4: Cronbach's Alpha

	Cronbach's Alpha	**No. of Items**
Social impact of innovative construction technologies	.855	15
Economic impact of innovative construction technologies	.792	15
Slum Upgrading	.815	13

4.4 Outcome and Impact of the Innovative Construction technologies

To assess the outcome, social and economic impact of innovative construction employed in the upgraded slums, respondents were presented with five statements on a Likert scale and asked to state how much they agreed with each statement. The responses ranged from 1-strongly disagree through 3-neutral to 5-strongly agree. The responses were averaged per statement and the results displayed in tables.

4.4.1 Perception on Improvement of Houses after Upgrade Process

This is the physical impact of upgrading which involves mostly the improvement of the physical environment. The majority of study respondents (82.4%) felt that the slum upgrading process had improved the houses as shown in table 4.5 below.

Table 4.5: Comparing Upgraded with the Previous Houses

	Frequency	Percent
Improved for the better	267	82.4
Remained the same	57	17.6
Total	324	100.0

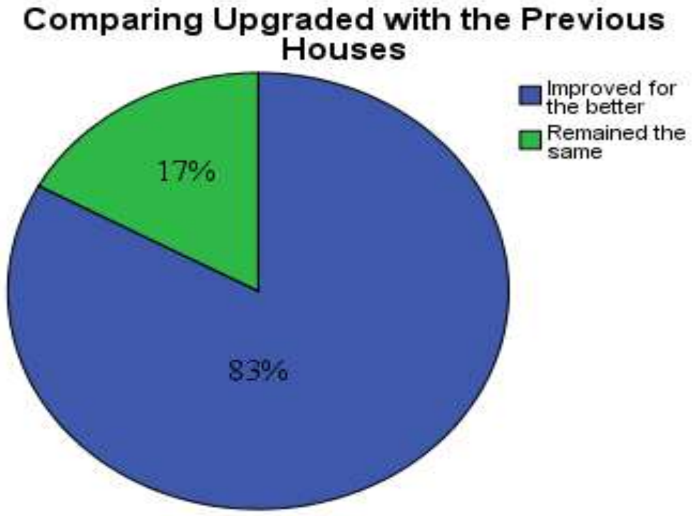


Figure 4.4: Comparing Upgraded with the Previous Houses

4.4.2 Outcome of Innovative Construction in Housing in Mathare Slum Upgrading

The study findings in tables 4.5 (a) and (b) indicates that majority of the respondents (56.2%, mean 3.48) strongly agreed that the community improved with the upgrading process followed by those who agreed that the experience with the upgrade is fulfilling (45.9%, mean 3.04). The least response is ‘I have plans to leave in the future due to the upgrade’ as is given by 11.9% for strongly agreed with a mean score of 2.46.

Table 4.6: Outcome of Innovative Construction Employed to Community – Physical Aspect

	SD	D	N	A	SA	Mean	Standard Deviation
The community improved with the upgrading process	11.7	9.0	6.3	13.5	59.5	3.46	0.836
The problems with the previous buildings and community were addressed with the upgrade	10.7	18.9	2.8	37.8	29.8	2.97	0.067
There are still problems that needs to be addressed despite the upgrade	18.4	4.1	7.9	28.9	40.7	3.05	0.789
The experience with the upgrade is fulfilling	6.0	9.3	5.7	45.9	33.1	3.24	0.941
I have plans to leave in the future due to the upgrade	26.2	35.1	8.7	18.1	11.9	2.46	0.96

SD=Strongly Disagree; D=Disagree; N=Neutral, A=Agree; SA=Strongly Agree (in Percentage)

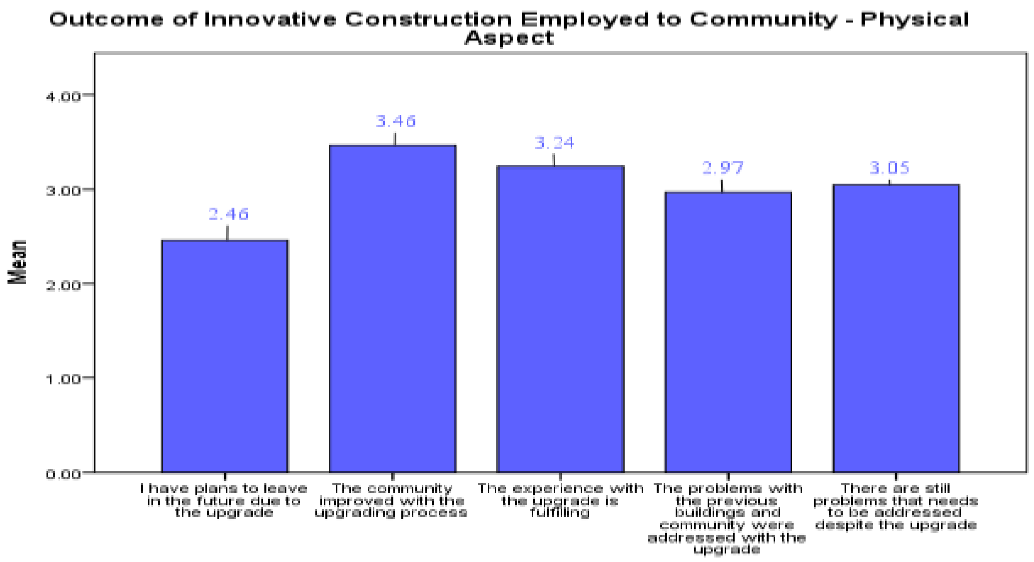


Figure 4.5: Outcome of Innovative Construction Employed to Community – Physical Aspect

In addition to the positive outcome on the community, there was increased perception that the community was better than others, increased pride for the community, care for community members, feeling at home, and acceptance as a community member, and community prosperity in the last five years. On the contrary, innovative construction did not positively implicate on the consistent presence of someone to help, and community honesty and trust for one another. The standard deviation of less than 1 indicates that the mean response registered by the study is not less deviated from the overall mean of the performance. This suggests high acceptance of the scheme which denotes a significant positive social impact.

Table 4.7: Outcome of Innovative Construction Employed to Community – Social Aspect

	Increase	Decrease	No Change	Mean	Standard Deviation
This community is better than others	75.7%	0.0%	24.3%	1.26	0.72
I feel proud of this community	71.7%	22.6%	5.7%	1.41	0.54
In this community we take care of each other	59.5%	26.0%	14.5%	1.92	0.21
I feel at home in this community	72.7%	21.1%	6.2%	1.53	0.58
I feel accepted as a member of this community	75.7%	20.0%	4.3%	1.44	0.78
This community has prospered in the last five years	94.3%	2.7%	3.0%	1.04	0.72
If I have a problem, there is always someone to help me	52.1%	28.6%	19.3%	1.95	0.54
In this community, one has to be alert, or someone is likely to take advantage of you	14.4%	21.6%	64.0%	2.46	0.21
Most people in this community are basically honest and can be trusted	10.8%	27.0%	62.2%	2.62	0.58

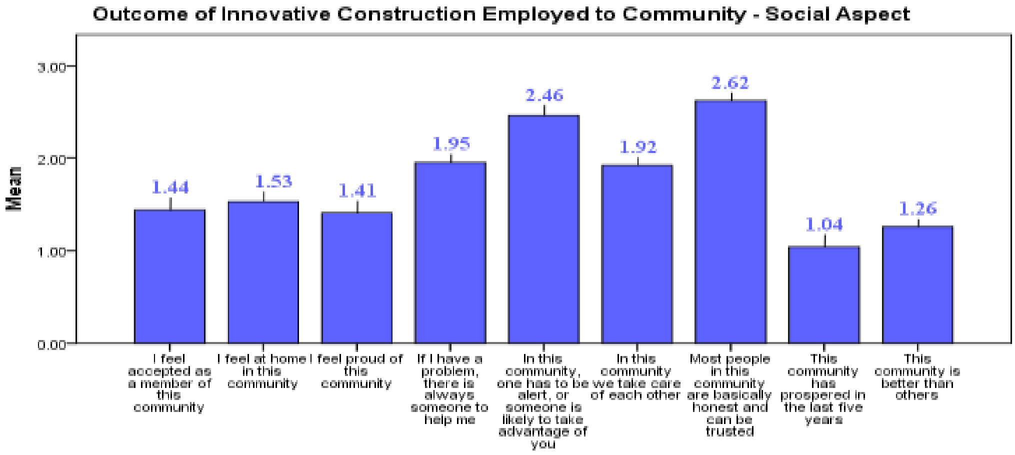


Figure 4.6: Outcome of Innovative Construction Employed to Community – Social Aspects

4.4.3 Outcome of the Innovative Construction on Individuals

The study findings in table 4.7 indicate that innovative construction has increased the willingness of the respondents to invest further in the homes as given by 83.8% (mean 1.24) of the respondents followed by willingness to help one another at 83.6% (mean 1.22) while the least response was trust between the neighbors with 43.2% (mean 2.08). The standard deviation in the study with a value less than 1 indicate that the mean of the responses obtained are not much deviated from the overall mean where most of the responses are geared towards a particular theme with no outliers. This indicates a generally positive social impact amongst the majority of respondents.

Table 4.8: Personal Changes due to the Upgrade Process

	Increase	Decrease	No Change	Mean	Standard Deviation
Your willingness to work collectively	56.8%	16.2%	27.0%	1.70	0.88
Your willingness to invest further in your house	83.8%	8.1%	8.1%	1.24	0.60
Your perception on slums and the possibility of better living in slums	70.3%	5.4%	24.3%	1.54	0.87
Trust between neighbors	43.2%	21.6%	35.1%	2.08	0.89
Willingness to help one another	83.6%	10.8%	5.6%	1.22	0.53

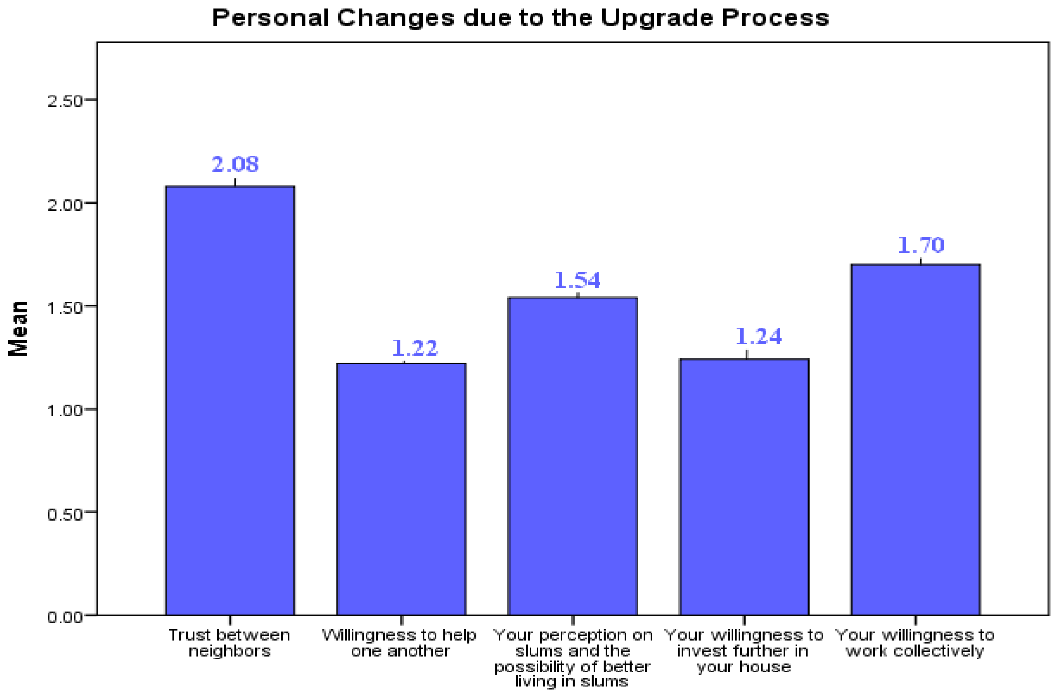


Figure 4.7: Personal Changes due to the Upgrade Process

The study findings in table 4.7 indicate that most of the respondents (49.5%) agreed that though the previous houses were replaced, the frameworks of their establishments have not been destroyed with a mean response of 2.95 and a standard deviation of 0.64 indicating that the mean response obtained is less deviated from the overall mean thus there is no outliers in the response. The second response indicate that the respondents agreed that (38.5%) there is provision of or improvements to infrastructure with the innovative construction with a mean response of 2.22 and a standard deviation of 0.85 indicating that the mean response is not deviated from the overall mean while the contrary response was that innovative construction led to the displacement of residents hence there is little to no poverty reduction was achieved with a mean of 3.35 where 36.2% of the respondents strongly disagreed.

Table 4.9: Social Impact of Innovative Construction Technologies

	SD	D	N	A	SA	Mean	Standard Deviation
Innovative construction technologies were accompanied by the construction of communal facilities	15.5	21.6	9.8	25.8	27.3	3.14	0.71
There is provision of or improvements to infrastructure with the innovative construction	10.5	15.9	6.4	38.5	28.7	2.22	0.85
Processes involved in innovative construction ensures that there is security of tenure to slum residents	17.3	19.8	10.7	29.6	22.6	3.16	0.88
Though the previous houses were replaced, the frameworks of our establishments have not been destroyed	5.0	11.2	5.4	49.5	28.9	2.95	0.64
Innovative construction led to the displacement of residents hence there is little to no poverty reduction was achieved.	36.2	28.8	11.0	15.8	8.2	3.35	0.79
Innovative construction developed units are smaller and built with higher densities	34.8	30.8	8.1	17.2	9.1	2.84	0.92

SD=Strongly Disagree; D=Disagree; N=Neutral, A=Agree; SA=Strongly Agree (in Percentage)

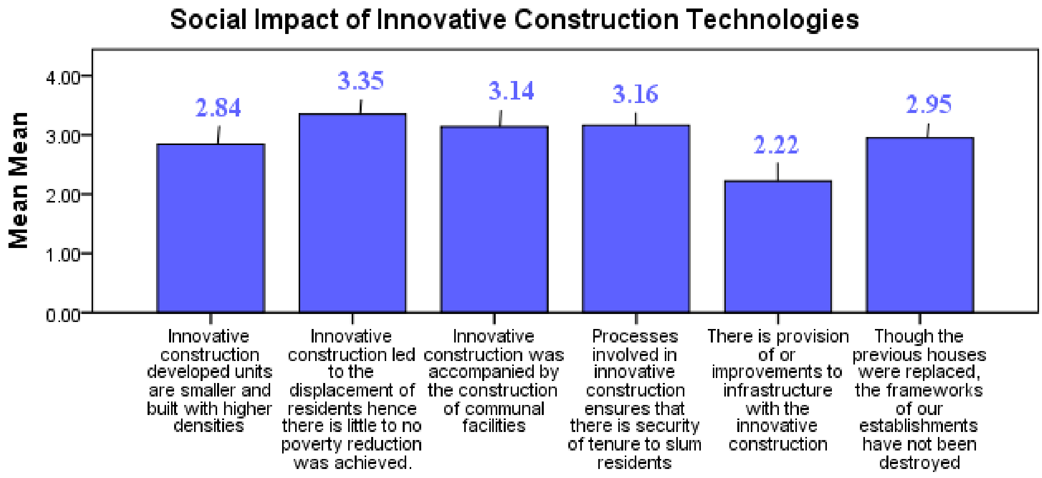


Figure 4.8: Social Impact of Innovative Construction Technologies

4.4.4. The Economic Impact of Innovative Construction Technologies

The study findings in table 4.8 indicate that 48.6% of respondents strongly agreed that subsidies provided for upgraded slum houses makes them affordable than other houses of the same standard with a mean response of 3.27 and a standard deviation of 0.7 indicating that the mean response obtained is not much deviated from the overall mean. The second response is the upgraded dwelling units are affordable with a response rate of 45.9% and a mean response of 3.78 with a standard deviation of 0.82 indicating that the mean is not much deviated from the overall mean. The least response (28.3%) was that there are increased employment opportunities in the maintenance of the upgraded buildings with a mean score of 2.94 and a standard deviation of 0.51. This suggests a positive economic impact characterized by house affordability and accompanying scheme subsidies and indirect employment.

Table 4.10: Economic Impact of Innovative Construction Technologies

	SD	D	N	A	SA	Mean	Standard Deviation
There are increased employment opportunities in the maintenance of the upgraded buildings	12.7	22.3	11.2	25.5	28.3	2.94	0.51
There are no minimum and maximum rent fees for different cadre of people living in the upgraded slums	19.8	9.4	8.9	27.5	34.4	3.13	0.88
Middle income individuals do not have opportunity to occupy the upgraded houses meant for the slum dwellers	10.1	15.4	8.1	36.4	30.0	3.24	0.84
Corruption would affect allocation of units in the upgraded slum dwelling I live in	5.5	8.7	14.3	31.6	39.9	3.85	0.93
The upgraded dwelling units are affordable	4.7	9.8	10.9	28.7	45.9	3.78	0.82
The subsidies provided for upgraded slum houses makes them affordable than other houses of the same standard	2.7	3.2	10.5	35.1	48.6	3.27	0.70

SD=Strongly Disagree; D=Disagree; N=Neutral, A=Agree; SA=Strongly Agree (in Percentage)

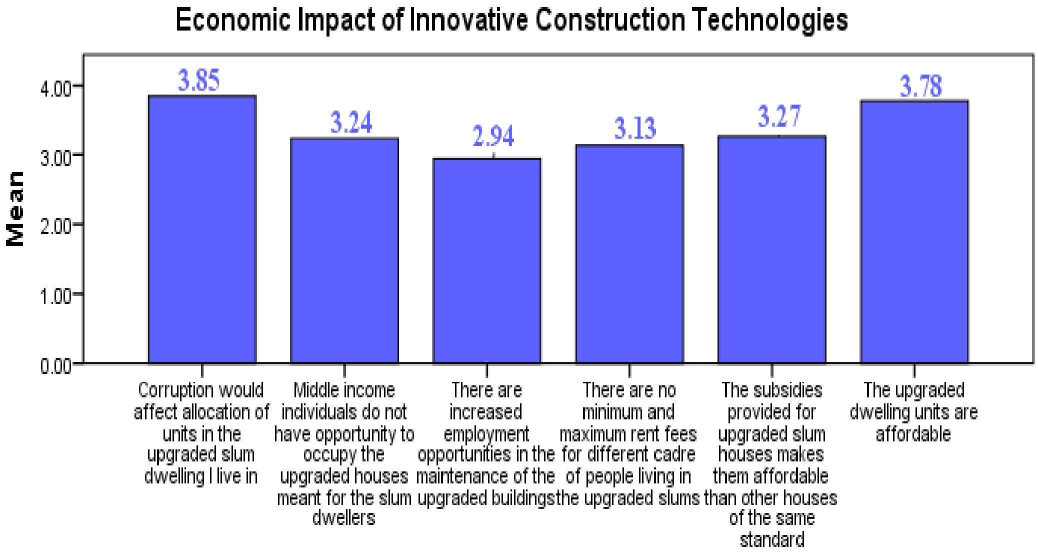


Figure 4.9: Economic Impact of Innovative Construction Technologies

4.4.6 Regression Analysis

For effective identification of how the economic and social impacts of innovative construction technologies can be used to predict slum upgrade projects, two regression models were developed.

4.4.6.1 Economic Impact as a predictor of Slum Upgrading

$Y = \beta_0+\beta_1X+€$

Where:

Y= Slum Upgrading

X= Economic impact of innovative construction technologies

β_0 = Coefficients of economic impact of innovative construction technologies

€ = Standard Error

The study findings in table 4.11 indicate that the independent variable in the study explained a significant proportion of variance in the adopted innovative construction technologies, R^2= 0.753 which implies that 75.3% of the change in the adopted innovative construction technologies can be explained by the independent variable while other variables not covered by this study contributes to 24.7% of the variance as indicated in table 4.11.

Table 4.11: Model Summary for all the economic impact variable

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.788[a]	.753	.759	.45809

a. Predictors: (Constant), Economic impact of innovative construction technologies

Table 4.12: ANOVA for the economic impact variable

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.163	1	8.163	38.898	.000[b]
	Residual	67.570	322	.210		
	Total	75.733	323			

a. Dependent Variable: Slum Upgrading
b. Predictors: (Constant), Economic impact of innovative construction technologies

The findings in table 4.12 indicate that the significance value in testing the reliability of the model for the relationship between independent variable and the dependent variable was F (1, 323) = 38.898, p = 0.00; therefore, the model is statistically significant in predicting the relationship between the independent and dependent variables.

Table 4.13: Regression Coefficients for economic impact and slum upgrade variables

Coefficients[a]

Model		**Unstandardized Coefficients**		**Standardized Coefficients**		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
1	(Constant)	.634	.159		3.977	.000
	Economic impact of innovative construction technologies	.287	.046	.328	6.237	.000

a. Dependent Variable: Slum Upgrading

Based on the linear regression model, $Y = \beta_0 + \beta_1 X + €$ the model therefore becomes.

$Y = 0.634 + 0.287X$

The findings indicate that for every unit change in innovative construction technologies, there will be 28.7% change in economic impact in the slum upgrading. Table 4.13 displays the regression coefficients of the independent variable (Economic impact of innovative construction technologies) reveals that this independent variable is statistically significant in explaining the slum upgrading programmes in Kenya.

4.4.6.2 Social Impact as a predictor of Slum Upgrading

$Y = \beta_0 + \beta_1 X + €$

Where:

Y= Slum Upgrading

X= Social impact of innovative construction technologies

β_0 = Coefficients of social impact of innovative construction technologies

€ = Standard Error

The study findings in table 4.14 indicate that the independent variable in the study explained a significant proportion of variance in the adopted innovative construction technologies, R^2= 0.763 which implies that 76.3% of the change in the adopted innovative construction technologies can be explained by the independent variable while other variables not covered by this study contributes to 23.7% of the variance as indicated in table 4.14.

Table 4.14: Model Summary for the social impact variable

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.788[a]	.763	.759	.48197

a. Predictors: (Constant), Social impact of innovative construction technologies

Table 4.15: ANOVA for the social impact variable

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.281	1	7.281	29.898	.000[b]
	Residual	58.728	322	.112		
	Total	66.009	323			

a. Dependent Variable: Slum Upgrading
b. Predictors: (Constant), Social impact of innovative construction technologies

The findings in table 4.15 indicate that the significance value in testing the reliability of the model for the relationship between independent variable and the dependent variable was F (1, 323) = 29.898, p = 0.00; therefore, the model is statistically significant in predicting the relationship between the independent and dependent variables.

Table 1 - Regression Coefficients for the social impact variable and Slum upgrade

Based on the linear regression model, $Y = \beta_0 + \beta_1 X + €$ the model therefore becomes.

$Y = 0.938 + 0.356X$

Table 4.16: Coefficientsa for the social impact variable

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.938	.218		5.421	.000
	Social impact of innovative construction technologies	.356	.070	.111	2.003	.001

a. Dependent Variable: Slum Upgrading

The findings indicate that for every unit change in innovative construction technologies, there will be 35.6% change in social impact in the slum upgrading. Table 4.15 displays the regression coefficients of the independent variable (Social impact of innovative construction technologies) reveals that this independent variable is statistically significant in explaining the slum upgrading programmes in Kenya.

4.5 Discussion of Findings

The majority of respondents in the study felt that the slum upgrading process using the innovative walls, floor and roofing materials improved the houses to some extent. The positive perception can be attributed to the fact that before the upgrading process, the residents were largely tenants and therefore had to part with relatively high amount of rent to occupy the house. The project reclaimed the land from the former landlords, since it was government land, and compensated the absentee owners for the homes on the land. With this property, the Catholic Archdiocese then upgraded the infrastructure and created a non-profit housing system where the residents paid a fair amount of rent over a period of time (7 Years) to own the houses. These findings support UN-HABITAT (2008) that during the slum upgrading process, insufficient attention was paid to residents who did not want to own houses and instead wanted to continue renting houses. The assumption was that considerable numbers of slum dwellers wanted nothing more than to become homeowners.

4.5.1 Outcome of the Innovative Construction technologies

Innovative construction positively impacted on the community. The positive outcome was evidenced by community improvement with the upgrading process; addressed problems in the previous buildings; fulfilling experience associated with the upgrade; and lack of plans to leave the houses because of upgrade.

In addition to the positive outcome on the community, there was increased perception that the community was better than others, increased pride for the community, care for community members, feeling at home, and acceptance as a community member, and community prosperity in the last five years. Therefore, the innovative construction technologies did not positively impact on the consistent presence of someone to help, and community honesty and trust for one another.

Innovative construction technologies with respect to use of stabilized earth walling blocks, floors and sisal cement roofing sheets positively implicated on the individuals. The positive outcome was evidenced by; willingness to invest further in the houses; individuals' increased willingness to work collectively; and the positive perception on slums and the possibility of better living in slums. There was community improvement with the upgrading process that addressed problems in the previous buildings such as dysfunctional walls, roofs, and floors; fulfilling experience and improved self-esteem associated with the upgrade; and lack of plans to leave the houses as a result of upgrade and motivations to own the houses. Innovative construction technologies did not however influence individuals' trust in one another.

4.5.2 Social Impact of Innovative Construction Technologies

The positive social impact of innovative construction technologies included construction of communal facilities including toilets, roads, and proper drainage system. There was assurance of security of tenure to slum residents. According to Majale (2008), slum upgrading was actualized in various forms, including the regularization of tenure security, provision of or improvements to infrastructure and the construction of communal facilities. Similarly, in a Pumwani-Majengo upgrade project, beneficiaries cited improved living standards in form of better sanitation, water supply and infrastructure (Mgele, 2014).

There were retained frameworks of establishments. Developed units were not significantly smaller and built with higher densities. Similarly, beneficiaries of an upgrade project reported satisfaction with the housing quality, size of area, and storage area aspects (Zappettini, 2001).

On the contrary, innovative construction technologies were not concomitant to provision of or improvements to infrastructure; and led to the displacement of some residents hence little to no poverty reduction was achieved. These findings were like Buckley and Kalarickal (2005) who found out that since slum dwellers were normally displaced during upgrading, little to poverty reduction is normally achieved.

4.5.3 Economic Impact of Innovative Construction Technologies

The positive economic impact of innovative construction technologies included increased employment opportunities in the maintenance of the upgraded buildings. Similarly, Kvarnstrom (2014) established that slum upgrading normally employed locally produced building materials, such as stabilized soil blocks which were abundant in supply and required easily acquirable skills hence creating more job opportunities. SSBs used for the upgrading project were locally made and during the construction employment opportunities were created.

According to Muraguri (2011), there was high uptake of innovative construction technologies in upgrading slums due to reduced cost, production simplicity, raw materials availability, and social acceptance. On the contrary, Buckley and Kalarickal (2005) argued that providing subsidies for slum upgrading made it very expensive to implement on a big scale, and rent became unaffordable for the majoritsy of slum dwellers. Study on Pumwani-Majengo upgrade project reported lack of the redevelopment approach to sufficiently address community economic empowerment aspects to enable the project beneficiaries have a means of sustaining better livelihoods and the total lack of direct involvement by the government to subsidize the economic burden borne by the beneficiaries in paying the monthly rents or mortgages (Mgele, 2014).

The upgraded dwelling units, according to the residents responses, were better durable and of good structural quality as compared to the former. However, innovative construction technologies did not reduce rent significantly for the people living in the upgraded slums

There was lack of opportunity to occupy the upgraded houses for a lot of middle-income individuals. However, allocation process of the units was affected by corruption. These findings echo those of Huchzermeyer (2008) who found out that corruption was a significant negative consequence of slum upgrading that would affect unit allocation. Middle income individuals always had opportunity to occupy the upgraded houses meant for the slum dwellers in Kenya.

According to an interview with one of the key informants, "there *are several outsiders who were able to get houses during the slum upgrade, additionally those who were able to pay more were able to influence the process so that they can get bigger and better houses than the rest of the slum dwellers.*"

4.5.4 Guiding Framework for Innovative Construction technologies

In summary, although the project of upgrading Mathare Valley is complete and preliminary assessments has shown mixed opinions as regards satisfaction or dissatisfaction with the process employed in the upgrading process. The lessons learnt and gaps inherent in the process can form basis for future improvements in the implementation process. It is apparent that a bottom-up approach should be reemphasized in the effort of incorporating innovative construction technologies in slum upgrading. This approach when accompanied by adequate public or slum dwellers participation not only present opportunity for consensus but also enables solicitation of critical information that would inform the desirable functional requirements of the houses. The hopes, fears and aspirations of the slum dwellers can also be captured which in turn would provide information for private or public bodies interested in slum upgrading. Involvement of residents calls for instituting of committees that would be responsible for overseeing the transition processes when using innovative technologies. Slum upgrading activities should embark in rehabilitating the existing as opposed to extensive demolitions. A more “pro-poor” systematic approach would suppress conceptualizing of slums as structures waiting to be demolished but as inevitable residential quarters that appeal to be rehabilitated and be accepted as part of the urban system.

Preconstruction or pre-rehabilitation evaluation is demanded for any prospective slum upgrading projects and possibly consistent with the propounded sigma six process improvement methodology of defining, measuring, analyzing, improving and controlling. Continuous improvement is important as different projects have their own unique characteristics and circumstances.

In developing a guiding framework for innovative construction technologies in slum upgrading, significant outcomes, social and economic impact should be considered with a view of reinforcing the positives and mitigating the negatives.

4.5.5 Framework Development Critical Indicators

The study results isolated several parameters that have significant impact. Critical indicators with lowest standard deviation from the results were considered to form basis for guiding framework development.

The intervention had both positive and negative outcomes. The positive outcomes included community improvement, buildings’ improvement, fulfilling experience, and the desire of the residents to remain in the area. The negative outcomes entailed pending problems, lack of consultation, lack of involvement of the residents, and lack of understanding of residents’ needs. The social and economic impact can similarly be categorized into positive and negative impact. The positive social impact comprised improved security, health, community participation, self-esteem, provision of social amenities facilities such as toilets, roads, and drainage system. Others included security of tenure for residents, retained frameworks of establishments, and satisfaction with housing quality, size, and storage area. The negative social impact included the displacement of some residents, gender bias, and a lack of consideration for the interests of vulnerable groups. The positive economic impact comprised of employment opportunities, the use of local materials, and access to affordable housing due to subsidies.

There was negative economic impact that entailed corruption, especially in the allocation of units to the slum dwellers whereby the middle-income individuals also got a share of the units contrary to the original plan of having only low-income slum dwellers.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of major findings, conclusions drawn from the findings and recommendations made.

5.2 Summary of Major Findings

The specific objectives of the study were: To determine the effect of innovative construction technologies in housing in Mathare valley slum upgrading in Nairobi County, to establish the social impact of innovative construction technologies in housing in Mathare valley slum upgrading in Nairobi County, to establish the economic impact of innovative construction technologies in Mathare valley slum upgrading in Nairobi County. A total of 384 sample population was reached (from a population of 6673 households out of a population 20733) for the study where 324 questionnaires were filled and returned which is 84% response rate of the study. The study used both inferential (regression analysis) and descriptive units of analysis for the study where the descriptive statistics included the mean, percentages, and the frequencies while the inferential statistics were the regression analysis. The analyzed data was then presented inform of tables and graphs for easy understanding and interpretation.

Identifying the findings with the highest means, the research study found out that the community improved with the slum upgrading process (mean 3.46; standard deviation 0.836) with most of the respondents (73%) agreeing. Part of the personal changes emanating from the upgrading process is the increased sense of trust between neighbours (mean 2.08; standard deviation 0.89). Additionally, the community members are now basically more honest and can be trusted (mean 2.62; standard deviation 0.58).

The negative social impact of the process is also evident because the respondents felt that the innovative construction led to the displacement of residents hence there is little to no poverty reduction was achieved (mean 3.35; standard deviation 0.79). There was also a concern that corruption would affect allocation of units in the upgraded slum dwelling I live in (mean 3.85; standard deviation 0.93)

Additionally, very few residents have plans of leaving Mathare valley in future because of the upgrade.

The study further found out that the social and economic impact of innovative construction technologies are key components of explaining the successes of slum upgrading programmes in Kenya.

5.3 Conclusion

The slum upgrading using innovative technologies had improved the houses for the slum dwellers. Innovative construction positively impacted on the community. There was a fulfilling experience associated with the upgrade and reduced chances of vacating the houses. The upgrading process addressed problems in the previous buildings, however, there were still pending problems that needed to be addressed. The upgrading process positively influenced the social well-being of the community- better perception of slums, unity in working, and increased pride for the community, and acceptance as a community member. .3

Innovative construction had positive economic impact. The upgrading process created employment opportunities. The process led to more affordable upgraded dwelling units that were durable and of good structural quality. Innovative construction did not bring down about minimum and maximum rent fees for different cadre of people living in the upgraded slums; and allocation process of the units was subject to be affected by corruption.

5.4 Guiding Framework –

Based on the findings of the outcomes and social and economic impact of slum upgrading in Mathare Valley, there are key issues have come out very strongly that can guide the development and implementation of future projects. The address of these issues is likely to help in mitigating or eliminating the negative outcomes and impacts of these projects.

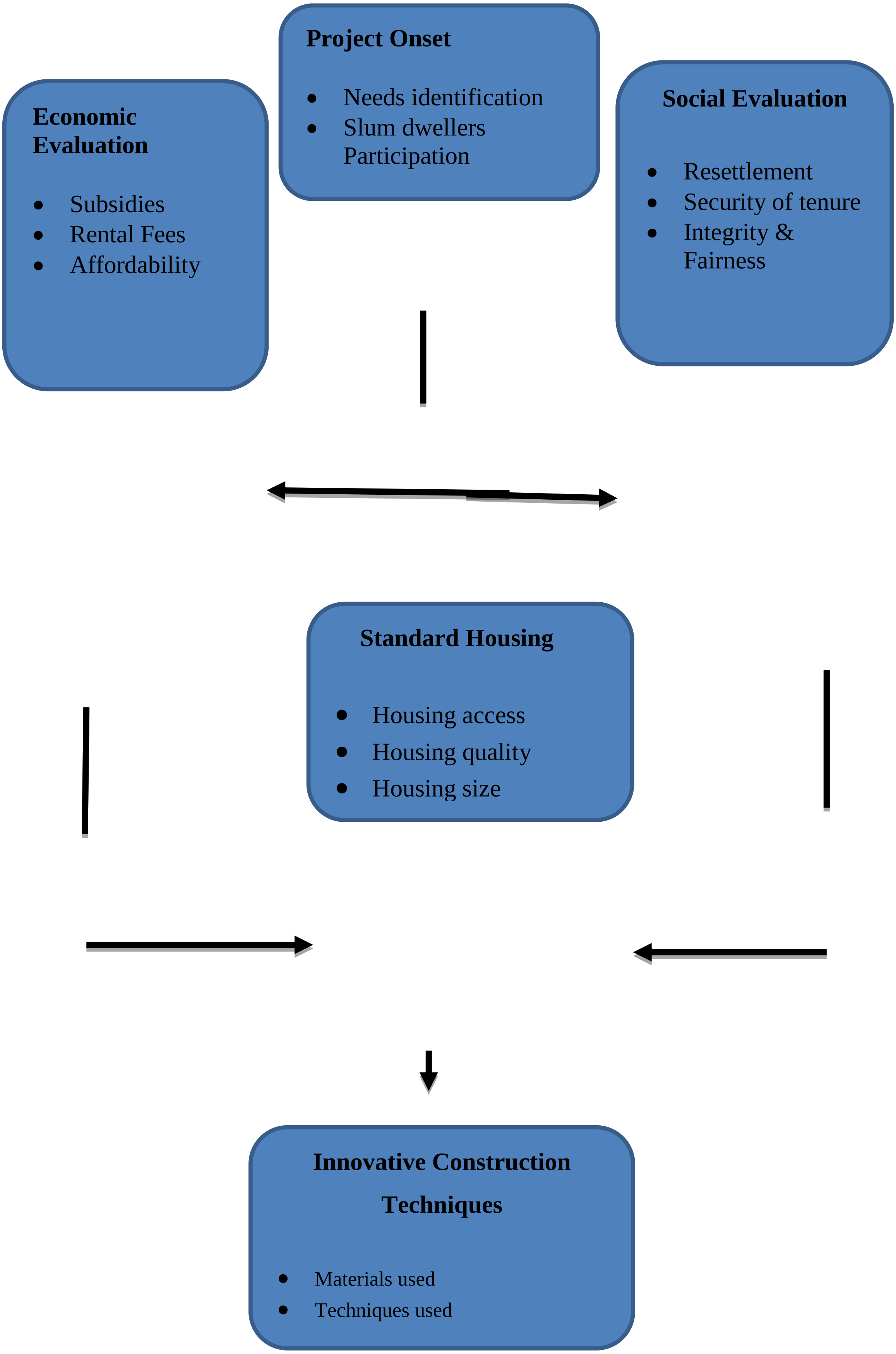
- The findings of the study shows that the innovative construction led to the displacement of residents hence there is little to no poverty reduction was achieved (mean 3.35; standard deviation 0.79). For similar projects to be done in future, there is need to work out on the alternative resettlement of the residents displaced by the projects.
- To ensure that the processes involved in innovative construction provides the security of tenure to slum residents (mean 3.16; standard deviation 0.88). Therefore, the implementation should also guarantee a security of tenure to the slum residents to avoid future conflicts. A framework can be developed to guide on the tenure security of the slum residents.
- The study findings indicate that majority of respondents agreed that subsidies provided for upgraded slum houses makes them affordable than other houses of the same standard with a mean response of 3.27 and a standard deviation of 0.7. Therefore, the subsidies play a key role in the affordability of the slum houses.
- Rent fees play a role in the affordability of the upgraded slum houses. Majority of the respondents (62%) agreed that there were no minimum/maximum rent feeds for different cadre of people with a mean of 3.13 and standard deviation 0.88. Future projects should ensure that there are no minimum and maximum rental fees for the different cadre of people living in the upgraded slums to increase the affordability of the houses by the low-income earning slum dwellers.
- The study shows that more than 70% of the respondents felt that corruption would affect the allocation of units with a mean of 3.85 and standard deviation 0.93. Therefore, for successful planning and implementation of the slum upgrade projects, there’s needed to identify measures that shall encourage transparency, integrity, and fairness in all the project phases.
- About three quarters of the respondents felt that the upgraded dwelling units are affordable with a mean of 3.78 and standard deviation 0.82. The pricing

of the upgraded units was well within the financial capability of the slum dwellers. Therefore, future projects should also consider the purchasing power of the slum dwellers in deciding an optimal pricing model. The terms of payments should also factor in the inconsistency of the income that the slum dwellers get.

- Majority of the respondents (67%) felt that there was provision of or improvements of infrastructure during the project lifecycle with a mean of 2.22 and standard deviation 0.85. This provided easy access of raw materials, labour and other construction process necessities to the site. Future projects need to have an infrastructure plan that can provide the necessary support as and when expected.
- Future projects should use a holistic approach design that focuses not only on infrastructure upgrade but also on improving livelihoods and social and economic aspects of slum dwellers. They should improve the consultation and involvement of slum dwellers at all stages of slum upgrading process. This will enable slum upgrading team to grasp the needs of the slum dwellers and ensure that they have been addressed. Future slum upgrading projects should be all inclusive to ensure no slum dwellers are displaced. The process of unit allocation should be structured and transparent. Ethics and Anti-Corruption authorities should be involved to preempt or seal any presenting loopholes. Proper social impact and gender analysis should be carried out to ensure the interests of vulnerable groups like people living with disabilities, women, and youth are taken into consideration. Slum upgrading projects disrupt livelihood networks that have taken slum dwellers several years to build. The process should therefore provide alternative networks of livelihoods for the affected people. Slum upgrading through subsidies is not sustainable and feasible for large scale projects that are required for addressing the problem of slums in Kenya. A diverse approach in interventions is critical. Public-private partnerships can play a significant role in slum upgrading projects. While the government intervenes to remove hurdles that make slum upgrading not attractive for investors, the investors can bring in the much-needed resources and innovation required to make such

projects successful. Researchers in the construction industry have an enormous task to conduct studies and disseminate their findings on innovative construction technologies. As people become more aware of available options, the more likely they are to trust and adopt innovative construction technologies leading to decent housing for all. Post occupancy evaluation is also important to streamline problems that the upgrading process may have missed as well as learning lessons for future projects.

- Figure 5.1 shows a graphical representation of proposed process of project evaluation for future slum upgrading projects.


Project Onset
Needs identification
Slum dwellers Participation
Economic Evaluation
Subsidies
Rental Fees
Affordability
Social Evaluation
Resettlement
Security of tenure
Integrity & Fairness
Standard Housing
Housing access
Housing quality
Housing size
Innovative Construction Techniques
Materials used
Techniques used

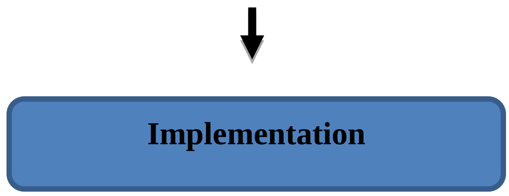


Figure 5.1: Process of Project Evaluation for Future Slum Upgrading Projects

Source: Author

5.5 Recommendations

The employment of innovative construction technologies has enhanced both economic and social development in Mathare Valley. However, the beneficiaries attested with reservations to the improvement of their standard of living as a result of the upgrade.

The following recommendations were drawn from the findings of the study:

1. The innovative construction technologies adopted should have a framework to help the displaced residents. Most of the respondents felt that there was little or no poverty reduction achieved by the slum upgrading process due to the huge number of displaced residents.
2. The research findings show that the process allocation of the units to the slum dwellers was marred by corruption concerns. There is need for effective monitoring of every step in the upgrading process to ensure all stakeholders' satisfaction, avoid displacement and minimize chances of political interference
3. Extend the scope of the project to cover even the middle-income individuals currently living in the slums. The research findings suggested that the middle-income individuals were not given an opportunity to occupy the upgraded houses meant for the slum dwellers.

4. The nature of the units developed by the innovative construction technologies are smaller and are built with higher densities. To increase the utility and satisfaction of the slum dwellers, the units can be increased to more considerate sizes to keep pace with the needs of the individuals.
5. Suggested guiding framework should be piloted as an evaluation initiative in preparation for eventual use when opportunity arises.

5.6 Areas of Further Study

This study has some limitations. It confined its focus to one slum area, Mathare 4A. Hence, future research should evaluate the social and economic impact of innovative construction in housing in slum upgrading with a larger sample incorporating most slums. The study narrowed its focus to only social and economic impact of innovative construction in slum upgrading whereas other the upgrading process has other impacts to the society which can also be studied.

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APPENDICES

Appendix I: Questionnaire

My name is Edmund Muthigani and I am a final year student at Jomo Kenyatta University of agriculture and technology of pursuing a Master's of Construction project management degree, and undertaking research entitled "The impact of innovative construction technologies in slum upgrading". It is in this regard that I am humbly requesting for your participation in filing this questionnaire. Any information collected will be treated with confidentiality and only used for academic purposes. Thank you in advance.

Instructions

This questionnaire consists of two parts; kindly answer all the questions by ticking in the appropriate box or filling in the spaces provided.

GENERAL INFORMATION

1. **Respondent's area of residence**

…………………………………………………………..

2. **Gender of the respondents**

Female [ ]

Male [ ]

3. Age of the respondent

21-29 years **[ ]**

30-39 years **[ ]**

40-49 years **[ ]**

50-59 years **[ ]**

60 years and above **[ ]**

4. How long had you lived in this community before the upgrading process began? _____years

SECTION B: ASSESEMENT OF THE OUTCOMES OF INNOVATIVE CONSTRUCTION

1. Why did you move to Mathare Valley?
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   …………………………………………………………………………………………
   ……………
2. How does your new home compare to the old one?
   Improved for the better
   Remained the same
   Worse than before

3. Please indicate the extent to which you agree with the following statements *(Key: 1 = Strongly disagree, 2= Somewhat disagree, 3= Somewhat agree, 4= Strongly agree, 5= Agree completely)*

To what level can you rate the following statement on the impact of innovative construction employed in the upgraded slums					
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1. The community improved with the upgrading process					
2. The problems with the previous buildings and community were addressed with the upgrade					
3. There are still problems that needs to be addressed despite the upgrade					
4. The experience with the upgrade at Mathare valley is fulfilling					
5. I have plans to leave Mathare Valley in the future due to the upgrade					

4. In your opinion has the upgrade in Mathare Valley led to an increase, decrease or no change in the following areas?

	Increase	**Decrease**	**No Change**
1. Your willingness to work collectively			
2. Your willingness to invest further in your house			
3. Your perception on slums and the possibility			

of better living in slums			
4. Trust between neighbors			
5. Willingness to help one another			

5. Please tell me whether in general you feel the following sentiments have increased, decreased or stayed the same since completion of upgrading:

	Increase	**Decrease**	**No Change**
1. This community is better than others			
2. I feel proud of this community			
3. In this community we take care of each other			
4. I feel at home in this community			
5. I feel accepted as a member of this community			
6. This community has prospered in the last five years			
7. If I have a problem, there is always someone to help me			
8. In this community, one has to be alert or someone is likely to take advantage of you			
9. Most people in this community are basically honest and can be trusted			

SECTION C: ASSESMENT OF THE ECONOMIC IMPACT OF ADOPTED INNOVATIVE CONSTRUCTION IN MATHARE VALLEY

6. How satisfied are you with the cost of the upgraded houses?
   1. Very dissatisfied **[ ]**
   2. Somewhat dissatisfied [ ]
   3. Neutral [ ]
   4. Somewhat satisfied [ ]
   5. Extremely satisfied **[ ]**

7. Please indicate the extent to which you agree with the following statements*(Key: 1 = Strongly disagree, 2= Somewhat disagree, 3= Somewhat agree, 4= Strongly agree, 5= Agree completely)*

To what level can you rate the following statement on the economic impact of innovative construction in Mathare Valley					
	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
1. There is increased employment opportunities in the maintenance of the upgraded buildings					
2. There is no minimum and maximum rent fees for different cadre of people living in the upgraded slums					
3. Middle income individuals do not have opportunity to occupy the upgraded houses meant for the slum dwellers					
4. Corruption would affect					

allocation of units in the upgraded slum dwelling I live in					
5. The upgraded dwelling units are affordable					
6. The subsidies provided for upgraded slum houses makes them affordable that other houses of the same standard					
7. The houses are of good structural quality and are durable					

SECTION D: ASSESMENT OF THE SOCIAL IMPACT OF ADOPTED INNOVATIVE CONSTRUCTION IN MATHARE VALLEY

8. During slum upgrading, local residents were involved in decision making, implementation, monitoring, evaluation, and maintenance levels
    1. Strongly disagree [ ]
    2. Disagree [ ]
    3. Not sure [ ]
    4. Agree [ ]
    5. Strongly agree **[ ]**

9. Innovative construction has allowed us to regain our environment while improving our lifestyles
    1. Strongly disagree **[ ]**
    2. Disagree **[ ]**
    3. Not sure [ ]

4. Agree [ ]

5. Strongly agree [ ]

10. Using a scale of 1 to 5, where 1 is Strongly agree and 5 is Strongly disagree tick the appropriate box to indicate your feelings about these statements

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1. Adopted innovative construction was accompanied by the construction of communal facilities.					
2. There is provision of or improvements to infrastructure with the innovative construction					
3. Processes involved in innovative construction ensures that there is security of tenure to slum residents					
4. Though the previous houses were replaced, the frameworks of our establishments have not been destroyed					
5. Innovative construction led to the displacement of residents hence there is little to no poverty reduction was achieved.					
6. Innovative construction developed units that are smaller and built with higher densities,					

11. Would you recommend innovative construction in Mathare Valley as an upgrading scheme to other communities? Why or why not?

____
____
____
____
____
____

Thank you for your cooperation

Appendix II: Interview Guide

1. Has the community in Mathare Valley improved with the upgrading process? In what way?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
………………………………………………………………………………………….

2. What are the economic impact of adopted innovative construction in Mathare Valley?

…………………………………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………
………………………………………………………………………………………….

3. What are the social impact of adopted innovative construction in Mathare Valley?

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…………………………………………………………………………………………
……………………………………………………………………………………….

4. What is the guiding framework for innovative construction?

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

Appendix III: Observations

1 What's the status of walls of the mathare units (supporting photo)?

………………………………………………………………………………………………

2. What's the status of floors of the mathare units (supporting photo)?

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

3 What's the status of roofs of the mathare units (supporting photo)?

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

4 What's the status of walking pavements of the mathare units (supporting photo)

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

Mathare 4A Before upgrade

Mathare 4A After upgrade

Source: :Dianga 2012

Pre and post upgrade images (2017)

Source: Author