

**ENVIRONMENTAL SUSTAINABILITY IN INFORMAL  
SETTLEMENT UPGRADING PROJECTS IN NAIROBI,  
MOMBASA AND KISUMU CITIES IN KENYA**

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**SEPTEMBER, 2020**

**DECLARATION**

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

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## **DEDICATION**

This thesis is dedicated to my mother, Jane Njeri Nguro whose hard work and resilience has inspired many.

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## ACRONYMS

BREEAM	Building Research Establishment Environmental Assessment Method
CA	Capabilities Approach
CASBEE-UD	Comprehensive Assessment System for Building Environmental Efficiency-Urban Development
CEMP	Community Environment Management Plan
CWS	Cities Without Slums
EA	Environmental Audit
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EMM	Extended Metabolism Model
ESIA	Environmental and Social Impact Assessment
FGD	Focused Group Discussion
GoK	Government of Kenya
GRC	Grievances Redress Committee
ISUPs	Informal Settlement Upgrading Programs
HDI	Human Development Index
IUSIL	International Urban Sustainability Indicator List
KENSUP	Kenya Slum Upgrading Program
KISIP	Kenya Informal Settlements Improvement Program
KNBS	Kenya National Bureau of Statistics
LEED-ND	Leadership in Energy and Environmental Design-Neighbourhood Development
MDGs	Millennium Development Goals
MoLHUD	Ministry of Lands Housing and Urban Development
PRSP	Poverty Reduction Strategy Papers
SDGs	Sustainable Development Goals
SEC	Settlement Executive Committee
UNDP	United Nations Development Program
QL	Quality Life

## ABSTRACT

The phenomenal growth of urban centres in developing countries makes cities important sites for engaging with environmental issues. The prevalence of informal settlements in cities and its implication on environmental sustainability has become a growing concern. Metabolic processes of these spatial units significantly shape the urban ecological system and define quality of life in cities. However, the significance of this space in the environmental sustainability function has not been adequately considered. Policy makers and urban planners have often failed to recognize informal settlement upgrading projects as conduits for integration of environmental sustainability in cities. As a result, the upgraded settlements do not sufficiently contribute to improved urban environmental quality. In this regard, this study sought to establish the environmental sustainability performance of government led informal settlement upgrading projects in Kenyan cities so as to recommend measures that can be taken to improve environmental quality in the upgraded settlements. It assessed the environmental performance of 11 upgraded informal settlements, the existing environmental sustainability integration pathways and analysed the impact of institutional arrangements on environmental sustainability integration in informal settlement upgrading programs in Kenya. A list of 16 environmental sustainability indicators was developed based on the theoretical and empirical frameworks. The indicators were grouped into four categories: resource consumption, waste management, environmental quality and community organization. The study adopted a case study research design. Household and key informant interviews, observations and focused group discussions were used to collect data. A total of 600 households were sampled from the eleven settlements through multistage method involving cluster and systematic sampling. These households were distributed equally between Nairobi, Kisumu and Mombasa. The 200 households in each city were distributed proportionately among the selected settlements. A scoring system was devised to help determine significant differences in performance between the three cities. The highest environmental sustainability score in the upgraded settlements is 61.4% while the lowest score is 37%. The scores vary significantly between cities. Upgraded settlements in Nairobi have higher scores than those in Kisumu and Mombasa. Environmental quality indicators have the highest predictive ratio for environmental sustainability performance of an upgraded settlement. Government led informal settlement upgrading programs indicate significant achievement in the use of green enterprises, clean technologies, community based institutions and environmental education to integrate environmental sustainability in upgraded settlements. Environmental infrastructure and environmental impact assessment have achieved minimal environmental outcomes. Housing tenure is not a significant environmental integration pathway in informal settlement upgrading. Institutional structure and functional reconstruction poses both challenges and opportunities for environmental integration in informal settlement upgrading processes. Informal settlement upgrading programs have not been adequately utilized to diffuse environmental sustainability in the urban space. The study recommends improved actor coordination; broader stakeholder engagement, institutionalizing an environmental unit in the ministry in charge of informal settlement upgrading and multi levelled environmental education in the implementation of upgrading programs.

## **1. CHAPTER ONE: INTRODUCTION**

### **1.1 Background of the study**

Environmental sustainability in cities has become one of the greatest concerns as rapid urbanization threatens the urban ecosystems which consequently affects quality of life (Baynes & Wiedmann, 2012; Sampson, 2016). In 2015 for the first time in history, more than 53% of the world's population lived in urban areas (UN-Habitat, 2016). Further, this population is expected to reach 66% by 2050 (UN-DESA, 2014). The current 40% urban population in Africa is projected to reach 54% by 2050 (UN-DESA, 2014). A greater proportion of this urban population live in the informal settlement. In Sub Saharan Africa for instance, 59% of the urban population lives in these settlements and this proportion is projected to reach 70% by 2050 (UN-Habitat, 2016). The environmental implication of informal settlement growth is consequential. Thus, the peripheral position of informal settlement upgrading processes must be redirected to the centre of the environmental sustainability debate (Grant, 2015; Gupta, 2015; Vilar & Cartes, 2016).

Environmental sustainability in an urban development context is a process that continually improves resource use efficiency, management of waste and socio economic welfare (Marzluff, 2008; Drexhage & Murphy, 2010; Gao *et al.*, 2016; Dong *et al.*, 2018). It aims at safeguarding resources to support economic development and social wellbeing for the present and future generations (Morelli, 2011; Waas *et al.*, 2011). In this regard, informal settlements significantly affect urban environmental sustainability in several ways. First, they create a productive space within which resources are consumed and waste is generated (Baynes &

Wiedmann, 2012; Winston, 2013; UN, 2016). Secondly, the concentration of people in one location provides an opportunity for realization of economies of scale in consumption and provision of infrastructure (Balaban, 2013; Nagendra *et al.*, 2018). It additionally creates an effective platform for the promotion of environmental management practices (Marzluff, 2008). Thirdly, the inherent lack of adequate basic services results to inefficient consumption and poor management of waste (Marzluff, 2008). However, this inadequacy implies limited path dependency hence the adoption of innovative service provision methods. Finally, environmental sustainability is fundamental to economic development and social integration of the urban poor (Czischke *et al.*, 2015).

Therefore, Informal Settlement Upgrading Programs (ISUPs) provide one of the most important avenues for realizing environmentally sustainable cities. Depending on the approach adopted, informal settlement upgrading programs promote the recycling of derelict land and development of compact cities (Turcu, 2012), utilization of renewable energy, provision of waste management infrastructure, nonmotorized transport and green spaces (Riffat *et al.*, 2016).

Previous informal settlements improvement policies in Kenya have presented opportunities for improving environmental sustainability in informal settlements. However, such opportunities have been inadequately explored in program designs and implementation. The 1948 Nairobi Master Plan for a Colonial City laid emphasis on garden city planning approach in the redevelopment programs (Corburn & Riley, 2016). However, this planning approach which seeks to realize high environmental quality in neighbourhoods did not inform the ISUPs since the settlements were still

considered an urban blight. The site and service upgrading strategy adopted in the 1970s allowed for provision of infrastructure which would realize both socio economic and environmental goals (Davis, 2006). In addition, the public housing policy provided an avenue for shaping consumption patterns in the new estates (Söderholm & Wihlborg, 2016).

Further, the Earth Summit in 1992 instigated a global interest in urban environmental sustainability (Mutisya & Yarime, 2014). Consequently, the Istanbul Declaration of 1996 which informed the informal settlement upgrading target in the millennium agenda recognized the role of ISUPs in realizing environmental sustainability in cities (UN-Habitat, 2008; Mutisya & Yarime, 2014). In 2001 when the Kenya Slum Upgrading Program (KENSUP) was initiated, environmental sustainability became one of its key objectives (UN-Habitat, 2008). The program which seeks to improve the quality of life among 5.3 million slum dwellers by the year 2020 cited environmental integration as a key enabler of the process (UN-Habitat, 2008). In addition, the 2006-2011 Ministry of Housing Strategic Plan recognized environmental management as a key pillar in the provision of adequate housing (Adero, 2008). Recently, Kenya Informal Settlement Improvement Project (KISIP) was initiated to augment the efforts of KENSUP in urban towns and municipal centres. Despite these numerous efforts, the contribution of these programs to environmental sustainability remains under-researched (Balaban, 2013; Mutisya & Yarime, 2014; Zheng *et al.*, 2016).

The growing interest in the contribution of redevelopment programs to environmental sustainability has led to the development of environmental sustainability assessment

frameworks (Shen *et al.*, 2011). Despite their multiplicity, previous studies argue that most of the sustainability assessment indicators lack adequate scientific basis. The urban metabolism concept has emerged as one of the most scientifically sound methodological approach for identifying environmental sustainability indicators (Newman *et al.*, 1996; Baker *et al.*, 2001; Browne *et al.*, 2009; Kennedy *et al.*, 2010). Urban metabolism, in line with the environmental sustainability definition, helps to determine material flows in a system so as to establish the levels of resource efficiency and waste generation (Kennedy *et al.*, 2010). Though attempts have been made to utilize sustainability assesment tools based on urban metabolism, availability of data particularly in Kenya has posed major impediment. Kenya's Vision 2030 for instance recognizes the instrumental role of enviromental indicators in realizing sustainable development outcomes (GoK, 2013). Adero (2008), however, notes that their effective use in informing urban development programs such as ISUPs has been constrained by lack of data on key resource flows. Despite this challenge, Kennedy *et al.* (2010) notes that existing resource flow data is equally useful in drawing the attention of policy makers and practitioners to the impact of consumption and waste generation on urban environments.

As the government is subjected to increasing pressure to address environmental concerns in the cities, the ISUPs need to respond to this challenge. Deliberate strategies to leverage on existing opportunities in environmental integration processes should be adopted. This will require a clear understanding of the current situation and the pathways through which environmental sustainability in ISUPs can be modelled.

## **1.2 Statement of the Problem**

The impact of unprecedented growth of informal settlements on environmental sustainability of cities in developing countries has become one of the greatest concerns in the 21<sup>st</sup> century (Marzluff, 2008; Balaban, 2013). The causal linkage between ecological changes and proportion of people living in informal settlements cannot be underscored (Marzluff, 2008). However, the potential contribution of informal settlement upgrading program to environmental sustainability is not adequately recognized in many cities (Balaban, 2013). In Kenya, the environmental sustainability goal has been greatly disconnected from informal settlement upgrading processes (Mutisya & Yarime, 2011). Consequently, these programs have not only failed to improve the inherent poor environmental quality but they have also aggravated consumption inefficiencies, waste management problems and disrupted the social structures through which environmental management can be propagated (Adero 2008; Mutisya & Yarime, 2014). Consequently, this has led to the impairment of ecosystem functions, economic losses and social disintegration all which are fundamental to the wellbeing of urban residents particularly those living in deprived areas (Turok, 2015).

Further, traditional approaches that have been used to address environmental concerns in cities have, to a greater extent, been sector specific and isolated within a specific agency (Sharma & Singh, 2016). This has led to poor linkage in decision making between different sectors, organizations and departments involved in informal settlement upgrading. Runhaar (2015) noted that institutional ‘compartmentalisation’

is one of the greatest barriers in the progress towards environmental sustainability. In addition, despite the development of environmental management tools to integrate environmental sustainability objectives across different sectors, institutional arrangements that create bureaucracies and managerialism often limit this potential (Baynes & Wiedmann, 2012; Fitzgerald & Lenhart, 2016). This has led to the adoption of superficial environmental management mechanisms in an effort to sanitize the ISUPs. Consequently, deep rooted systemic environmental dynamics within the informal settlement are rarely addressed (Ferrao & Fernandez, 2013). Kyobutungi *et al* (2008) observed that despite the intensified upgrading efforts in Kenya, the environmental burden disease for children under the age of five in informal settlement is four times that of the other population. Poor environmental quality therefore continues to undermine the economic and social benefits accrued from ISUPs.

Additionally, inadequate policy provisions according to Mutisya & Yarime (2014) constrains the integration of environmental management into the ISUPs. Existing policies fail to provide a clear and pragmatic framework to cascade the environmental goals from the national to the local level. Consequently, environmental management plans are generic and non responsive to local environmental opportunities (Berger & Steurer, 2009). They also fail to promote active community participation. Decision making at various levels is largely static and thus does not allow for experimentation, continuous assessment and learning (Sharma & Singh, 2016; Ferrao & Fernandez, 2013; Dizdaroglu, 2017). UN-Habitat reported in 2008 that the disintegrated implementation approach was the greatest obstacle in the realization of environmental, social and economic sustainability in informal settlements.

The opportunities provided by ISUPs to catalyze progress towards environmental sustainability in cities remains under researched (Balaban, 2013). This study therefore seeks to address this lacuna by investigating the current environmental sustainability performance and process of environmental integration in the ISUPs. In addition, the study analyzes the institutional arrangements that influence environmental considerations in the ISUPs. This research seeks to contribute to existing body of knowledge in urban environmental sustainability and informal settlement upgrading processes.

### **1.3 Research Questions**

- i. What is the level of environmental sustainability in informal settlements in Kenyan cities?
- ii. How effective is the environmental integration system in slum upgrading programs in Kenya?
- iii. How do institutional arrangements influence environmental integration in slum upgrading programs in Kenya?

### **1.4 Objectives**

The main aim of the study is to assess environmental integration in informal settlement upgrading programs in Kenya. The specific objectives are:

- i. To assess environmental sustainability performance of upgraded informal settlements in Kenyan cities
- ii. To evaluate environmental sustainability integration pathways in informal settlement upgrading projects in Kenya

- iii. To analyze the effect of institutional arrangements on environmental sustainability integration in informal settlement upgrading programs in Kenya

### **1.5 Research Hypothesis**

H<sub>0</sub>: There is no significant performance variation in resource consumption, waste management, environmental quality and community organization amongst the upgraded informal settlements in Nairobi, Mombasa and Kisumu.

$$H_0: \mu_1 - \mu_2 - \mu_3 = 0$$

H<sub>0</sub>: There is no significant variation in environmental sustainability performance amongst upgraded settlements in Nairobi, Mombasa and Kisumu

$$H_0: \mu_x - \mu_y - \mu_z = 0$$

### **1.6 Justification of the study**

The functions of a settlement as a microcosm of an urban system contribute to the overall environmental sustainability of a city (Gao, et al., 2016). Therefore, the pursuit of sustainable cities as envisioned in the Sustainable Development Goal 11 cannot overlook the growing number of informal settlements and their inhabitants in the cities of developing countries (Mutisya & Yarime, 2014). For instance, in Kenya more than 60% of the city residents live in informal settlements (Ngayu, 2011, Maoulidi, 2012). The metabolic processes of this population are a key function in relationships that define the ecological balance in the urban areas (Newton & Meyer, 2010; Grant, 2015). The characteristics that shape this informal space create environmental challenges and risks on one hand and provide opportunities for

resource efficiency and risk mitigation on the other hand (UN-Habitat, 2012; Grant, 2015).

Consequently, informal settlement upgrading processes provide the most effective avenue for integrating environmental sustainability in the informal settlements (Balaban, 2013). Since settlements are pivotal points for city infrastructure, ISUPs provide a space within which consumption patterns and waste management practices can be shaped (Edwards & Bulkeley, 2015). Integrating environmental objectives into sectoral policies, planning and practices has long been advocated as a promising strategy for promoting environmental protection and sustainable development (Runhaar, 2016). Not only can integration avoid trade-offs and inconsistencies between environmental and sectoral objectives, also synergies might be realized. A critical evaluation of the design and implementation framework of ISUPs is therefore critical in establishing key leverage points in the integration of environmental sustainability in informal settlements (Zheng *et al.*, 2016; Liu *et al.*, 2017).

In addition, improved quality of life and poverty reduction in informal settlements are strongly interlinked with environmental sustainability (Borriello, 2013). Inadequate environmental infrastructure such as sanitation systems, poor waste management and environmental hazards affect the informal settlement dwellers' social and economic wellbeing (Keles, 2012). It is estimated that 25 per cent of all deaths in developing countries are attributable to environmental factors (Narain, 2012). Majority of these deaths are among the urban poor in informal settlements and rural areas. Nussbaum (2012) emphasizes the relationship between environmental quality and wellbeing by embedding most of the threshold human entitlements on environmental sustainability.

Consideration of the environmental dimension in informal settlement upgrading processes is imperative to attainment of the overall informal settlement upgrading goal.

### **1.7 Significance of the study**

Recent studies in the field of urban development have highlighted the need for sustainable cities with the main discourse being centred on effective strategies for the realization of this goal (Cameron, 2004; Gibson, 2006; Keivani, 2010; Cronin & Guthrie, 2010; Mutisya & Yarime, 2014; Parry, 2015; Turok, 2015). This study will greatly contribute to this knowledge since it assesses the extent to which informal settlement upgrading programs contribute to environmental sustainability within the informal settlements. The evaluation of opportunities provided by ISUPs to enhance environmental sustainability in cities will inform urban development policies and strategies (Pugalis *et al.*, 2014).

Additionally, the study will also contribute to the existing literature in the field of urban environment assessment (Shen *et al.*, 2011; Zheng *et al.*, 2016). This will be particularly crucial in the area of informal settlement upgrading processes where research is still limited (Mutisya & Yarime, 2014). The information on environmental integration tools and methods will inform environmental assessment framework for the current and future informal settlement upgrading programs. Researchers in this

field could also use this information to explore different aspects of sustainability in urban development and other fields.

### **1.8 Scope and Limitations**

The study was conducted in three Kenyan cities; Nairobi, Kisumu and Mombasa. It focused on settlements that have been upgraded through government led initiatives. This excludes settlements upgraded through initiatives that were led by non governmental organizations in collaboration with the government. The study targeted settlements where a planned improvement intervention was deemed to be complete. This is because informal settlement upgrading is a continuous and progressive process. A cross sectional research design was adopted for this study. Data was collected within a period of six months between October 2017 and March, 2018.

Environmental sustainability is the dependent variable, upgraded informal settlement is the independent variable and the mediating variable is the settlement upgrading processes, policy and institutional framework. Environmental sustainability constitutes a set of 16 indicators. An upgraded settlement is a functional unit of household's education, income, family size, environmental values, housing tenure, community organization and geographical location. The upgrading process entails a sequence of stages; planning, tenure regularization, infrastructure development and operation and management of infrastructure.

### **1.9 Study Assumptions**

The study was conducted based on the assumption that:

- i. Environmental sustainability is one of the expected informal settlement upgrading outcomes. The realization of environmental sustainability is important for improved housing conditions and quality urban life.
- ii. Upgrading plans implemented by the government have significantly mediated environmental sustainability outcomes in upgraded informal settlements. There are no other factors that have significantly influenced environmental sustainability in these settlements.

### **1.10 Operational Definition of Terms**

**Informal settlement:** Settlements that transgress planning and construction regulations and exhibit multiple deprivations particularly lack of tenure security, inadequate access to basic services, overcrowding and dilapidated housing structures (UN-Habitat, 2000; Huchzermeyer, 2011).

**Environment:** An ecological system and its interplay with social and economic attributes (Marzluff, 2008; Mutisya & Yarime, 2014).

**Environmental integration:** Informed and verifiable inclusion of environmental sustainability objectives into the decision making and implementation processes of ‘non’ environmental actors (Gibson, 2006; Nunan, *et al.*, 2012; Runhaar, 2015).

**Environmental sustainability:** A state where the social and economic activities within a socio-spatial system do not compromise the productive capacity of ecological elements within and outside this system (Drexhage & Murphy, 2010; Lemons *et al.*, 2013). It is the ultimate goal of environmental integration.

**Informal settlement Upgrading:** A set of interventions aimed at improving the social, economic and environmental conditions of an informal settlement (Frediani, 2007; Chatfield & Reddick, 2015).

**Pathways:** These are alternative possible trajectories for knowledge, interventions and change which prioritize environmental goals in informal settlement upgrading processes (Strömberg *et al*, 2015; Lindahl *et al*, 2016).

## 1.11 Thesis Outline

**Chapter One:** The chapter provides a background of the research topic and explains the statement of the problem. It presents the research questions, objectives and hypothesis that guide the study. It discusses the justification and significance of the study and describes the scope and limitations. It highlights the study assumptions and provides the operational definition of key words as used in the study.

**Chapter Two:** A systematic review of literature is presented in this chapter. It provides a general overview and historical perspectives of the main topic. It further provides information on the specific study objectives including; environmental sustainability assessment, environmental integration processes and institutional frameworks governing environmental sustainability in ISUPs. The chapter analyzes theories, approaches and concepts of environmental sustainability so as to identify variables of investigation. The theoretical framework analysis is used to develop a conceptual framework. Finally it presents selected empirical studies and research gaps in this area of study.

**Chapter Three:** This chapter discusses the research methodology adopted for this study. It presents the geographical location and socio economic characteristics of the study area. It discusses the research design, the sampling procedure and sample size, data collection methods, data analysis techniques and the research output quality control methods.

**Chapter Four:** The chapter presents data analysis and findings of this research. Findings, discussions, hypothesis testing and conclusions are presented for each objective.

**Chapter Five:** This chapter presents the conclusion and recommendations of the research study. It highlights the proposed areas of further study and the contribution of this research to new knowledge.

## **2. CHAPTER TWO: LITERATURE REVIEW**

### **2.1 Introduction**

This chapter discusses environmental sustainability in the context of informal settlement upgrading processes. It analyzes environmental sustainability paradigms and theories which define the environmental sustainability assessment framework. It further discusses theoretical integration pathways in the context of environmental sustainability. Institutional theories are analyzed to configure environmental integration elements within the informal settlement upgrading process. A conceptual framework is then developed to highlight the variables under investigation and their relationship.

### **2.2 Overview of Environmental Sustainability in Informal settlements**

One of the greatest assumptions in the context of informal settlements is that any form of upgrading process will bear environmental outcomes in the long term (Mutisya & Yarime, 2014). This is not true because environmental sustainability is not inherent to economic and social development. Evidently, even the high income countries exhibit environmental degradation (Marzluff, 2008). The increase in number and size of informal settlements in developing countries can no longer be ignored as it is consequential to the environmental sustainability of their cities (Benítez et al., 2012; Balaban, 2013). The number of urban residents living in informal settlements in these countries has grown from 689 million in 1990, 791 million in 2000 to 880 million in 2014 (UN-Habitat, 2016). Sub Saharan Africa (SSA) accounts for 56 per cent of the

increase between 1990 and 2014 (UN-Habitat, 2016). In the same breath, the proportion of urban population in informal settlements in Kenya has been increasing steadily and currently stands at 56 per cent way above the SSA's average of 37.4 per cent (UN-Habitat, 2016).

In addition to the increase in the number of informal settlement dwellers, the settlements have become more deplorable in state. They have evolved from the smaller adaptive urban housing alternatives to immense settlements that occupy a significant portion of many urban areas (Ferguson & Navarrete, 2003). They are no longer the simplistic 'urban blight' that was referred to by urban policymakers in the 1950s (Davis, 2006). The growth of these settlements has drawn attention from the traditional shelter debate to their implication on urban environmental sustainability (Ferguson & Navarrete, 2003; Mutisya & Yarime, 2014).

Benítez et al. (2012) established that environmental sustainability is a cause and effect of informal settlement formation and prevalence. The inherent inadequate infrastructure and encroachment into ecological sensitive areas compromises the ability of ecosystems to provide essential capital for urban resident's wellbeing. In addition, the impacts of environmental degradation such as waterborne illnesses and mortality are disproportionately high in these settlements (Siddiqui & Pandey, 2001; Narain, 2012).

Mutisya & Yarime (2014) argue for the recognition of informal settlement upgrading programs as avenues for environmental management integration in urban areas. Siddiqui & Pandey (2001) and Balaban (2013) agree that the concentration of households in an urban space provides economies of scale in provision of

environmental infrastructure and creates a hub for innovation which significantly contribute to sustainable consumption and waste management. Despite this recognition, there are limited studies on the contribution of Informal Settlement Upgrading Processes (ISUPs) on environmental management (Adero, 2008; Mutisya & Yarime, 2014). Most of the research has been centred on the social outcomes such as access to healthcare (Colantonio & Dixon, 2009), capabilities' enhancement (Frediani, 2007) and economic development (Zhang & Pei, 2007). Minimal attempts have been made to assess environment outcomes through adoption of composite socio economic and environmental indicators (Mutisya & Yarime, 2014). However, this aggregated methodology does not adequately reveal the impact of ISUPs on the environment in informal settlements. This study provides a comprehensive assessment of the contribution of ISUPs on environmental sustainability.

### **2.3 Historical Perspective of Environmental Integration in Urban Upgrading Processes**

Informal settlement upgrading is a constituent of urban upgrading processes that seek to address inter related socio economic and environmental aspects of an informal settlement (Keles, 2012). Urban upgrading dates back to the nineteenth century and has since developed as a revolutionary strategy in the field of urban development (Davis, 2006; Popkin, 2016). Historically, upgrading processes have created space within which environmental sustainability can be propagated. In the mid nineteenth century, the Haussmann's redevelopment plan made significant attempts to improve environmental quality in Paris (Gandy, 1999). Central to this plan was the redefinition of nature in a metropolitan context through inscription of new patterns of social and spatial order (Gandy, 1999; Anastasia, 2019). Much of the focus was on provision of

infrastructure such as storm water drains, establishment of green spaces and enhanced light and air circulation within the buildings through housing design. However, Haussmann's plan was more inclined towards the recreation and convenience utility of environmental sustainability vis-a-vis its material necessity (Basiago, 1999).

In the early twentieth century, there was a gradual shift from the pursuit of urban environmental sustainability merely for aesthetic purposes (Gandy, 1999). The challenges of rapid urbanization such as inadequate housing and congestion in cities necessitated the consideration of efficiency in land use and transport in city upgrading plans. This pursuit ushered in the garden city planning approach in upgrading processes. The approach advanced essential sustainability goals of enhancing walkability and equitable access to infrastructure and services principles. During the same period, resource use efficiency was birthed through Le Corbusier's radiant city concept. Upgrading projects in cities notably London were centred on promoting efficiency in cities through technological advancement (Popkin, 2016). However, limited advancement of this theme was realized. It is only recently when global challenges such as climate change have necessitated the rebirth of efficient cities.

In the 1970s, attention was drawn to the growing challenge of air and water pollution in urban areas (Appleyard, 2017). This led to the emergence of environmental movement which spearheaded the marking of the first Earth Day. One of the most significant outcomes of these celebrations was the development of environmental policies and tools to assess the environmental impact of development projects in America and Europe. During the same period, environmental quality was included as a critical component of liveability (Appleyard, 2017). Therefore, development

programs were to incorporate environmental sustainability objectives in their plans. In the US for instance, transportation choices were expanded to include non-motorized transport options and recreational opportunities which also served ecological functions.

In 2000, the Millenium Development Goals recognized environmental sustainability as an instrumental pillar in improving the quality of life among slum dwellers. Consequently, environmental objectives were incorporated in informal settlement upgrading programs. However, in most countries where large scale upgrading programs have been implemented, the integration of environmental objectives has rarely gone beyond the policy level (UN-Habitat, 2008; Mutisya & Yarime, 2014).

## **2.4 The Concept of Environmental sustainability**

The concern for environmental limits in relation to increasing natural resource demand has been evident throughout human history (Waas *et al.*, 2011). Though the concept of environmental sustainability is old, it is only in the twentieth century that its significance and urgency emerged. This section discusses the paradigms that have shaped the definition and conceptualization of environmental sustainability.

### *i. The Ecological Limit Perspective*

Firstly, there was heightened debate on ecological carrying capacity which was instigated by the writings of Hardin in 1968 on the ‘Tragedy of Commons’; Ehrlich in 1970 on ‘Population, resources, environment: issues in human ecology’ and Meadows *et al.* in 1972 on ‘Limits of Growth’ (Adero, 2008). Emphasis was placed on pollution, excessive consumption of natural resources and degradation of ecosystems

(Jerneck, 2015). The increasing rate of urbanization during this period became of great interest in the conservation debate. It was evident that cities were not only engines of economic growth but also producers of environmental problems such as pollution (Hodson & Marvin, 2017). There was need to limit consumption of natural resources and negative environmental impacts in the cities.

In view of this, the 1972 United Nations Conference on the Human Environment singled out human settlements as an effective avenue for implementation of conservation measures. This resonated with Ian Mc Harg's work in 1969 on 'Design with Nature' which advanced the principles of ecological land planning, watershed planning and protection of sensitive lands (Beatley & Manning, 2013). As a result, many ecological approaches to human settlements development and improvement have emerged. The eco neighbourhood for instance, is a strategy to safeguard the ecological carrying capacity through compact development, mixed land use and restoration of degraded areas (Beatley & Manning, 2013; Hodson & Marvin, 2017). However, conventional economists and planners have argued against these limits through the ecological modernization theory (Marzluff, 2008). The theory contends the fundamental basis of determining ecological limits by presenting technological and economic interventions as the most effective regulating instruments of sustaining and restoring ecosystem functions (Yigitcanlar & Dizdaroglu, 2015). Many scholars in the field of sustainable development have argued that the theory is reductionist in nature and is based on the assumption that environmental degradation is a function of social democracy (Yigitcanlar & Dizdaroglu, 2015).

This environmental sustainability perspective led to the development of ecological footprint (EF) as a tool for measuring the ecological carrying capacity of a specific population. The EF determines the amount of productive land regardless of the location, which can adequately support a given population indefinitely taking into consideration varied consumption patterns (Collins *et al.*, 2009). The total productive land assumes sustainable production during the indefinite period. In addition to natural resources that a population consumes, the amount of land or water required to assimilate waste is also included in the consumption factor (Marzluff, 2008). The measure is based on the assumption that the environment is the dominant pillar in the overall sustainability function.

Critics have argued that it is too simplistic and static while in essence the environment is dynamic in nature (Marzluff, 2008). It fails to take into consideration the social and political systems that influence availability of productive land such as technology advancement and trade and factors that affect consumption trends such as societal values. Though they are not the predominant factors as ecological modernization theory suggests, they significantly influence the two EF variables. Despite this weakness, ecological footprint plays significant role in communicating the cumulative effect of consumption habits at micro levels such as household and neighbourhood units. Environmental impact of local development activities on the city, national and global environment. It also helps to illuminate the distribution processes of ecological deficits within the society.

Informal settlement dwellers are presumed to have lower EF compared to the rest of the population due to limited access to resources such as water and energy. However,

this assumption may not hold when their contribution to waste assimilative capacity is considered. This is in the form of emissions due to unsustainable energy sources, encroachment into critical ecosystems such as river banks and disposal of waste into open spaces and water ways. Urban development policies therefore need to be synchronized with environmental management with particular attention to informal settlements.

*ii. Integrated Perspective*

Secondly, environmental sustainability emerged as a means of integrating ecological values in the mainstream planning field (Newman, 2005). The Brundtland report of 1987 indicated that effective environmental sustainability would only be realized if it is conceptualized as a function of environmental, social and economic interactions (Cameron, 2004; Gibson, 2006; Drexhage & Murphy, 2010; Baffoe & Mutisya, 2015). This is the basis of the popular interlocking or triple bottom sustainability model. Though the model proposes equal consideration of the economic, social and environment dimensions, environment remains dominant (Waas *et al.*, 2011). This is because the development of all the other aspects fundamentally relies on environmental resources while the environment would continue without society.

In this regard, the economic system plays a significant role in delivering environmental services and functions. This includes adoption of green technologies, development of green businesses and employment and establishment of environmental infrastructure (Yigitcanlar & Dizdaroglu, 2015). Effective economic instruments allow for equitable distribution of environmental costs (Morelli, 2011). For instance, the cost of river pollution among informal settlement residents should not be borne solely by the downstream communities. Beatley & Manning (2013)

suggested that neighbourhood development programs should promote a sense of belonging and interconnectedness so as to nurture responsibility and commitment to invest in environmental quality.

The United Nations Conference on Environment and Development (UNCED) of 1992 noted that despite human settlements being among the major stressors of the global ecosystems, they had not received any significant attention in the conservation agenda (Western, 2001). The UNCED's Agenda 21 indicated the need for integration of environmental and socio economic goals in the human settlement development and improvement plans. The Millennium Development agenda reflected the aspirations of the integrated approach to environmental sustainability. Though not much progress was made during this period, lessons learnt have progressively concretized its vague conceptualization.

### *iii. Normative Perspective*

Thirdly, environmental sustainability has developed as a means and end in the social justice arena (Beatley & Manning, 2013). The Earth Charter of 2000 adopted a normative perspective where the society has the freedom to determine their desired environmental sustainability goals (Waas *et al.*, 2011). These goals however should make consideration of neighbouring jurisdictions. In addition, the environmental burden and benefits should be equitably distributed (Waas *et al.*, 2011). This development pathway has widened the lenses through which environmental sustainability is viewed. It is rooted in societal values and ethics. However, it poses a challenge of adaptive and conflicting morals which compromise globally acceptable environmental limits.

### *iv. Pragmatic Perspective*

The fourth development has occurred within a framework of dynamism. Environmental sustainability entails continuous assessment of emerging and potential risks to the environment (Bina, 2013). Socio economic activities are dynamic and hence their impacts evolve in nature and significance. Consequently, development policies should allow for adaptation of unanticipated impacts.

The framing of environmental sustainability challenges and responses depends on the views that are adopted. The 1987 Brundtland Commission definition of sustainable development integrates all the four environmental perspectives. It can therefore be deduced that environmental sustainability is a state where current development meets the needs of the current and future generations without compromising the health of ecosystem that supports them (Drexhage & Murphy, 2010; Morelli, 2011; Waas *et al.*, 2011). It entails consideration of social, economic, environmental and institutional factors and their interconnection with the recognition that environmental factors have greater and significant influence on the current and future development needs (Marzluff, 2008).

**Table 2-1: Implications of varied ES perspectives on ISUPs**

<b>Environmental Sustainability Perspective</b>	<b>Implication on ISUPs</b>
Ecological Perspective	<ul style="list-style-type: none"> <li>i. Intervention targets consumption domains at the settlement level</li> <li>ii. Interventions increase biocapacity</li> <li>iii. Consideration of EF intervening factors-income, education, household size, technology level, values, economic incentives</li> <li>iv. Multi sectoral intervention approaches</li> </ul>
Integrated Perspective	<ul style="list-style-type: none"> <li>i. Interventions demonstrate linkage between environment, social, economic and governance factors</li> </ul>

Normative Perspective	<ul style="list-style-type: none"> <li>i. Equitable distribution of environmental costs and benefits</li> <li>ii. Interventions influence adaptive preferences, conflicting values</li> </ul>
Dynamic Perspective	<ul style="list-style-type: none"> <li>i. Feedback mechanisms to monitor emerging environmental issues</li> <li>ii. Responsive and flexible structures</li> </ul>

#### **2.4.1 Environmental Sustainability Assessment Framework**

There has been extensive research on environmental sustainability assessment. Many of these studies focus on global sustainability (Marzluff, 2008) national and city wide sustainability trends (Turcu, 2012; Shen *et al.*, 2011) and green building (Adero, 2008). There is still limited focus on environmental sustainability at the neighbourhood level (Balaban, 2013). This is the achilles heel of city wide sustainability assessment since neighbourhoods including informal settlements are components of the city (Zheng *et al.*, 2016). Unsustainable outcomes at this level are reflected in the overall city sustainability equation.

Previous environment sustainability assessment studies have adopted varied frameworks based on the spatial scale and the socio-political context (Turcu, 2012). This has instigated interest and growth of environmental sustainability frameworks including the ecological footprint, energy flow accounting and energy flow metabolism ratio (Marzluff, 2008; Zheng *et al.*, 2016). However, the use of indicator sets has been cited as the most effective means of communicating the impact of human activities on the environment (Balaban, 2013).

Indicators are variables that have been assigned a measurement role to a given phenomenon (Pope *et al.*, 2005; Balaban, 2013). They provide a tangible assessment and monitoring system in development processes (Balaban, 2013). The extent to which this benefit is realized is dependent on policy and institutional environment

(Persson *et al.*, 2016). However, indicators have a limitation to their use because they are static and hence do not reflect progress towards sustainability (Turcu, 2012). Despite this, indicators have been widely adopted in the assessment field since they offer a framework within which parameters can be compared across different regions using standard measures (Shen *et al.*, 2011).

There are varied views on selection of assessment indicators but there is a consensus on three fundamental aspects (Karol & Brunner, 2009; Shen *et al.*, 2011; Turcu, 2012). First, the indicators should be scientifically sound and theoretically well founded. Secondly, it should be based on internationally or locally accepted standards to allow for comparability. Thirdly, the indicators should be simple, localized, valid and sensitive to substantial system changes. Moffatt *et al.* (2001) also notes that the information from which an indicator is calculated should be readily available.

Most researchers adopt adhoc sets of indicators which do not have scientific basis (Turcu, 2012). Such indicators provide inadequate information which consequently lead to the development of ineffective environmental sustainability strategies. Most studies use integrated sets of indicators in an effort to meet the criteria for a good indicator by drawing on the strengths of different sets (Zheng *et al.*, 2016). In addition to the generally accepted criteria, other critical considerations include: selection of the number of dimensions to be used, establishing the relevant scale of measure and weights to be attached to the observations and the robustness of the measures used (Moffatt *et al.*, 2001).

In regard to informal settlement upgrading, there are various indicator sets which target neighbourhood sustainability including: Leadership in Energy and Environmental Design-Neighbourhood Development (LEED-ND), Building Research Establishment Environmental Assessment Method (BREEAM), Comprehensive Assessment System for Building Environmental Efficiency-Urban Development (CASBEE-UD), Sustainable Renovation of Buildings for Sustainable Neighbourhoods (HQE<sup>2</sup>R) and Eco city (Shen *et al.*, 2011; Zheng *et al.*, 2016).

Recent scholarship in urban regeneration has spurred the development of composite indicators such as Urban Sustainability Indicator List (USIL) (Shen *et al.*, 2011) Integrated Indicators (Turcu, 2012) and Urban Ecosystems Europe (UEE) (Balaban, 2013) which aggregate relevant indicators into a single indicator set. There are still limited environmental sustainability assessment studies in the field of informal settlement upgrading (Mutisya & Yasmine, 2014). The study draws on existing aggregate indicators to frame environmental sustainability indicators in ISUPs (Table 2-3).

#### **2.4.2 Environmental Integration Processes in Informal Settlement Upgrading**

Program development and implementation is a multifaceted and multiscale process which requires involvement of multiple stakeholders across sectors (Thabrew & Ries, 2009). Integrating environmental concerns into a development program therefore requires an equally elaborate approach across relevant sectors and governance levels. In this regard, environmental integration is commonly classified as either horizontal or vertical (Nunan *et al.*, 2012).

Vertical integration entails supportive policy and sectoral institutional frameworks which shape decision making processes at the national, city and local levels (Berger & Steurer, 2009; Fitzgerald & Lenhart, 2016). Horizontal integration focuses on intersectoral linkages in environmental management normally with a coordinating lead agency (Fitzgerald & Lenhart, 2016). Despite this distinct classification of integration levels, horizontal and vertical integration are interdependent hence difficult to establish a clear cut between the two (Nunan *et al.*, 2012). For instance, a policy may be cascaded down to local levels through a cross sectoral collaboration. Since its emergence in the 1992 United Nations Conference on Environment & Development, environment integration efforts have focused on addressing varying sectoral interests and dissimilar governance systems (Berger & Steurer, 2009; Nunan *et al.*, 2012). However, much of the attention has been on integration at the policy level (Nunan *et al.*, 2012; Briassoulis, 2010). Consequently, comprehensive analysis of the integration performance is limited due to lack of information on the extent to which these policy intentions are implemented and their outcomes (Nunan *et al.*, 2012).

Liu *et al.*(2017) suggest that program environmental integration assessment should focus on three key domains including: policy and institutional framework, institutional processes and substantive elements. Policy and institutional framework allows for identification of procedural factors that influence integration effectiveness(Berger & Steurer, 2009; Persson *et al.*,2016). The program processes and substantive elements help to establish practical responses for realization of environmental sustainability such as appropriate technologies and green economy (Liu *et al.*, 2017).

Previous studies reveal that urban development processes have realized significant progress in environmental integration at the policy level but perform poorly in practice due to weak institutional coordination across sectors (Newman, 2006; Berger & Steurer, 2009; Sharma & Singh, 2016). Berger & Steurer (2009) attributes this to bureaucratic and managerial governance systems in the public sector. Such systems allow for creation of agencies that work in isolation from the wider policy and program context. On the same note, Thoenig (2012) observes that the weak sectoral linkage across public agencies is not due to incongruence of interests but a self seeking strategy fueled by legitimacy and power interests. Dalal-Clayton & Bass (2009) argue that co-ordination approaches rather than varied governance systems are key determinants of an effective integration process. They further note that a strong coordinating mechanisms ensures all stakeholders have internalized the environmental goals regardless of their institutional structure and interests. Nunan et al.(2012) agree with this statement but points out that institutional co-ordination should not be conceptualized as being synonymous to a coordinating unit or department. They observe that most of the coordinating units are more of impediments than facilitators of integration.

Fitzgerald & Lenhart (2016) while analyzing the effectiveness of Malmo eco district established that while environmental integration is centred on broad actor participation and institutional linkages, policies are also imperative. Policies that allow for pragmatic decision making process facilitate horizontal integration and consequently more effective integration (Sheate *et al.*, 2003). Such policies provide a framework for innovation, experimentation and learning. This however remains under exploited due to non responsive policies and legislations (Bulkeley, 2010). Similarly,

Sharma & Singh (2016) argue that environmental integration is a function of smart governance which entails technological innovations in decision making processes. Other studies demonstrate the critical role of political leadership in creating and maintaining integration momentum from program inception to implementation at the community level (Haus & Klausen, 2011).

The extent to which environmental sustainability in the informal settlement upgrading programs is realized depends on a number of factors with the overarching being the level of actor co-ordination across and along the program cycle. This will address the complexities of varying institutional structures and interests (Nunan *et al.*, 2012; Briassoulis, 2010).

### **2.4.3 Environmental Sustainability Integration Pathways**

Diffusing environmental sustainability into urban development programs such as ISUPs requires pragmatic strategies which seek to reduce ecological footprints from production, consumption and waste management (UN-Habitat, 2009). Green infrastructure, renewable energy and decentralized service provision systems (UN-Habitat, 2009), urban designs that minimize reliance on motorized transport (World Bank, 2016), energy efficient technologies, ecologically sound building standards, environmental assessment tools and community management plans (Timar, 2005) green enterprises (Edwards & Bulkeley, 2015) present opportunities for minimizing ecological footprints while simultaneously improving the quality of urban life. These strategies have however remained largely ineffective in most urban areas where they have been adopted. Miller (2005) observes that this is attributed to two major challenges.

Firstly, most of the strategies fail to strike a balance between methodological sophistication and practical applicability (Miller, 2005). Their complex and intricate orientation requires substantive changes to current institutional and social structures. Davidson & Arman (2014) suggest that resource use efficiency, technological fixes and linkage of environmental management to market mechanisms are feasible starting points in an effort to build up to more transformative strategies. Secondly, the thin line between prescription and participation remains a major barrier in the adoption of environmentally sustainable pathways (Miller, 2005). Stenberg *et al* (2005) propose community based planning to ensure broad participation of residents and other stakeholders. This can be effectively mainstreamed in existing tools such as EIA, local land use plans and zoning plans. Thirdly, most of the strategies are ambiguous and fail to provide clear implementation details. Consequently, development programs such as ISUPs lack detailed plans to realize environmental sustainability objectives.

#### **2.4.4 Policy and Legal Framework Governing Environmental Sustainability**

##### **Sustainable Development Goals (SDGs)**

The Sustainable Development Goals (SDGs) is a fifteen year global development blueprint adopted in 2016 as a build-up to the Millennium Development Goals (UNDP, 2018). The 17 goals broadly seek to end poverty, protect natural resources and promote peace and prosperity. Though critics have argued against the large number of goals compared to the eight MDGs, the SDGs have attempted to reflect emerging societal issues such as climate change, sustainable consumption and innovation (Swain, 2017). Integration of environmental sustainability in informal settlement

upgrading programs is directly hinged on SDG 11 which aims to ‘make cities inclusive, safe, resilient and sustainable’ (UNDP, 2018). This is based on the rationale that it is possible for cities to increase productivity and also minimize the associated environmental impacts (Turok, 2013).

The realization of this goal implies providing adequate housing with basic services, sustainable transport systems, participatory human settlement planning, minimizing per capita environmental impact, increasing access to green space and promoting integrated policies and plans. This goal is interlinked with the other goals because its outcome significantly impacts other goals and vice versa. For instance, reduction of poverty (SDG 1), increased access to safe water and sanitation (SDG 6) would result to increased affordability and access to adequate housing while the achievement of SDG 11 would contribute to improved health and wellbeing (SDG 3), sustainable consumption (SDG 12) and climate change resilience (SDG 13).

The interlinkage of these goals calls for integrative and pragmatic implementation approaches. Parallel planning strategies for the 17 thematic areas will only lead to inefficiencies and insignificant impact. This is clearly outlined in target 11 which aims at increasing the number of cities and human settlement adopting integrative plans. This target represents a fundamental planning approach that should inform all the 17 SDGs. The SDGs make reference to specific tools that should be adopted in realizing environmental sustainability in ISUPs such as use of environmental education and innovative technologies to enhance sustainable consumption and leveraging on relevant initiatives such as the 10-Year Framework of Programmes on Sustainable Consumption and Production (UNDP, 2018).

Agenda 21 is a plan of action for sustainable development into the 21st century (Waas *et al.*, 2011). It was one of the outcomes of the United Nations Conference on Environment and Development (UNCED) held in 1992. The purpose of the conference was to discuss the emerging implications of development on the environment. Agenda 21 recognizes the contribution of human settlements to sustainability. Chapter 7 outlines key strategies for promoting sustainable human settlements including: promoting adequate shelter for all, promoting the integrated provision of environmental infrastructure particularly water, sanitation, drainage and solid waste; and promoting sustainable energy and transport systems (Evans *et al.*, 2005). It is notable that most of these concerns have been reflected in the Sustainable Development Goals. Actions contained in Agenda 21 are based on key sustainability principles including:

- i. Sustainable development is that which meets the needs of the current generation without compromising the ability of future generations to meet their own needs.
- ii. Sustainable development is largely dependent on reduction and elimination of unsustainable consumption patterns.
- iii. The importance of new and innovative technologies.
- iv. The need for adoption of environmental impact assessment as a decision making tool in development activities.

Despite the wide consensus on the contents of Agenda 21, not much progress has been recorded in its implementation (Dahl, 2014). Many countries including Kenya are reported to have developed local agenda 21 (LA21) but most are neither participatory nor effective (Hardoy *et al.*, 2013). This is attributed to little government

interest, slow and partial integration processes; limited co-ordination at different spatial scales, limited implementation capacity and weak local democratic systems (Hardoy *et al.*, 2013). Despite this, local authorities that have effectively developed and are implementing their LA21 have realized systemic benefits such as operationalization of the concept of sustainability, environmental policy development and enhanced decision making processes leading to participatory and inclusive planning (Jorby, 2002; Waas *et al.*, 2011).

In Kenya, LA21 development process is entrenched in the Environment Management and Coordination Act Cap 387 (Government of Kenya, 2016). The act makes provision for preparation of environmental action plans at the national and county level as an environmental mainstreaming strategy. The action plans allow for identification of environmental planning issues in different sectors including human settlements. It also provides for mechanisms through which the action plan is integrated into development processes. However, the extent to which this is realized remains unclear due to inadequate and unco-ordinated monitoring procedures. This is, however, likely to be addressed by the new environment action planning guidelines which provide systematic procedures and unambiguous plan structure that allows for impact monitoring (Government of Kenya, 2016).

### **National Environment Policy, 2013**

The policy aims at providing a framework that promotes an integrated and sustainable environmental planning and management approach in the country. Sustainable resource use is recognized as one of the key principles upon which the policy is embedded. The conceptualization of sustainable resource use in the policy implies that it is an overarching principle as it encompasses aspects such as right to a clean

environment, right to development, public participation and equity (Republic of Kenya, 2013). In the context of urban development, the policy recognizes the major sustainability threats to be unsustainable consumption patterns, rapid expansion of human settlements, infrastructure development, water supply and waste management. It therefore acknowledges the need for the government to mainstream environmental mitigation and management measures in urban development processes through multiple substantive and procedural strategies. These include:

- i. Development of sectoral strategies which integrate environmental sustainability aspects including a national infrastructure development strategy; Integrated Housing Policy and Housing Master Plan.
- ii. Creation of awareness on sustainable consumption practices such as the impact of non biodegradable materials e.g. plastics.
- iii. Utilization of public procurement processes for diffusion of environmental sound goods and services.
- iv. Employment of environmental management tools such as environmental audits, monitoring indicators in development projects.
- v. Providing incentives for private sector investment in appropriate technologies in water, sanitation and waste management.
- vi. Promotion of sustainable practices such as eco-settlement centres, adoption of clean energy, use of non-motorised transport, water use efficiency, waste recovery, recycling and re-use.

Though the policy provides elaborate strategies to promote sustainable urban development, the implied role of local communities as consumers is minimal particular in regard to sustainable production and consumption where most of the

actions target producers. This may however be addressed through the implementation of the national strategy on environmental education and public awareness.

The policy recognizes the adequacy of National Environmental Management Authority (NEMA) as a coordinating agency in environmental matters across all sectors. It further acknowledges the need to strengthen the Directorate of Environment in the State Department responsible for environment to support the Cabinet Secretary in the oversight role in environmental policy formulation, coordination of intervention activities and to monitor the implementation (Republic of Kenya, 2013). The role of these two organs is fundamental since successful integration of environmental issues in development processes requires cross sectoral and multi levelled integration (Thabrew & Ries, 2009; Nunan *et al.*, 2012).

This policy identifies the key environmental threats in urban development based on the principle of sustainable resource use upon which it is anchored. It however accords the community a minimalist role in promoting sustainable development. It takes cognisance of the importance of institutional, technological and market based approaches to environmental sustainability. These will however require elaborate co-ordination strategies spearheaded by the Ministry of Environment and Natural Resources. It is therefore perspicuous that the policy underscores the need to strengthen the Directorate of Environment in the State Department to support the Cabinet Secretary undertake this responsibility.

#### **Housing Policy, 2004**

The policy primarily seeks to enable access to adequate and sustainable housing for all. It describes adequate and sustainable housing as that which is functional, healthy, aesthetically pleasant and environmentally friendly. Infrastructure is recognized as a central pillar in enabling housing access. This recognition facilitates the integration of

environmental infrastructure in housing development plans. On the same note, the policy acknowledges the need for infrastructure maintenance guidelines that clearly indicate the role of developers, local authorities and communities. It mentions that the maintenance guidelines are to be complemented by standards on acceptable maintenance status of the built environment and public awareness programs on environmental cleanliness.

The policy also highlights the need to protect the human settlement environment from degradation as a means of attaining sustainable development. This will be mainly realized through the use of environmental impact assessment and incorporation of stakeholders from environmental related sectors during policy implementation.

### **National Slum Upgrading and Prevention Policy, 2016**

The policy conceives an informal settlement as a human settlement characterized by insecure land tenure, dilapidated housing structures, overcrowding, abject poverty and inadequate infrastructure (Republic of Kenya, 2016). Though environmental quality is not mentioned, it is implied as an impact of these deprivations. The policy seeks to provide an integrated framework within which informal settlements upgrading programmes are implemented. The policy recognizes that adequate housing is not limited to structural aspects but entails a clean and healthy environment. This is consistent with its core principles which include sustainability, inclusiveness, participation and collaboration.

The role of slum upgrading programmes in addressing environmental challenges is highlighted. The upgrading programs are required to adopt planning strategies that promote adequate living conditions, promote sustainable solid waste management, integrate tree planting and protect environmentally sensitive areas. It also recognizes the need to facilitate infrastructure provision and establish clear roles of infrastructure

management among residents, county government and other stakeholders. A new institutional framework is also provided. It entails an Inter Government Agency for Slum Prevention and Upgrading that will coordinate slum upgrading activities; a Kenya Slum Upgrading Low Cost Housing and Infrastructure Trust Fund which will be a depository of all slum upgrading funds; a national and county Slum Upgrading Multi Stakeholder Support Group (MSSG) to implement the day to day function of the agency. At the national level, the MSSG will be largely involved in policy development and research while at the county level it will be the policy implementation vehicle.

Most of the environmental management strategies in this policy are implied through development of integrated slum upgrading plans and provision of infrastructure. The provision of an MSSG at the county and national level could also imply that environmental agency will be involved in the policy implementation hence allowing for unbundling of the broad environmental provisions.

### **Environment Management and Coordination Act CAP 387 (EMCA).**

This Act seeks to ensure that every person in Kenya lives in a clean and healthy environment and also safeguards their environment. It defines environment as the physical and social factors that characterize a human surrounding. The Act provides for the establishment of the National Environment Management Authority to coordinate environmental management activities undertaken by lead agencies. It also mandates the authority to promote integration of environmental considerations into development policies and programmes.

Environmental impact assessment, environmental monitoring, environmental action planning and environmental awareness are provided as key strategies for effective

environmental integration in development processes. In addition, the act recognizes the need for establishment of environment committee at the national and county level to allow for decentralized management of environmental issues. Though the act mentions a broad range of environmental management aspects, the focus is mainly on industrial and commercial activities. There are limited provisions to govern environmental management in residential spaces. The act fails to mention conditions in residential areas that should warrant corrective measures by an agency in a residential zone.

### **Building Code, 2009**

The building code provides standards aimed at promoting safety, convenience, sustainability and innovation in the built environment. The standards address various aspects of environmental sustainability including: energy and water efficiency, solid waste management and sanitation. The code makes provision for:

- i. Adequate natural lighting, natural cooling and ventilation provision in all new buildings or alternations. This is aimed at minimizing energy usage in thermoregulation and also lighting during the day.
- ii. Installation of solar hot water heating for bathroom use. It prohibits the use of national grid electricity for water heating in bathrooms.
- iii. Generation of electricity from stand-alone photovoltaic installation should be considered.
- iv. Rainwater harvesting should be provided for in all buildings. The code points out that rainwater should be used for flushing toilets or cleaning and not for drinking unless it is treated.

- v. Recycling of grey water for flushing toilets and irrigation should be considered. It therefore requires buildings to have waste water management systems designed to separate grey water (from wash hand basins and sinks) from (black water from toilets).
- vi. Storm water drains should be provided at all levels and should be covered to mitigate clogging.
- vii. Open waste water discharge channels are prohibited.
- viii. One latrine should serve one family or a group not more than twelve persons.
- ix. Waste receptacles should be sited so that residents do not carry refuse further than 30 meters. It also provides for local authority to make satisfactory arrangement for collection of waste.

To ensure adherence, penalties are provided against each of the prohibitions. However, most of the environmental related standards such as adoption of solar energy and waste water recycling are mentioned as recommendations where transgression does not attract any penalties. It is however notable that the code provides an entry point through which subsequent revision of standards therein can entrench concrete and compulsory environmental sustainability provisions.

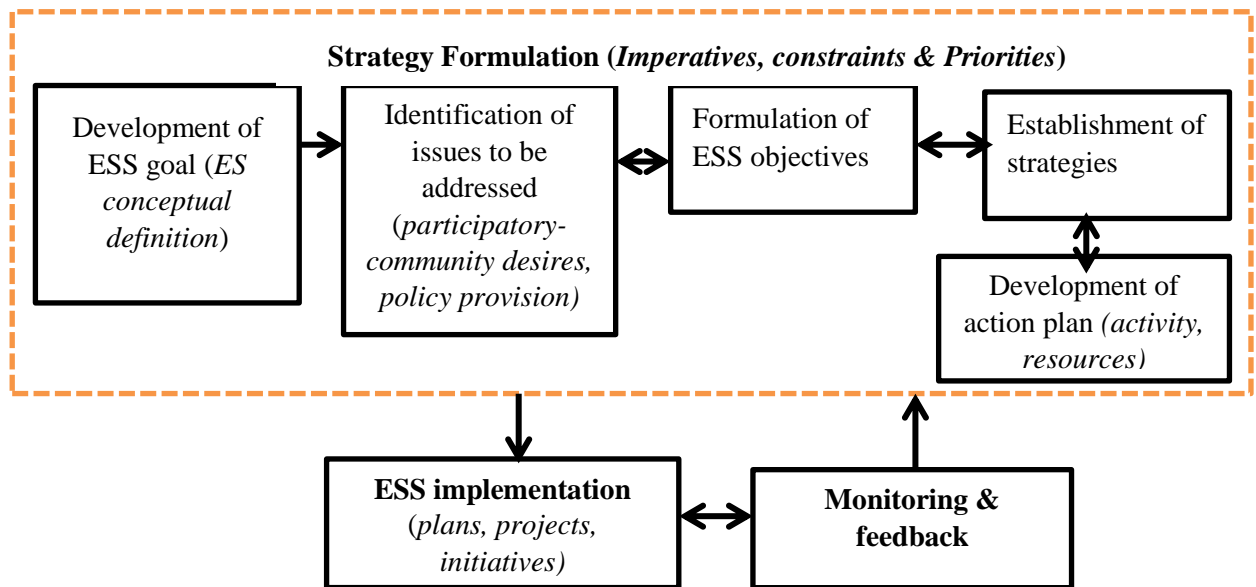
**Table 2-2: Policy instruments and recommended sustainability pathways**

<b>Policy Instrument</b>	<b>Provision in relation to environmental sustainability in Informal Settlement Upgrading Processes (ISUPs)</b>	<b>Recommended implementation Pathway</b>
Sustainable Development Goals	Human settlement planning in cities should be participatory and aim at improving: -access to basic services, waste management, resource efficiency, access to green spaces	<ul style="list-style-type: none"> <li>i. Integrative human settlement plans</li> <li>ii. Environmental education</li> <li>iii. Technological Innovations</li> <li>iv. 10-Year Framework of Programmes on Sustainable Consumption and Production</li> </ul>
Agenda 21	Sustainable human settlements should seek to provide adequate shelter, environmental infrastructure, sustainable and transport energy use	<ul style="list-style-type: none"> <li>i. Adoption of Local agenda 21 at all planning levels</li> <li>ii. Innovative technologies</li> <li>iii. Environmental Impact Assessment</li> </ul>
National Environmental Policy, 2013	Need to integrate environmental aspects in ISUPs- sustainable consumption, waste management, environmental quality and public participation	<ul style="list-style-type: none"> <li>i. Integrated Housing Policy and Housing Master Plan</li> <li>ii. Infrastructure Development Strategy</li> <li>iii. Environmental Audit</li> <li>iv. Technology, innovation</li> <li>v. Economic, regulatory incentives</li> </ul>

#### **2.4.5 Environmental Sustainability Strategy**

Strategy is an ancient term that originated from military operations but has since been extended to other fields such as environmental planning (Gane, 2007). An Environmental Sustainability Strategy (ESS) is a multi faceted road map that provides direction towards improving environmental performance within a system or organization (Kashmanian *et al.*, 2011; Satyro *et al.*, 2017). It provides a framework through which broad government intentions can be actualized at all levels within a specific sector (Gane, 2007). ESS is an outcome of a deliberate systematic planning process and therefore it may not result from simply muddling through as has been suggested by proponents of emergent strategy (Grünig & Kühn, 2011).

A strategy constitutes the direction to be pursued, actions to improve performance and clear roles of internal and external stakeholders (Kashmanian *et al.*, 2011). Strategy development involves strategy formulation, implementation and continuous review. Strategy formulation process broadly involves identification of a strategy goal, establishment of issues and challenges that need to be addressed, development of strategies which are anchored on key issues and objectives that need to be addressed and finally development of a plan of action (Milne & Kendal, 2007; Satyro *et al.*, 2017). Clarity of action is paramount as it allows for determination of the most appropriate actor and the timeline within which an action should be implemented (Milne & Kendal, 2007).



**Figure 2.1: Basic strategy formulation process**  
 Source: Milne & Kendal, 2007

one's conceptual definition of environmental sustainability. Identification of issues and subsequent formulation of objectives should be participatory and be embedded on international and national policy objectives particularly those in SDGs and Agenda 21 (Vinz, 2009). The strategy objectives should seek to create maximum possible benefit to all the stakeholders in the planning area. These benefits create interests in strategy implementation among the stakeholders leading to enhanced incorporation of environmental issues in the system or organization (Satyro *et al.*, 2017). The strategies are long term ideas on how to realize the set objectives. They are devised within the scope of an organizational activities and capabilities and also in cognisance

of the effect of external environment. Gane (2007) identified three elements that influence the systematic process of formulating strategies. They include:

- i. Imperatives which are prior conditions that need to be respected e.g. national or sectoral principles.
- ii. Constraints as internal or external factors that limit the implementation of planned activities e.g. resources.
- iii. Priorities which determine actions that are implemented before others regardless of their importance or impact significance.

Development of an ESS is often considered complex due to the multifaceted nature of the sustainability concept. To address this challenge, Marshall & Brown (2003) suggested the suitability of systems theory in developing an ESS scope which has a significant impact and also based on scientifically sound delimitation procedures. The scope details the key elements of the system which ESS targets including operational activities, stakeholders and networks that link stakeholders (Figure 2.1). Once the scope is determined, the system theory also helps one to establish cause linkages of elements and identification of significant system leverages which enable or constrain realization of goals (Marshall & Brown, 2003).

Previous studies have pointed out significant enablers and barriers to successful implementation of an ESS. Klassen (1989) proposes demonstration projects to provide concrete examples on of the integration of environmental sustainability in development of programs such as ISUPs. He further indicates the need to anchor the strategy on legal, institutional frameworks and city wide environmental management initiatives so as to promote integration of strategy activities with other planning

processes. Nandagopal & Sankar (2009) emphasized on the significance of leadership in formulating and implementing an ESS. They attributed the successful implementation of an ESS in Wal-Mart, a leading global retailer, to the commitment of the top management. Since the development of an ESS, Wal-Mart has been recognized for its substantial contribution to green goals across the globe (Nandagopal & Sankar, 2009).

Vinz (2009) observed that the existence of an institution to spearhead the strategy implementation is a key determinant of the success of the ESS. For instance, in Germany one of the highly rated green countries, a parliamentary committee is often credited for the success of the German Sustainability Strategy (Vinz, 2009). Radomska (2014) pointed out the need to adopt multiple evaluative tools so as to continuously enhance the strategy. Pisters et al. (2017) highlighted the importance of ensuring ESS inculcate among stakeholders a culture of considering environmental issues in development projects. The need to normalize environmental strategies is mentioned in the institutional theory as a fundamental driver in realization of policy objectives (Hodgson, 2006).

In addition to conservation benefits, ESS should be perceived as a tool for realizing other benefits such as cost reduction and enhanced social benefits in development processes. Collaborations and networks which are established for ESS formulation and implementation can be utilized to realize additional benefits as increased actor significance and improved information flow (Pisters *et al.*, 2017).

## **2.5 Theoretical Perspective on Environment Sustainability**

### **2.5.1 Systems Thinking Approach**

The systems thinking is drawn from the systems dynamics field which was developed by Forrester in 1956 (Aronson, 2011). It allows for analysis of a social system in a manner similar to a mechanical system (Morath, 2015). It addresses the weaknesses of traditional social analysis approaches which focused on individual elements of a system without considering the interaction of this element with other components of the whole system. It assumes non linear causal effect chains which are characterized by key domains including: sequence of events, multiple causations, varied feedbacks and interconnectedness of social, economic, institutional, and environmental factors (Morath, 2015; Moore *et al.*, 2017). According to this approach, a societal problem cannot be addressed by a single intervention due to the multiplicity of causes and variance in effect. It therefore provides an effective exploratory framework through which certain elements and relationships in a system can be used to effect leverage significant changes. The knowledge of the system allows for identification of context specific interventions rather than generic ones (Browne *et al.*, 2015).

Assessing environmental sustainability in informal settlement upgrading programs from a system thinking perspective implies that first and foremost, there is no definite state of sustainability but there is need to progressively improve the current state (Gao *et al.*, 2016). Secondly, that there exists biophysical elements, actors, institutions and inter-relationships which present leverage points in the realization of environmental sustainability (Browne *et al.*,2015). Thirdly, some inter-relationships within the informal settlement influence environmental sustainability more than others and hence the need to identify the ones that are most significant.

Interrelationships, which are a sequence of events and their feedback, demonstrate the nature, strength and impact of connections between elements in a system (Browne *et al.*, 2015). Program environmental sustainability assessment is therefore a process of determining the nature and leverage impact of an intervention on the ecological and social attributes in the defined area.

Morath (2015) adopted the system thinking in assessing the impact of an agriculture policy on public health and observed that contrarily to the public perception, that held that direct benefits had not been realized, the policy had instigated significant inter-relationship changes that would enhance public health in the long term. Institutions are critical since environmental impacts are mediated through socio economic and political institutions that control the human activities.

### **2.5.2 Extended Metabolism Model**

The Extended Metabolism Model (EMM) was developed in the late 1990s as an analogy to the metabolic processes of an organism (Kennedy *et al.*, 2011). The model elucidates the processes that occur within socio systems such as residential areas as if they were biological functions of an organism. From this perspective, environmental sustainability is attained when inflows of material and energy resources and disposal of waste in a social system remains within its ecosystem capacity (European Union, 2015). Similar to an organism's environment, a social system such as an residential area is delineated by porous boundaries which allow for interaction with the wider rural and city fabric (Brebbia & Wadhwa, 2004). The interconnection of different systems through trade, communication and transport allows for movement of inputs and outputs in and out of the residential system (Fragkou *et al.*, 2014). This complex

network of systems makes it difficult to accurately measure the net consumption of materials within a residential area against its ecosystem capacity (Fung & Kennedy, 2005). Despite this weakness, the extended metabolism model has been widely used in the development of environmental sustainability principles and assessment indicators since it provides a scientifically sound analytical basis (Newman, 1999; Brebbia & Wadhwa, 2004; McDonad & Patterson, 2007; Gao *et al.*, 2016). These principles include:

- i. Optimum waste management where all the waste generated from production and consumption activities is treated within the system (Fragkou *et al.*, 2014). A system that is characterized by either flows of solid waste from the point of generation to a treatment point within the residential area or the utilization of waste as a raw material within or outside the residential area.
- ii. Adoption of low emission pathways through integration of energy efficiency and renewable energy strategies (Newman, 2010). Fung & Kennedy (2005) identified cooking, water heating and lighting as the most significant contributors of methane and carbon dioxide in residential areas. They further pointed out that the magnitude of these emissions depends on the population, household sizes, technologies adopted and individual behaviour in energy use. The overall nature and form of energy demanded in the residential area influences supply and hence to a great extent the energy flow chain (Rutherford & Coutard, 2014). The residential area offers a space for low emission interventions through technological and social innovations (Edwards & Bulkeley, 2015).

iii. Emissions from transport within and outside the residential area depend on the urban form including street planning, population growth and income growth (Wackernagel *et al.*, 2006). Boschken (2012) observed a strong positive correlation between income growth and increased mobility demand leading to high carbon footprints in 53 cities. Compact residential areas exhibit less mobility demand and consequently contribute less emissions.

Urban development strategies such as the informal settlement upgrading programs need to adopt integrated resource flow approaches rather than the traditional parallel development and environment plans (Newman, 2010). Hammarby Sjöstad, one of the neighbourhoods in Stockholm presents a case study of urban metabolism planning approaches. Approximately 1,000 flats in this neighbourhood use biogas generated from their waste water to meet their domestic fuel needs. The biogas is also used to power the buses that serve this area. The organic waste is treated and used for heating and cooling. Social organization also allows for car sharing and hence reducing private automobile demand.

### **2.5.3 Driver-Pressure-State-Impact-Response Framework**

The Driver-Pressure-State-Impact-Response (DPSIR) framework was originally developed by Organization for Economic Co-operation and Development (OECD) as a means for identifying environmental indicators (Moffatt *et al.*, 2001). It is based on the rationale that an environmental system is shaped by stressors that produce a given environment state and factors that restore the system balance. The drivers (D) are social factors that regulate the factors that cause pressure on the environment. They include market systems, institutions and household characteristics. These drivers exert pressure (P) on the environmental system through changing production and

consumption patterns (Ferrao & Fernandez, 2013). In an urban residential setting, consumption patterns are defined by daily routines (Waite, et al., 2012).

The state (S) is the quantity and quality of the physical and biological elements of the environment which are attributed to the pressure from the drivers. However, the linkage between P and S in urban environments remains very elusive due to extensive importation of production inputs and exportation of waste. This is further aggravated by limited data on these inputs and outputs. The environmental state produces social economic impacts (I) which are often assessed using proxy indicators (Ferrao & Fernandez, 2013). Response(R) focuses on the nature and effectiveness of individual, market and institutional efforts to address potential or existing negative impacts in the environmental system.

The DPSIR provides a means of contextualizing the systems theory and urban metabolism in an assessment of environmental sustainability (Alberti, 1999). It allows for characterization of metabolic activities within a particular urban environment system. The framework helps to establish which system loops are critical so as to avoid the problem of addressing symptoms rather than the causes of unsustainable trends.

Ferrao & Fernandez (2013) observed that drivers present the greatest leverage point for environmental sustainability. Decisions made by these actors influence to a greater extent the appropriation of resources, the market operations and institutional responses. Additionally, institutions play a critical role in enabling actors overcome

libertarianism by nurturing collective environmental responsibility (Ferrao & Fernandez, 2013).

**Table 2-3: Environmental Sustainability Indicators for Informal Settlement Upgrading**

<b>ES domains derived from theoretical framework</b>	<b>Urban Sustainability Indicator List</b>	<b>Integrated Indicators List</b>	<b>Urban Ecosystems Europe Indicator List</b>	<b>IS Upgrading Environmental Sustainability List</b>
Drivers(D)(households , businesses, social institutions, government)	Residential density Interest in upgrading project	Levels of home owners/social tenants/private tenants Residents satisfaction with their home	Human density Age diversity Income per capita	Human density Household size Individual environmental values Income per capita Education level Levels of home owners/ tenants Interest in upgrading project
Pressure (P) Consumption processes	Building with green roofs Buildings generating/ Consuming renewable energy Percent of land devoted to roads Percent of land devoted to walking Common mode of transport to work Percent of infrastructure renewed Per capita Water consumption	Energy efficiency measures implemented Local use of energy Water saving measures implemented; local use of water Provision and quality of local public transport Quality of local services and facilities	Public transport diversity Residential /commercial/ Recreational ratio Electricity consumption Water Consumption Land use mix	Buildings generating/ Consuming solar energy Percent of land devoted to walking Common mode of transport to work Per capita Water consumption Energy efficiency measures implemented Water saving measures implemented Electricity consumption
Pressure (P)Waste	Per capita	Waste	Per capita	Households

ES domains derived from theoretical framework	Urban Sustainability Indicator List	Integrated Indicators List	Urban Ecosystems Europe Indicator List	IS Upgrading Environmental Sustainability List
Generation and management	amount of waste collected Percent of building involved in waste recycling	recycling measures implemented	waste generation Waste recycling facilities Air quality index	involved in waste recycling Waste recycling measures implemented in settlement Waste recycling facilities Waste collection services(frequency )
State & Impact (S&I)Environmental Impact		Area's overall physical outlook Quality of and access to (local) green open space	Open space/total area	Area's overall physical outlook Quantity,Quality of and access to (local) green open space Residents involved in green enterprenuership
Responses (R) Institutional Responses	Community involvement in upgrading process	Community activity (no. of organisations) Existence and type of local partnerships		Local environmental management plan Community environmental association Community involvement in environmental programs Existence and type of partnerships

#### 2.5.4 Capabilities Approach to Environmental Sustainability

The capability approach was developed by Amartya Sen in 1979 as he sought to unify the economic, philosophical and liberal concept of wellbeing (Clark, 2005). He recognized the subjective and inadequate nature of existing utilitarian and resource assessment approaches (Wells, 2011). He points out that the most critical aspect in attaining a 'well lived' life is to have the freedom to choose what one values (capabilities) in order to be or do what they consider essential (functionings) (Sen,

2001). This viewpoint was also a reflection of the normative ideas advanced by Aristotle, Adam Smith and Karl Marx which express the need for every human being to be actively involved in shaping their own destiny (Deneulin, 2005). Sen however, did not disregard commodities as a measure of wellbeing but he argued that wellbeing measures should focus on the ability of an individual or community to utilize these resources in a manner desirable to them so as to achieve what they consider important (Sen, 2001; Wells, 2011). Though Sen was not explicit about environmental quality, it is implied that this is one of the conditions that an individual would require to attain certain functionings (Pramono & Woltjer, 2011). A list of ten essential capabilities for any human being developed by one of the proponents of the capabilities approach positions environmental sustainability at the centre of wellbeing discussion. Nussbaum (2001), also included the intrinsic value of environmental management as a basic constituent of quality life. In addition to its intrinsic and instrumental value, the capabilities approach conceives environmental sustainability as a conversion factor (Sen, 2001). It catalyzes or inhibits the ability of an individual to realize their desired functionings.

Based on the capabilities approach, environmental sustainability is a critical pillar in development programs such as informal settlement upgrading programs. It creates a space within which individuals and communities can live and produce essential services without compromising the ability of neighbouring jurisdictions and future generations to meet their own needs (Goodwin, 2003). It enhances the realization and sustainability of development outcomes such as health, economic empowerment and social integration (Ranis *et al.*, 2006; Pramono & Woltjer, 2011). The World Health

Organization for instance estimated that 20% of total deaths in the pan- European region were related to environmental factors (European Environment Agency, 2016).

Environmental sustainability is not only a function of physical components but also of individual and societal values as Nussbaum (2006) notes. Adaptive preferences may influence the choices that communities make in shaping their environment. Communities that have lived in a sanitarydeprived state for a long time may not have any value for environmental quality. Siddiqui & Pandey (2001) argued that at the lowest economic level, people are so overwhelmed by economic challenges that they do not perceive the magnitude of environmental problems in their neighbourhoods. These attitudes act as a major barrier to new information on sustainable practices (Poortinga *et al.*, 2004). Development programs in informal settlement upgrading programs should therefore move beyond improving the housing structure and other physical elements to addressing residents' environmental values.

Previous studies (Bolland *et al.*, 2002; Brown *et al.*, 2004; Hall & Lamont, 2009, Lawless, 2010;Ramkissoon, 2016) underscore the role of social institutions in establishing environmental sustainability values. These institutions are fundamental conversion factors as they shape specific attitudes which determine environmental behaviour (Poortinga *et al.*, 2004; Frediani, 2007).

The capabilities approach implicitly moves the environmental sustainability agenda from the periphery to the centre of development programs. It illuminates its intrinsic value as a factor of overall wellbeing, a perspective which has been missing in most

urban development policies. Similarly to the Systems Thinking Approach and the Urban Ecosystem Model, this approach recognizes the role of social institutions in the realization of environmental sustainability (Alberti, 1999; Sen, 2001; Morath, 2015).

### **2.5.5 Urban Political Ecology Theory**

The Marxist urban political ecology highlights the social relations that shape urban environments (Heynen, 2017). It recognizes the unequal distribution of the benefits and costs of urban development (Smith, 2000; Swyngedouw & Heynen, 2003). The interests of the powerful elites are always at the centre of the development processes. Edwards & Bulkeley (2015) argued that the urban environment transformation debate should be centred around capital interests. They use the case of Philadelphia where housing renovation programs are being used by the state to implement climate change policies to show the dynamics of aligning state and capital interests. The process of environmental integration is therefore not limited to infrastructure development as conventional policies have held but is a far reaching attempt to balance conflicting ecological and capital interests. Democratic and participatory processes are fronted as effective tools in the pursuit of this balance.

### **2.5.6 Institutional Theory**

North (1990) defines institutions as ‘rules of the game in a society or more formally, humanly devised constraints that shape human interaction’(Edvardsson *et al.*, 2014). They are rules, procedures and norms that define the way the game is played. Therefore, institutions are socially embedded system of rules (Hodgson, 2006). This implies that even organizations are unambiguous institutions bearing clearly defined structures. This claim has been disputed by arguments that present organizations as subjects of the rules in the game rather than constraints by themselves. On the other

hand, human agency within organizations frames organizations as institutions that govern their employees and clients (Hodgson, 2006). This study focuses on all the agents that overallly contribute to environmental sustainability in ISUPs including employees and their clients hence the logical consideration of organizations as a form of constraint.

Institutions work through enforcement systems that are defined by operating procedures. Therefore, the extent to which institutions realize their objective is largely dependent on two aspects: the institutional design and the enforcement system. However, Hodgson (2006) points out that unlike norms which are embeded into customs and habits, rules are not self sustaining until they reach a normative stage. Therefore, enforcement systems should primarily aim at integrating the institutional aspirations into existing customs. This provides an avenue of addressing gaps inherent in existing rules. For instance, rules that require development to be subjected to environmental assessment may not compel the developer to continously uphold environmental values.

In addition, the process of enforcement of instittuions may result in the emergence of undesigned institutions. Some studies characterize these instituions as informal but the self organization literature refers to them as organic formal institutions (Hodgson, 2006). They are developed through structured interactions between actors and they are therefore within the bounderies of a defined system. These institutions are enforced and propagated by the attributes that facilitated their formation such as community cohesion, common interest.

Rules and their enforcement processes do not exist independently because they rely on human interaction for perpetuation (Thoenig, 2012). Institutions are therefore deeply interconnected with their actors (Hodgson, 2006).

### **2.5.7 Actor Network Theory**

Actor Network Theory (ANT) provides a framework within which non linear and dynamic relationships in a defined system can be studied (Ortiz-Arroyo, 2010). A network within a system is defined by nodes and edges. The nodes represent actors while edges depict interaction between components. Network theory has been widely adopted in management studies since 1960s to establish significant nodes for purposes of diffusing a concept or approach using the node as a leverage point (Borgatti, 2006; Scott, 2015). The theory is founded on the ideology that the society is constructed around flows within social and spatial spaces (Smith, 2003). Interaction among entities create multi level networks that are modelled round these flows (Rydin, 2012).

Networks are developed in response to a need in the management of flows within a system. Such a demand is created by formal institutions or evolves organically within a formal arrangement. In response to the need, actors align themselves to meet obligations within a dominant framework (Rydin, 2012). The alignment entails negotiations over roles and power relations which model actor positions and significance in the network. Rydin (2012) observed that positions are contested around three major factors:

- i. Institutional mandate of an actor or entities therein. This ascribes positions by rendering some actors as focal actants and establishes agency among actors and their primary and secondary entities
- ii. Access to resources such as information, money, equipment
- iii. Actor influence as a function of net connections to other actors. Ortiz-Arroyo (2010), established that actor influence is determined by their proximity to other actors and resources through geodesic paths. It is measured by the number of direct ties a node has (centrality), closeness to central actors (eigen vector) or actors in brokerage positions (betweenness) (Marsden, 2003, Scott, 2015). This linkage is usually physical or conceptual (Borgatti, 2006).

In addition power influence, networks are shaped by flows such as money and technological changes. Further, networks at macro and micro levels shape institutional outcomes similarly hence the need for multi level actor network analysis in establishing system efficacy (Moliterno & Mahony, 2011).

Critics have questioned the theoretical foundation that underpins structuring of dynamic and volatile actor networks (Scott, 2015). Proponents such as Scott (2015) argue that the inherent role of networks in maintaining system equilibrium and offering a conduit through which resources flow implies that changes in networks are in conformity to these two functions. Therefore the network changes do not depart significantly in functionality from initial formations.

This theory presents public agencies as institutional actors rather than machines that perform specific tasks within a framework defined by a principal (Thoenig, 2012).

Therefore, public agencies not only seek societal productive ends but are also self reinforcing. The struggle to achieve the dual outcomes results to neglect of the primary goal in pursuit of self supporting interests (Peters & Pierre, 2007). The drive to enhance their legitimacy and improve their member's social image far outweighs that of progressive institutional effectiveness (Thoenig, 2012). As a result, innovations that seek to realize the later encounter artificial obstacles which masquerade as government bureaucracies. Similarly, proponents of new institutionalism agree that management of public agencies is rarely a function of applied techniques but a product of human activities (Thoenig, 2012).

Previous studies observe that major institutional reforms do not often yield significant organizational changes because routine is perceived to be risk averse. The most effective triggers are mainly external factors such as market changes and consistent internal innovations within the organization's units. This may be achieved through diffusion of a policy value into organizational processes which necessitates staff training and establishment of external linkages with institutions sharing similar values (Thoenig, 2012). In addition, the functions of agencies are modelled by power games which determine the extent to which instrumental goals are pursued visa vie self seeking goals.

### **2.5.8 Public Management Theory**

The public management theory has developed over the years in response to its field dynamism (Dunn & Miller, 2007; Osborne, 2007). One of the most notable revolutions in the field of public management was the departure from traditional bureaucratic to decentralized, market centred systems. This is commonly referred to

as the New Public Management or new managerialism. It was driven by the need to deal with the inefficiency of bureaucratic and hierarchical systems. However, Osborne (2007) notes that this new managerialism has not enhanced institutional performance because traditional barriers such as employee working norms and political patronage have persisted.

The inherent decentralization, public entrepreneurship and performance management has presented co-ordination, linearity, actor participation and accountability problems (Dunn & Miller, 2007; Edvardsson, *et al.*,2014). Consequently, efforts to integrate ‘non sectoral’ have been limited by the challenges associated with new managerialism (Sowman & Brown, 2006; Edvardsson, *et al.*,2014; Bandeira & Ferraro, 2017). Actor coordination is particularly important due to the management shift from single organizational to inter agency program based approach to service delivery (Ewalt, 2001). Such interdependence provides conditions that could potentially breed subversion and opportunism.

In view of these challenges, public management reforms are imperative. Osborne (2007) observes that such reforms must be well designed so as to create substantial ripple effect in the institutional system. He further proposes four areas within which effective leveraging can be done within public institutions:

- i. Clarification of institutional core function to facilitate clarity of purpose that may be obscured by multiplicity of functions. This allows for justification of mainstreaming agendas such as environment management and consequently their consideration for budgeting. A clear institutional purpose and strategy compels public agencies to respond to long term issues in addition to their day to day operations

(Miller & Dunn, 2006). Benson et al. (2014) observes that this is not practical in most cases since electoral systems require public agencies to respond to emerging and quick win issues.

- ii. Development of performance management mechanisms with reward and penalty against performance.
- iii. Increased accountability for quality output to both citizens and higher level organs. Strong feedback loops are a prerequisite to accountability.
- iv. Decentralization of decision making power within public organizations. However, decentralization without clarity of roles and objectives is counter effective.
- v. Institutional culture reforms which can be realized through employee training

In addition to these four strategies, Dunn & Miller (2007) emphasize the need for public agencies to progressively empower communities for self governance. This allows them to decide what services they want and how they should be delivered. Haywood et al (2014) suggests that integration objectives should be tied around the major institutional thematic areas. The issues that these strategies seek to address are interlinked and are therefore effective when implemented in combination. These reforms are only viable when implemented within the context of an established rule of law and embedded national values such as transparency (Osborne, 2007).

### **2.5.9 Principal Agent Theory**

The Principal Agent Theory (PAT) explains the relationship between a principal and an agent and its implication on institutional outcomes (Collier, 2007). The principal-agent relationship is founded on the principle of delegation or roles, public

entrepreneurship and efficiency in service delivery. It is governed by a contract which sets out the rights and obligations of each party (Sengul *et al.*, 2012). Additionally, the contract is used to communicate the values of the principal.

Effective propagation of such values necessitates a clear framework of operation and performance management (Sengul *et al.*, 2012). However, Fredrickson (2012) observes that the engagement in most cases is marred by governance problems such as corruption and vendor opportunism. Principals often yield their supervisory authority to agents as a result of the agent’s perceived and actual expertise which exceeds that of the principal. As a result, the agent’s position takes dominance and so do the interests. Based on the actor network theory, shifting the centre of power and controlling actor agency provides a leverage point for the principal (Rydin, 2012; Scott, 2015).

**Table 2-4: Summary of Elements of Assessment in Environmental Sustainability of ISUPs based on the theoretical framework**

<b>Theory</b>	<b>Elements of Assessment in Environmental Sustainability of ISUPs</b>
Systems theory	Informal settlement space as a function of interconnectedness elements (stocks and feedback loops), multiple causations (flows) and varied feedbacks Sustainability is hitched on establishing system leverage points with most significant impact
Extended Metabolism Model	Informal settlement system components include: small scale home based production, consumption patterns and waste disposal arrangements
Driver-Pressure-State-Impact-Response (DPSIR) framework	Sustainability assessment factors in an informal settlement space: household/collective socio economic characteristics; production, consumption and waste management patterns; biophysical & socio economic feedbacks; household, communal & institutional responses
Capabilities Approach	Individual environmental values as key sustainability driver Individual/collective agency in corrective management
Urban Political Ecology Theory	Capitalistic sustainability approach, green enterprise

Institutional theory	as a pragmatic approach to environmental sustainability Institutional design and law enforcement or policy implementation procedures as key determinants of environmental policy efficacy Role of organic institutions in environmental sustainability integration
Actor Network Theory	Institutional agency and policy efficacy is largely dependent on its position and significance in the ISUP institutional framework Position and significant are influenced by legal mandates, access to resources and level of interaction with other actors
Public Management Theory	Role of organizational operation procedures environmental integration at multi governance levels
Principal Agent Theory	Effect of experts/consultant on environmental diffusion

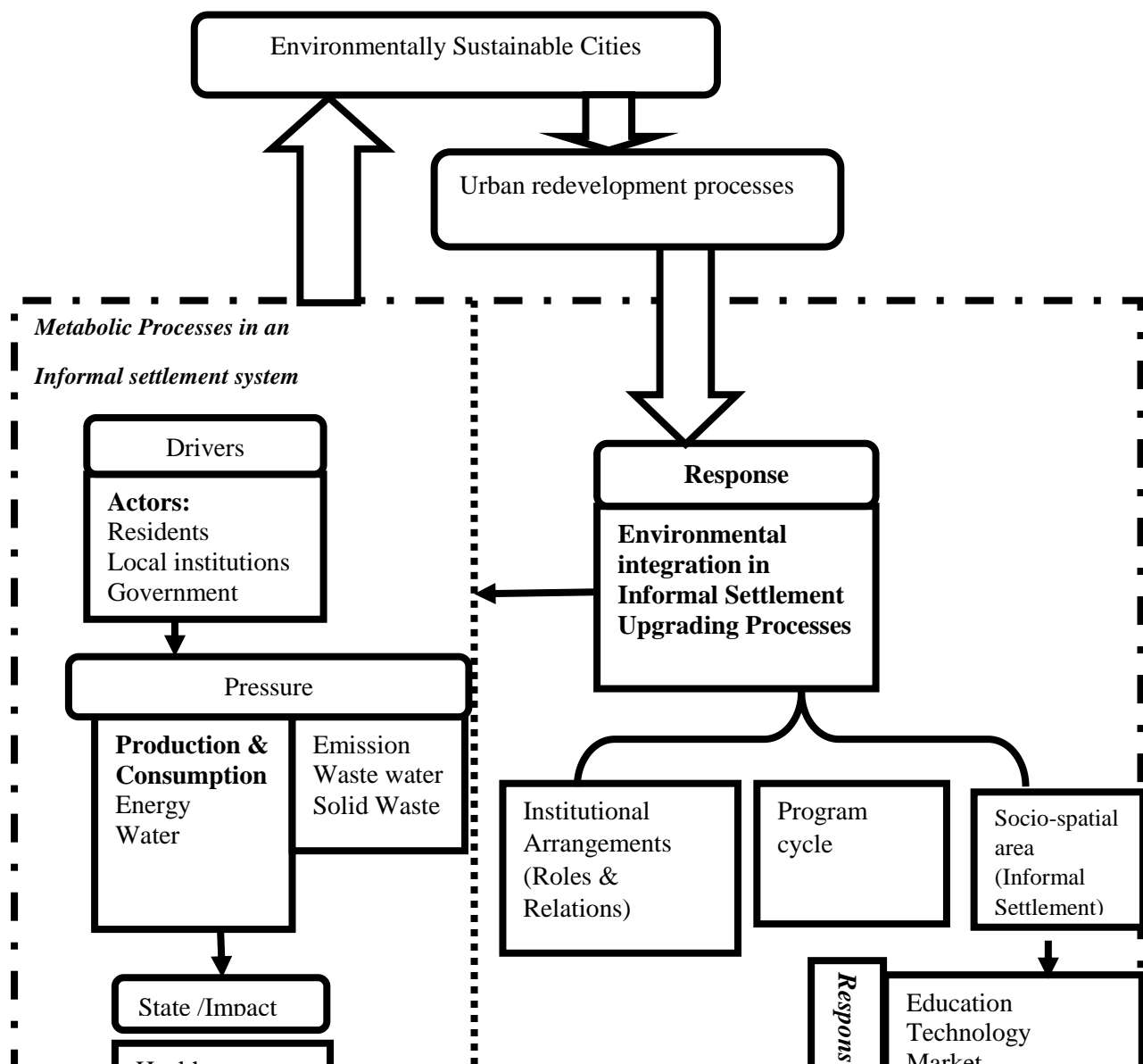
## 2.6 Conceptual Framework

Since the city is an agglomeration of different but interlinked systems, the environmental sustainability of each segment contributes significantly to the sustainability of a city. In developing countries like Kenya, informal settlements have a great impact on the city's environmental sustainability because more than half of the population live in these settlements. The distinct characteristics of informal settlements which shape their metabolic processes provide an opportunity for developing environmental sustainability mechanisms (Riffat *et al.*, 2016). The population density, social institutions and existing innovations that seek to address inherent deprivations are significant leverage points (Ferrao & Fernandez, 2013; Alfonso & Pardo, 2016).

Informal settlement upgrading provide the most effective channel through which environmental sustainability in informal settlements can be realized (Balaban, 2013). However, their success largely depends on two factors (Liu *et al.*, 2017). First, the extent to which existing institutions allow for environmental considerations to be

cascaded from national to local levels. Secondly, the extent to which these programs are responsive to existing environmental integration pathways.

Effective integration based on the systems theory focuses on elements that instigate significant positive change in the informal settlements. The urban metabolism model points to technology innovation, green infrastructure and alternative efficient processes (Fragkou *et al.*, 2014; Edwards & Bulkeley, 2015). The capability approach lays emphasis on social values and education while political ecology cites economic instruments and national and local institutions as the key determinants of environmental sustainability (Nussbaum, 2015). These factors provide a comprehensive and adequate environmental integration assessment framework for the informal slum upgrading programs.



**Figure 2.2: A conceptual framework for assessing environmental integration in ISUPs for sustainable cities**

Though environmental sustainability is not a definite point, the extent to which a project impacts these leverage functions is indicative of progress towards sustainability. In addition, the households' consumption and waste management practices and their impact on the social, economic and ecological functions indirectly demonstrate the environment integration levels of ISUPs (Dizdaroglu, 2017).

**2.7 Empirical Studies in Environment Sustainability in Informal Settlement Upgrading Programs**

Bojö & Reddy (2002) assessed the level of environmental integration in 40 Poverty Reduction Strategy Papers (PRSPs). The level of integration was rated based on issues considered, causal linkage between environment and poverty, responses adopted and the adequacy of the process. The study adopted a scale of 0-3 to rate 17 variables within the four categories. Findings indicated a weak level of integration in the mention of environmental issues and a more elaborate consideration of responses to environmental challenges. However, the study could not establish the extent to which the intentions in PRSPs had been implemented since the scope was limited to the formulation phase.

Mutisya & Yarime (2014) used the Triple Bottom model to assess the overall sustainability of informal settlements in Nairobi. They further used a reductionist approach to derive environmental sustainability indicators. Likert scale was used to measure perceived indicator improvement over time from a sample size of 3,660 respondents. Their findings indicated very low scores for water management, energy and solid waste management.

Turcu (2012) adopted an integrated indicator framework to assess sustainability in an urban renewal program covering three neighbourhoods. Findings indicated that the impact of the renewal program was differentiated on the sustainability indicators across the three neighbourhoods. The study established significant correlation between environmental sustainability and household characteristics including housing tenure. In addition, neighbourhood renewal plans that were aligned to environmental policies demonstrated higher sustainability outcomes. The study further established that inadequate regulatory framework and lack of environmental values among households are key impediments to environmental sustainability in redevelopment programs.

Balaban (2013) combined two sets of indicators to establish the contribution of an urban regeneration project to climate change mitigation and adaptation. Data was collected through institutional interviews targeting 8 organizations which had been involved in the renewal project. A scoring system based on Hemphill framework was used to weigh the sustainability level of the project within four different categories. Similar to Turcu (2012) the high performance in the resource efficiency category was

attributed to a citywide plan which was promoting waste reduction and recycling. The study further established that lack of proper coordination among different agencies within the renewal project was limiting progress towards climate change adaptation.

## **2.8 Research Gap**

Urban development literature provides plenty of information on environmental sustainability assessment of urban development policies, programs and plans which is attributed to an increasing interest in sustainability as a global agenda (Cameron, 2004; Gibson, 2006; Newman, 2005). Most of the studies in this field however have mainly focused on city wide policies (Portney, 2001; Winston & Eastaway, 2008). There is still limited information on the contribution of neighbourhood development policies and programs to environmental sustainability (Grant, 2015; Gupta, 2015; Vilar & Cartes, 2016; Duan *et al.*, 2017). In addition, most of the studies related to environmental integration address procedural issues within institutions (Briassoulis, 2010; Turcu, 2012; Nunan *et al.*, 2012; Shen *et al.*, 2011). This creates a lacuna in knowledge on the substantive integration issues and their linkage to the integration processes (Briassoulis, 2010).

### **3. CHAPTER THREE: METHODOLOGY**

#### **3.1 Introduction**

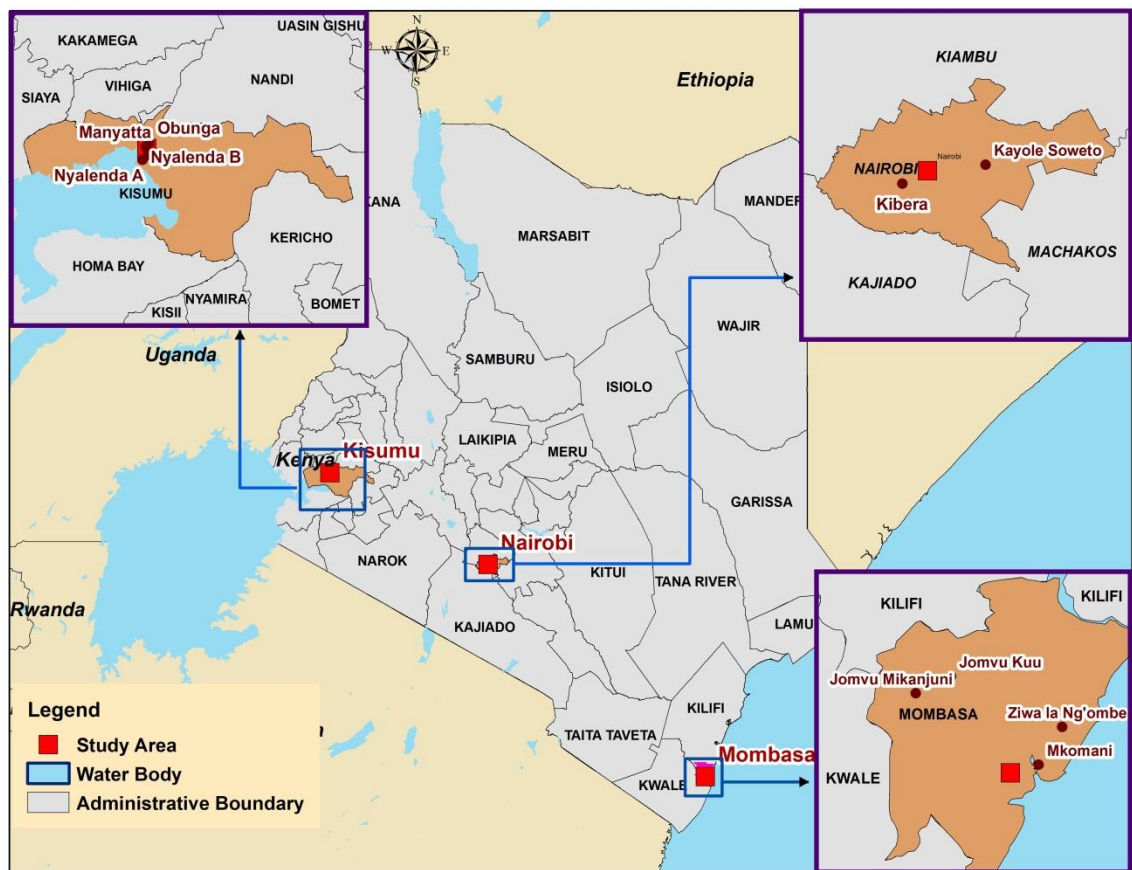
The study is aimed at assessing environmental sustainability in informal settlement upgrading projects. This chapter focuses on the methods and in particular the design to be used in this investigation. A research design is the framework within which research is undertaken including the study area, sampling techniques, data collection methods and analysis methods.

#### **3.2 Study Area**

Informal settlement upgrading projects in Kenyan cities are used to contextualize environmental sustainability in upgrading processes. Nairobi, the capital city of Kenya, has a population of 4,463,000 and a mean household size of 3.0 (KNBS, 2018). The poverty level is 16.7% which is lower than the national average of 36.1% (KNBS, 2018). The dependence ratio is 48.3. Housing is mainly supplied by individuals and private companies as the national and county government housing only accounts for 2.6%. Tenant and owner occupancy is 86.4% and 8.1% respectively. 90.7% of the households have electricity connection, 65.3% have either into dwelling or plot water access, 60.4% are connected to the sewer system and 2% have access to municipal waste collection services. Approximately 60% of the population in this city live in 100 informal settlements (KNBS, 2013).

The emergence of informal settlements in Nairobi can be traced back to 1900s. It was driven by restrictive laws which prevented Africans from owning land in the city. This was aggravated by the 1948 master plan which excluded African

neighbourhoods (Anderson, 2010). It was until 1963, after independence that consideration was given to the poor state of housing among Africans. Public housing and site and service schemes were initiated through the National Development Plan 1974-1978. Slum redevelopment was initiated in 1970s by the National Housing Corporation in Pumwani Majengo and Kibera (Huchzermeyer & Karam, 2006). Since 1990s other upgrading programs were implemented by international agencies such as the German Development Bank (Huchzermeyer & Karam, 2006). A total of 16 settlements have been upgraded through the Kenya Slum Upgrading Program (KENSUP) (Republic of Kenya, 2017; 2018).



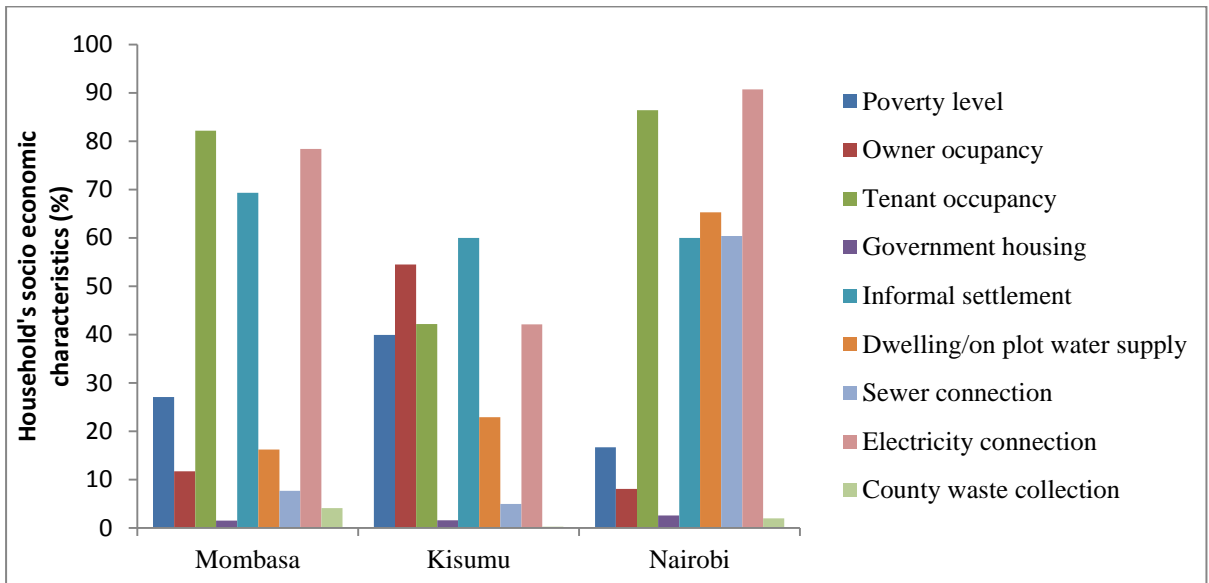
Map 3.1: Sampled upgraded settlements in Nairobi, Kisumu and Mombasa

Mombasa city is the second largest city after Nairobi with a population of 1, 185,000. The poverty level is 27.1% and a dependency ratio of 51.0 (KNBS, 2018). 91.5% of the residential housing is privately owned while 1.5% is owned by the national and county government. 11.1% of this is owner occupancy while 82.2% is tenant occupancy. 16.2% have into dwelling or on plot water connection. Mombasa has the lowest sewer connection among the three cities at 7.7% of the households but it has the highest coverage of municipal waste collection services at 4.1%. 75.8% of the households used shared toilet facilities.

Proliferation of informal settlements in Mombasa has been greatly influenced by land administration. As early as 1930, the Arab, Swahili and Asian communities had been issued with freehold land titles (Rakodi *et al.*, 2000). The prevalent private land ownership and ineffective development control mechanisms led to increased informal residential developments and limited public land for infrastructure development. By 1960s, half of the city was living in informal settlements under varying arrangements including: unofficial land allocation, temporary occupation with permission, temporary land allocation to those displaced by government projects or political violence and tenancy at will (Rakodi *et al.*, 2000). Currently, 69.3% of the population lives in the informal settlements (KNBS, 2018). The settlements are characterized by single storey multi roomed houses constructed in a village layout. Community leadership is dominated by the area administration chief and religious leaders. To date, thirteen settlements have been upgraded through KENSUP.

Kisumu, the third largest city in Kenya, has an estimated population of 1,132,000 and a mean household size of 4.0 (KNBS, 2018). The poverty level is 33.9%. It has the highest dependency ratio among the three cities at 82.9 (KNBS, 2018). 96.9% of the residential housing is privately owned while 1.6% is government housing. Owner and tenant occupancy accounts for 54.5% and 42.2% respectively. Kisumu has the highest owner occupancy percentage among the three cities (Figure 3.1). 22.9% of the population has into dwelling or on plot water connection. Household sewer connection is 5%. 65.7% of the households use shared toilet facilities. The city has the lowest electricity connection of 42.1% households compared to the other cities. Municipal waste collection services cover 0.3% of the households.

Kisumu city is divided into three major zones: the Central Business District (CBD); informal settlements surrounding the town centre; and peri-urban areas located on the outskirts of the CBD (Maoulidi, 2012). The peri -urban zone forms 80% of the city after the city boundaries were extended in 1971 when Kisumu was a township (Otieno, 2013). This informal settlement zone was designated for civil servant quarters and site and service scheme housing in the 1984 structural plan. However, increased demand for low cost housing in a rapidly industrializing town and poor implementation of the site and service scheme led to development of informal houses. This was aggravated by free hold land ownership within the town centre which limited the extent to which development control could be effected. There are 15 settlements which account for 60% of the city population (Maoulidi, 2012 KNBS, 2018). Out of these, 10 settlements have been upgraded through KENSUP (Republic of Kenya, 2018).



**Figure 3.1: Socio economic characteristics of households in Kenyan cities**

The three cities were identified as priority areas for implementation of informal settlement upgrading projects through the Kenya Slum Upgrading Program (KENSUP). This because cities have a higher population living in the informal settlements in more deplorable conditions compared to towns. To date, four projects have been implemented through this program, namely, Kenya Slum Upgrading Project, Mombasa Slum Upgrading Project, Kisumu Slum Upgrading Project and Kenya Informal Settlement Improvement Project (Table 3-1).

The Kenya Slum Upgrading Project focuses on improving informal settlements in Nairobi. It is through this project that Soweto East settlement in Kibera was redeveloped to what is known as Canaan Estate. In addition, this project provided for a decanting area where residents affected by redevelopment can live temporarily. The Decanting Estate is located 500 meters from Kibera.

**Table 3-1: Informal Settlement Upgrading Projects' Components**

Project Interventions	Kenya Slum Upgrading Project	Mombasa Slum Upgrading Project	Kisumu Slum Upgrading Project	Kenya Informal Settlement Improvement Project
Tenure provision	✓	✓	✓	✓
Housing construction	✓	x	x	x
Infrastructure provision	✓	✓	✓	✓
Institutional capacity building	✓	✓	✓	✓
Master planning	✓	x	x	✓

Mombasa Slum Upgrading Project (MSUP) targets informal settlements in Mombasa. The focal areas are provision of secure land tenure, physical and social infrastructure upgrading including construction of schools, health centres and toilet facilities and institutional capacity building. Kisumu Slum Upgrading Project focuses on settlements in Kisumu with interventions similar to those of MSUP. The Kenya Informal Settlement Improvement Project (KISIP) has been implemented in 15 municipalities including the three cities (Appendix 3). The primary intervention areas in this project are tenure security, infrastructure upgrading, institutional capacity building and master planning.

**Table 3-2: Summary of characteristics and modes of upgrading in selected informal settlements**

<b>Settlement</b>	<b>City</b>	<b>Project</b>	<b>Population</b>	<b>Average Household size</b>	<b>Average household income (Ksh)</b>	<b>Per capita residential floor area(sq ft)</b>	<b>Owner /tenant occupancy ratio</b>	<b>KENSUP Intervention</b>
Canaan	Nairobi	KENSUP	145,000	3.99	75,710	19.36	1:0.63	Redevelopment-demolition, relocation to Decanting Site, construction of modern high rise apartments
Decanting Site	Nairobi	KENSUP	5,467	4.02	22,862	23.87	1:0	High rise apartments constructed to serve as a decanting settlement
Kayole KCC	Nairobi	KISIP	8,000	3.49	12,513	27.84	1:0.57	Infrastructure-tenure, access roads, sewer system, footpaths, storm water drains, recycling unit
Ziwa la Ngombe	Mombasa	KISIP/ KENSUP	37,500	4.04	21,465	12.25	1:1.3	Infrastructure-tenure, access roads, footpaths, drains, health centre, school, community ablution, street lighting
Jomvu Kuu	Mombasa	KISIP	1,119	5.17	31,250	33.0	1:29	Infrastructure-tenure, access roads, footpaths, drains, ablution, water storage tank
Jomvu Mikanjuni	Mombasa	KISIP	3,718	4.41	17,897	30.71	1:3.3	Infrastructure-tenure, access roads, footpaths, drains, water supply, ablution, water tanks
Mkomani,	Mombasa	KISIP	939	4.44	18,389	39.11	1:2.6	Infrastructure-tenure, access roads, footpaths, drains, street lighting
Nyalenda A	Kisumu	KISIP	12,679	4.16	18,541	9.80	1:0.21	Infrastructure-tenure, access roads, footpaths, drains
Nyalenda B	Kisumu	KISIP	32,430	4.68	20,248	8.03	1:0.21	Infrastructure-tenure, access roads, footpaths, drains
Obunga	Kisumu	KISIP	1,009	4.09	20,665	12.60	1:0.25	Infrastructure-tenure, access roads, footpaths, drains
Manyatta	Kisumu	KENSUP	27, 327	3.23	19,951	17.41	1:0.15	Infrastructure-construction of a market, ablution, water supply

### **3.3 Research Design**

This study adopted a case study research design. It is an in depth investigation process which entails description and analysis of single or multiple bounded systems based on information collected from multiple sources (Harrison *et al.*,2017). The suitability of this research design is based on three major factors including: the purpose of the research, theoretical prepositions of the subject of investigation and the philosophical orientation of the research. The purpose of the study is to investigate how environmental sustainability is constructed in the informal settlements upgrading processes. This design effectively provides operational linkages of the sustainability variables under investigation which help to answer the ‘how’ and ‘why’ questions (Yin, 2003).

With regard to the theoretical proposition, this research is based on the assumption that urban redevelopment processes are potentially the most significant conduits of environmental sustainability in Kenyan cities but this opportunity is underutilized. To assess the extent to which this is true or false, an indepth investigation of a redevelopment program is critical. In addition, the views and opinion of subjects in this program regarding the existence of perceived environmental integration opportunities and subsequent utilization are central to this research. Since case study design allows for adoption of a range of methods such as exploratory and interpretive research to facilitate an indepth analysis, it presents a suitable choice of research design.

The philosophical orientation of this research is both relativist and constructivist. It is framed against a background knowledge of the complexity of environmental sustainability and the role of the researcher in operationalizing this concept. Owing to the abstract nature of sustainability, the research utilizes theoretical frameworks to help contextualize variables and convey meaningful and applicable information. Case study research design is appropriately selected as it inherently allows for pluralistic philosophical orientations (Harrison *et al.*, 2017).

This study further adopts multi case, a case study sub type design, which presents the advantage of exposing patterns and relationships that could otherwise remain unnoticed on the single case study design (Yin, 2003). These patterns are critical in validating linkages between environmental factors and the phenomena under investigation. Although this design is limited in terms of the extent to which findings can be generalized, this weakness can be overcome through effective case bounding. This involves identifying specific parameters of the case to help in focusing and framing data collection and analysis. This process allows for generalization of the results of a case study investigation.

### **3.4 Sample Size and Sampling procedure**

#### **3.4.1 Sample Size**

Sampling is the process of learning about the population on the basis of sample collected from the population. A sample is constituted by a part or fraction of the population. Yamane (1967) provides a simplified formula to yield a representative sample for proportions of large sample.

$$n = N / (1 + N(e)^2)$$

where  $n$  is the sample size,  $N$  is the population size and  $e$  is the level of precision.

$$n = 253,163 / (1 + 253,163(0.05)^2)$$

$$= 399$$

The total  $n$  was divided equally among the three cities to allow for comparative assessment of sustainability performance. In this case, the total sample size in each city is 133. Kish (1965) & Sudman (1976) recommended a minimum sample size of 200 per sub group where a study involves rigorous comparative analysis of sub groups (Israel, 2003). Therefore the sample size in each of the three cities was increased to 200. This was proportionately distributed within the settlements (Table 3-3).

### **3.4.2 Sampling Procedure**

Kenya Slum Upgrading Program (KENSUP) was selected as the unit for investigating the environmental sustainability of upgraded informal settlements. This program provides a good case study because first and foremost its primary objective is to improve the living conditions including environmental quality in the informal settlements. Secondly, the program is a composite of projects implemented in different cities and towns within the country hence offering a wide evaluative space. The sampling frame comprised of a total of 119 and 90 informal settlements upgraded through KISIP and KENSUP projects respectively (Government of Kenya, 2017,

2018). Sampling for the household survey was done through a multi stage method involving cluster sampling followed by systematic sampling.

### **Cluster Sampling Method**

This method is used when it is not possible to obtain a sampling frame because the population is very large or scattered over a large geographical area (Mugenda & Mugenda, 1999). The target population was broadly clustered into the three cities; Nairobi, Kisumu and Mombasa and then further clustering was done in informal settlements upgraded through KENSUP. The total sample population was proportionately distributed within the broader city clusters (Table 3-3).

### **Systematic Sampling Method**

Respondents in each settlement were selected in equal intervals along the streets. The first respondent within the settlements was selected using the Rand Between function in MS Excel program [ $r=RANDBETWEEN(x, y)$ ] where  $r$  is the random integer number,  $x$  is the lowest range value and  $y$  is the highest range value. Using a range of 1 to 10, a random integer of 4 was generated. The fourth household nearest the main entrance of a settlement was selected as first respondent. The main entrance was assumed to be where the settlement access road joins the main road and also serves as the public transport terminus for the settlement. The same integer was used as a constant interval between consecutive respondents. Apart from Canaan and Decanting site, the primary streets that are directly linked to the main access road were used to select the respondents systematically. In Canaan and Decanting, every fourth household was selected in the order of house numbers starting from the first block which is Block A in both settlements.

**Table 3-3: Sampling procedure for household interviews**

<b>City</b>	<b>Upgraded Informal settlements- Clusters</b>	<b>Sampled Settlements</b>	<b>Total Population</b>	<b>Sample size</b>	<b>Sample per village</b>
Nairobi	Kibera-Soweto East (145,000) Kahawa Soweto (10,000), Kayole KCC (8,000)	Kibera-Soweto East (145,000) Kayole-KCC (8,000)	153,000	200	Kibera-Soweto East: Canaan & Decanting settlements (150) Kayole-KCC (50)
Kisumu	Bandani (1,066), Manyatta (27, 327), Obunga (1,009) and Nyalenda (12,679) Kaloleni (14,806)	Manyatta (27, 327), Obunga (1,009) and Nyalenda (12,679)	56,887	200	Manyatta (25), Obunga (75) and Nyalenda (100)
Mombasa	JomvuKuu (1,119), JomvuMikanjuni (3,718) and , Mkomani (939) and Ziwa la Ng'ombe (37,500)	JomvuKuu (1,119), JomvuMikanjuni (3,718) and , Mkomani (939) and Ziwa la Ng'ombe (37,500)	43,276	200	JomvuKuu (30), JomvuMikanjuni (50) and , Mkomani (20) and Ziwa la Ng'ombe (100)
<b>Total</b>			<b>253,163</b>	<b>600</b>	

Key informants will be used to assess the extent to which environmental considerations are integrated into the informal settlement upgrading projects.

**Table 3-4: Sampling procedure for Key informant interviews**

<b>Institutions</b>	<b>Sampling procedure:</b>	<b>Basis of informant selection</b>	<b>Sample Size</b>
Kenya Slum Upgrading Directorate	(1) National program coordinator*; (1) head of each of the 4 departments	-Knowledge of project components -More than 5 years' experience in program implementation	5
Kenya Informal Settlement Improvement Project-MOLHUD	(1) Program coordinator-; (1) head of each of the 4 departments (3) municipal coordinators	-Knowledge of project components -More than 5 years' experience in program implementation	9
Ministry of Lands, Housing & Urban Development	(1) Head of each of the (2) departments in 3 city counties	Relevance of department to housing & environment	6
Funding agencies	1 Head of department (primary funding agencies); World Bank	-Experience in program implementation -Knowledge of agency environmental provisions	2
City counties-Housing department in the three cities	(1) Head of each of the housing department in Nairobi, Mombasa, Kisumu city county	-Experience in implementing KENSUP -Knowledge of county service provision arrangements	3
National Environment Management Authority	(1) Head of EIA section-Nairobi County Environment Director-Kisumu & Mombasa	Knowledge of program activities in the respective county	3
Professional bodies	(1) urban environmental sustainability expert from - Centre for Sustainable Urban Development; SGS	Knowledge of local environmental sustainability indicators/standards	2
Partner Non-Governmental Organizations (NGOs)	Officer from partner NGO (1) Pamoja Trust	Experience in program implementation activities Interest in environmental management in IS	1
<b>Total</b>			<b>31</b>

\*There is no provision for a national coordinator position in current institutional framework

The key informants will be drawn from the program staff, government agencies such as Ministry of Lands, Housing & Urban Development, relevant county governments, professional organizations, donor agencies and Non-Governmental Organizations (NGOs) (Table 3-4).

### **3.5 Data Collection**

Case study research design lays emphasis on the use of multiple data collection methods so as to understand the phenomena under investigation. Documentary analysis, household and key informant interviews, focused group discussions and observations were employed. The multiple methods enable triangulation which helps to circumvent data collection errors and add credibility to the results. The process of data collection involved development of data collection instruments, piloting of questionnaires and instrument adjustment.

#### **Pilot Study**

The piloting of instruments was done in September 2017 in Canaan and KCC Kayole settlements in Nairobi. A total of 15 questionnaires per settlement were administered. The rule of thumb for a pilot study sample size is 12 per group (Julious, 2005). The data collected during the pilot study was used to determine first and foremost the feasibility of the study and secondly the adequacy of the instruments. The data was not used in the main study since it had not been factored in the study design (In, 2017). The pilot study results were compared with the expected results and other similar studies on environmental sustainability. The study was shown to be feasible. In addition, the data collection process and study results pointed out questions that

needed to be reworded and restructured. The results were evaluated against the variables under investigation. Questions were added to address the identified gaps while some were expunged. The final questionnaire is attached in appendix 5.4.

Institutional questionnaire piloting helped to improve the contextual framing of questions during interviews. It was established that the ‘environment’ was ambiguous to the respondents and ‘environmental quality’ was identified as a suitable alternative term. Respondents were not sure whether to refer to current or previous institutional structure when answering questions related to the impact of institutional structure and function on environmental sustainability. It was established that the interview questionnaire should include a note to allow for responses that capture both scenarios.

### **Field work**

Data was collected within a period of six months between October 2017 to March, 2018. The process entailed recruitment and training of research assistants, mapping of settlement boundaries, identifying transects and administering questionnaires based on the sampling procedure. Research assistants training covered both the substantive and procedural aspects of data collection. Settlement elders were recruited to facilitate research assistants in obtaining consent for participation. The response rate in household questionnaire administration was 100%.

Data was collected on three major variables including: environmental sustainability performance, environmental integration pathways and institutional frameworks.

### 3.5.1 Assessing Environmental Sustainability Performance in Upgraded Informal Settlements

Based on literature review on environmental sustainability assessment and contextual consideration of informal settlement upgrading processes in Kenya, a list of indicators was generated to assess the state of upgraded settlements (Table 2-3). The indicators were grouped into four categories including: consumption patterns, waste management, environmental quality and community organization (Table 3-5).

**Table 3-5: Environmental Sustainability Assessment Indicators**

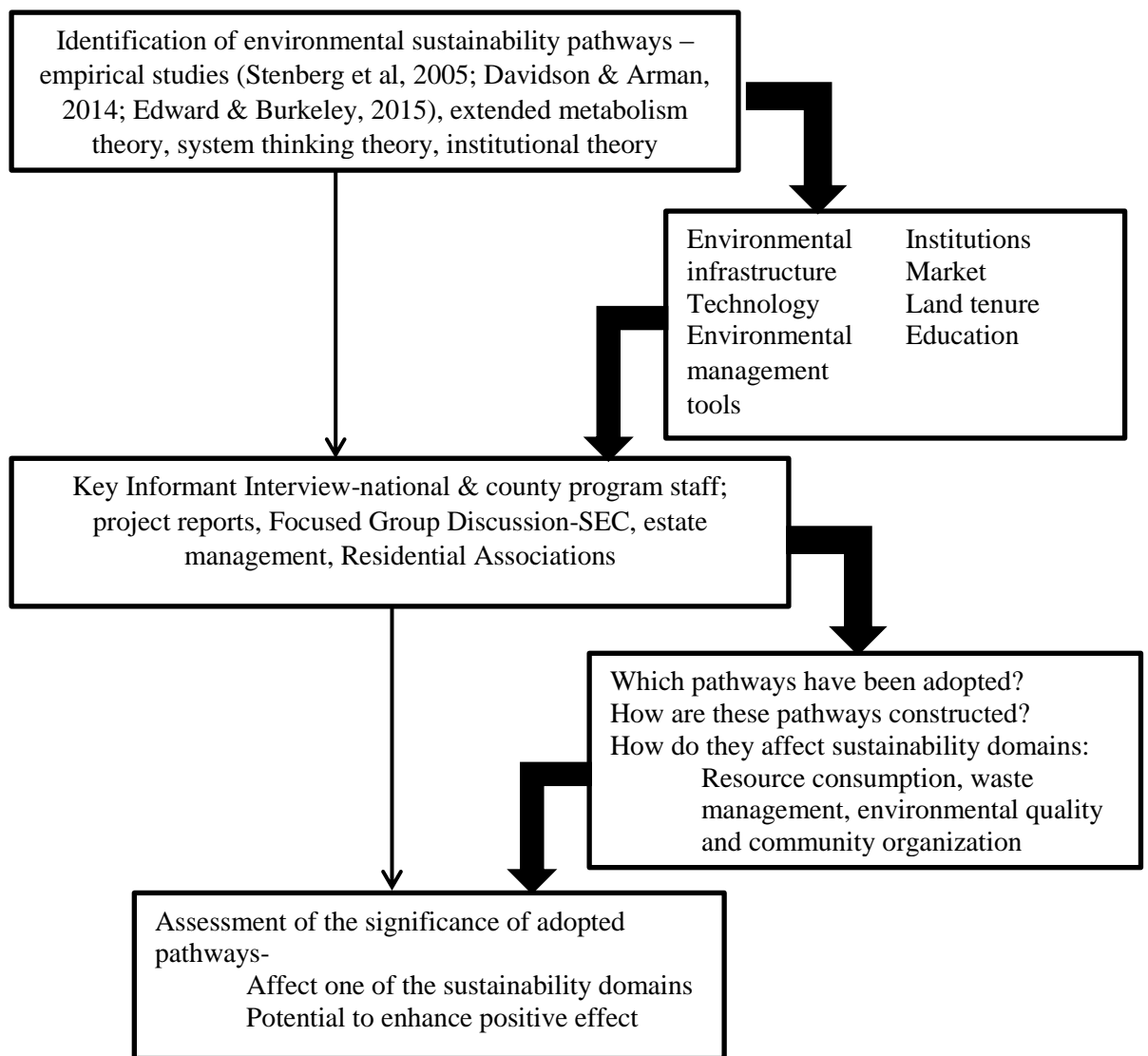
Category	Indicators	Measurement
Consumption Patterns	Water consumption	Total consumption per day/population
	Water conservation	Percent households involved in conservation practices
	Energy consumption	Total consumption per day/population
	Energy conservation	Percent households involved in conservation practices
	Transport	Percent households using non motorized transport to market
Waste Management	Solid waste collection	Frequency of collection per week
	Household solid waste recycling	Recycling facilities per settlement
	Settlement recycling arrangement	Percent households sharing a toilet
	Sanitation facilities	
Environmental Quality	Waterborne disease incidence	Percent households affected in last 1 year
	Open space	Area covered/total settlement area(m <sup>2</sup> )
Community organization	Overcrowding	Residential floor space/population
	Environmental management plans	No of plans per settlement
	Membership in community based organizations	Percent households with membership to CBOs
	Participation in upgrading activities	Percent households that participated
	Active settlement level partnerships	No of partnerships per settlement

Data required to measure the indicators was obtained from household interviews for example amount of water and energy consumed by households, household level conservation and waste management practices; interviews with project staff and county government officers for instance, open space coverage, existence of

environmental management plans; and FGDs with the settlement executive committee to establish settlement level conservation and waste practices. Document review was used to collect data for benchmarking amount and nature of resource consumption and waste management in these upgraded settlements.

### **3.5.2 Evaluation of environmental sustainability integration pathways in informal settlement upgrading projects**

Environmental sustainability pathways in ISUPs were identified through literature review. Seven environmental sustainability pathways were identified through review of empirical studies (Stenberg *et al*, 2005; Davidson & Arman, 2014; Edward & Burkeley, 2015) and theories such as extended metabolism theory, systems thinking approach and institutional theory (Table 3-6). These pathways include: environmental infrastructure, technology, alternative processes, institutions, housing tenure arrangement, market and environmental management tools. The study sought to establish which of these pathways exist in ISUPs, how they are constructed and how they affect environmental sustainability in upgraded settlements (Figure 3.2).



**Figure 3.2: Procedure for data collection & analysis of environmental sustainability pathways in ISUPs**

Interviews with program staff at the national and county level, review of project documents and focused group discussions were used to collect data on these sustainability pathways.

**Table 3-6: Variables and Sources of data for Environmental Sustainability Pathways**

<b>Environmental Sustainability pathway</b>	<b>Variables</b>	<b>Source of data</b>
Environmental infrastructure	Provisions in water supply, sanitation, storm water drainage, solid waste management, open space	Project monitoring (engineering and social) reports, ESIA reports), Household interviews, Key informant interviews-project staff and county staff, FGDs (SEC and Neighbourhood Associations, Nyumba Kumi group), Observations
Technology	Technologies adopted in resource consumption and efficiency and waste management	
Institutions	National, county and community level institutions	
Land tenure	Housing and land tenure arrangement	
Environmental management tools	Legal tools, donor tools and institutional based tools	
Markets	Green enterprises	

### **3.5.3 Assessment of the Impact of Institutional Arrangements on environmental sustainability integration in ISUPs**

Policies, laws, regulations, strategies and plans related to environment and informal settlement upgrading were reviewed. This was aimed at establishing the policy and administrative provisions for environmental integration processes through horizontal and vertical coordination, community participation and contract management. Face to face interviews with staff in government agencies at national and county level, funding agencies and NGOs, FGDs and household survey were used to collect information on policy, legal, institutions and tools that facilitate or impede environmental integration processes. Household interviews and FGDs were additionally be used to collect data on the role of local institutions such as neighbourhood associations in environmental management in informal settlements. The FGDs targeted community leaders and representatives of various community groups including: landlords, structure owners, tenants, traders, women, youth and minority groups.

### 3.6 Data Analysis

SPSS statistics 20 and MS Excel was used to analyze qualitative data. The environmental sustainability performance of upgraded informal settlements is analyzed by comparing the value of each indicator across the eleven upgraded settlements. The highest indicator value scores the highest points in the scale to the extent that it contributes positively towards the overall sustainability level otherwise it is scored inversely. For instance, high per capita water consumption scores highly up to a certain amount beyond which it is considered unsustainable and is hence scored progressively less. A scale equivalent to the number of settlements (1-11) is adopted for purposes of scoring performance. The maximum score for each indicator is 11 points against the first ranking settlement and a minimum of 1 point against the least ranking settlement. A nil value has a zero score though it is ranked to allow for comparison between settlements.

**Table 3-7: Environmental sustainability performance scoring scheme**

<b>Sustainability domain</b>	<b>Number of indicators</b>	<b>Maximum possible total score per settlement</b>
Consumption patterns	5	55
Waste management	4	44
Environmental quality	3	33
Community organization	4	44
<b>Total</b>	<b>16</b>	<b>176</b>

Source: Adopted from overall point scoring method by Zheng et al (2016)

Overall environmental sustainability performance is the aggregate score of the four categories (Table 3-7). It is the result of  $(X/Z*100)$  where X is the sum of the indicators' score in a settlement and Z is the total of the maximum possible score in

all indicators (176 points). A similar method of performance scoring was used by Zheng *et al.* (2016) to support decision making on neighbourhood sustainability in an urban renewal program in Hong Kong. Additionally, their study adopted multiple residential zones to make a comparative performance assessment. The only major difference is that their study selected residential zones from a single region while this study draws its zones from three regions.

### **Quantitative Data Analysis**

Descriptive and inferential statistics were used in analyzing and interpreting quantitative data. Descriptive statistics provide procedures for summarizing a collection of data. These statistics convey information on the distribution, central tendency and dispersion characteristics of data (Jaggi, 2003). Mean scores, percentages, range and variance have been used to compare and rate the sustainability performance of the eleven settlements. Frequencies were used in cases where the (n) of a variable in each settlement is less than 10. Multiple inferential statistical tests were used to support arguments and suggest reasons for variation in environmental sustainability performance within the eleven upgraded settlements and between cities. An alpha level of 0.05 is used for all inferential statistical tests.

Analysis of Variance (ANOVA) was used to establish significant differences in mean values within the eleven informal settlements and between cities. The use of ANOVA is conditioned by simple random sampling, normal distribution of response variable and similar population standard deviation among the groups (Jaggi, 2003). It however allows for mild violations without compromising the reliability of the results such as

slight deviations of data points from the normal line and different standard deviation to the extent that the ratio of the largest to the smallest group sample Sd is no more than two (Altman, 2005). The ANOVA output was presented in annotated format i.e.  $F(x, y), p$  where F statistic is the mean square regression divided by the mean square due to error (Table 3-8), x is between-groups degrees of freedom, y is within-groups degrees of freedom and p is the significance level.

**Table 3-8: ANOVA**

Source of variation	Sums of Squares (SS)	Degree of freedom (df)	Mean Squares (MS)	F (Test)
Between Groups	$SSB = \sum n_j (\bar{X}_j - \bar{X})^2$	k-1	$MSB = \frac{SSB}{k-1}$	$F = \frac{MSB}{MSE}$
Error	$SSE = \sum \sum (X - \bar{X}_j)^2$	N-k	$MSE = \frac{SSE}{N-k}$	
Total	$SST = \sum (X - \bar{X})^2$	N-1		

Where

$X$  = individual observation,  
 $\bar{X}_j$  = sample mean of the  $j^{\text{th}}$  group,  
 $\bar{X}$  = overall sample mean,  
k = the number of independent comparison groups, and  
N = total number of observations or total sample size.

SSB= Sum of Squares Between groups  
SSE =Error Sum of Squares  
SST= Total Sum of Squares  
MSB= Mean Squares Between groups  
MSE= Error Mean of Squares

Turkey post hoc test was used to reveal the particular settlements or cities whose mean values or scores differ. The  $p$  value is used to indicate which groups are significantly different within the larger set of settlements or cities. Welch's t-test which is an adaptation of the Student's t-test is used to establish the significant difference in means between two cities. This test is used where samples have unequal variances and sizes. Its suitability for this study is based on the fact that the settlements in each of the cities have different sample sizes.

Pearson and Spearman correlation tests were used to analyze parametric and non-parametric variables respectively. They were used to establish significant relationships between sustainability indicators and household characteristics identified in chapter two (Table 2-3). The results are presented as  $r(df)$ ,  $p$  where  $r$  is the correlation coefficient at a given degree of freedom ( $df$ ) and  $p$  is the significance level. The  $r$  value falls within the range of -1 to +1. Perfect correlations are exhibited by -1 and +1 values.  $r$  values between -1 and 0.5 indicate a strong negative correlation while those between -0.5 and 0 show a weak negative correlation. A value of 0 indicates no correlation. Weak positive correlation is shown by values ranging between 0 and 0.5 while strong correlation is exhibited by values between 0.5 and 1. Though correlations only assess relationships, they were used as initial pointers to possible causation. Subsequent analysis is then undertaken to establish causation.

Regression analysis was used to describe the relationship between environmental sustainability variables and household characteristics. This analysis assumes that the data is continuous, the variables being analyzed have a linear relationship, no significant outliers, independence in observations and normal distribution of errors (Wan, 2013). SPSS Statistic feature was used to ensure conformity of data to this set criteria: Casewise diagnostic (outliers), Durbin-Watson (independence of observations), Model fit (normal distribution of errors) and Collinearity diagnostic (linear relationships). The output of the analysis is an F-test and regression function. The F test is presented as  $F(x, y)$ ,  $p$ ,  $R^2$  where  $F$  is the test of collinearity,  $x$

and  $y$  is the degree of freedom while  $R^2$  is the extent to which the linear regression explains variance in the data. The regression function is presented as  $Y = \beta_1 + \beta_2 X$ , where  $\beta_1$  is an intercept term and  $\beta_2$  is a slope coefficient.

### Hypothesis Testing

The study hypothesized that the performance of upgraded informal settlements in the four environmental sustainability categories does not differ significantly in Nairobi, Mombasa and Kisumu. It also hypothesized that there is no significant difference in environmental sustainability performance of upgraded informal settlements in Nairobi, Kisumu and Mombasa. Non directional hypothesis was used and tested at a significance level of 0.05. ANOVA test was performed to establish if the environmental performance means score of the upgraded settlements within Nairobi, Kisumu and Mombasa are equal. A paired t-test was used to determine which mean scores among the three cities are different. The p-value of the t-score determines whether the difference between the means is significant. The null hypothesis is rejected if the differences in mean are significant ( $p < 0.05$ ) leading to acceptance of the alternative hypothesis and vice versa.

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \dots\dots\dots \text{Equation 3.1}$$

Where

$\bar{X}_1$  = Mean of first set of values

$\bar{X}_2$  = Mean of second set of values

$S_1$  = Standard deviation of first set of values

$S_2$  = Standard deviation of second set of values

$n_1$  = Total number of values in first set

$n_2$  = Total number of values in second set

## Qualitative Data Analysis

Qualitative data analysis involved reading through the questionnaires, FGD notes and reports to establish key themes on institutional arrangements and environmental sustainability integration pathways in ISUPs. Selective coding was done so as to group related sets of data according to the emergent themes. The data was then used to build a case and provide explanations on environmental integration trends, barriers and opportunities. Results were presented using examples from the field notes.

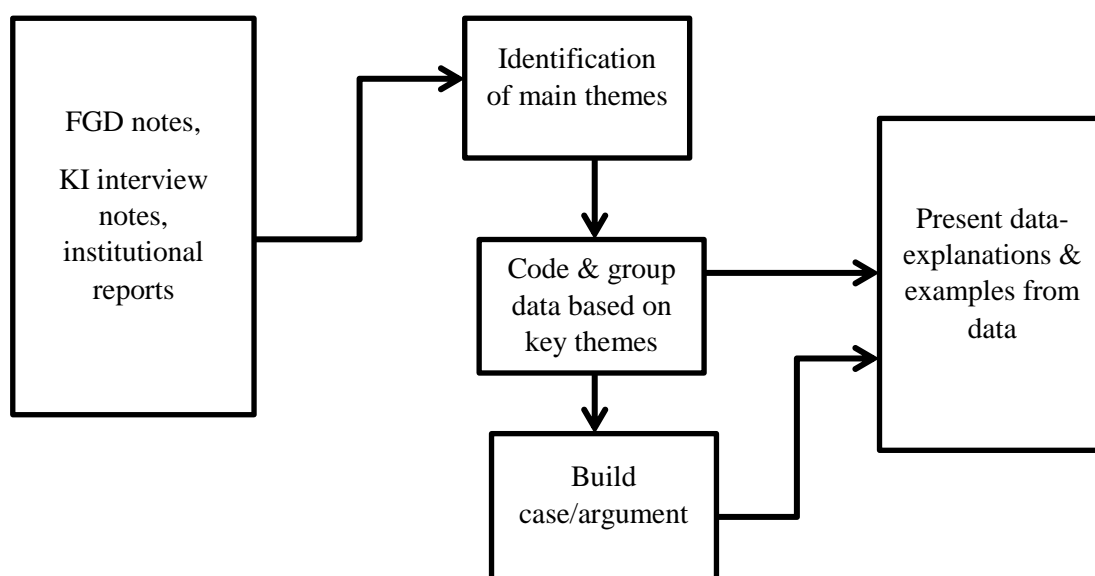


Figure 3.3: Qualitative data analysis

## 3.7 Quality Control Technique

### 3.7.1 Data Reliability

To ensure that the results are reliable, responses from household interview were compared with those from key informant interviews to establish the level of consistency. Standard environmental sustainability indices have been adopted to

enhance the reliability in rating of the 11 informal settlements (Price *et al.*, 2015). Cronbach's coefficient alpha was used to determine the internal consistence of multiple Likert scale questions measuring a single domain. A Cronbach's alpha of 0.70 and above is an indication of closely related items.

### **3.7.2 Data Validity**

To ensure content validity, the indicators that were used to measure environmental sustainability performance are informed by sustainability theories. Additionally, these indices have been used in similar studies on sustainability (Shen *et al.*, 2011; Zheng *et al.*, 2016; Mutisya & Yarime, 2014). Triangulation was used to cross validate data from various sources.

### **3.8 Presentation Techniques**

Quantitative data was presented using tables, charts, graphs and radars. Where qualitative data was analyzed using descriptive statistics, tables and figures were used to present the results. Flow diagrams were used to present other qualitative data results.

### **3.9 Field Study Constraints**

The main challenge encountered during data collection was political instability since the fieldwork was undertaken two months after the disputed August 2017 elections. Most of the residents in the study area were skeptical about interviews related to government projects due to political tension. This prolonged the fieldwork period as the intervention of settlement leaders and the chief was sought leading to increased fieldwork cost. In Kisumu where informal settlements had become post-election

violence hot spots, FGDs could only be done in locations outside the settlements. This necessitated facilitation of transport for the participants in the four settlements. In addition, access to data was constrained by poor data management in government registries. It therefore required numerous visits to these registries to retrieve documents.

## **4. CHAPTER FOUR: RESULTS, ANALYSIS AND DISCUSSIONS**

### **4.1 Introduction**

This chapter provides results and an analysis of the data collected for this study. The chapter is outlined according to the study objectives as follows:

- i. To assess the environmental sustainability performance of upgraded settlements in Kenyan cities
- ii. To evaluate environmental integration pathways in informal settlement upgrading programs in Kenya
- iii. To analyze the effect of institutional arrangements on environmental integration in slum upgrading programs in Kenya

The analysis aims to explain the position of Kenya's informal settlement upgrading programs on environmental sustainability and ascertain opportunities that such programs present for diffusion of environmental sustainability into urban spaces.

### **4.2 Environmental Sustainability Performance of Upgraded Settlements in Kenyan Cities**

This section presents an analysis of the level of environmental sustainability in eleven informal settlements in Nairobi, Kisumu and Mombasa. The analysis seeks to establish the comparative sustainability performance of the eleven settlements with a view to establish project based factors and neighbourhood and household characteristics that catalyze progress towards environmental sustainability in informal settlement upgrading processes; Four categories based on urban metabolic processes

provide thematic areas of analysis which include: resource consumption, waste management, environmental quality and local institutional arrangements.

#### **4.2.1 Resource Consumption**

Household water consumption, water conservation practices, energy consumption, energy conservation and non-motorized transport are used as indicators of sustainable consumption patterns in the eleven upgraded settlements.

##### **4.2.1.1 *Water consumption***

The average per capita water consumption for the eleven settlements is 31.85 l/c/d (Table 4-1). Prior to the upgrading, the average per capita water consumption was 29.2 l/c/d. Though there has been an increase, this average is still below the minimum WHO recommended amount of 50 l/c/d basic consumption (World Health Organization, 2003). This is below the standard set in the Practice Manual for water supply in Kenya of 75 l/c/d for low income settlements and is less than half the urban national average of 80.47 l/c/d (AfDB, 2016). The per capita water consumption between settlements ranges from 24.14 litres in Obunga to 39.25 litres in Mkomani. Though Mkomani has the highest per capita water consumption, it is marked by a comparatively large variation in household daily consumption of 106.89 (Table 4-1)

Comparing the period before and after the upgrading the eleven settlements have increased their per capita water consumption with the exception of Manyatta, which has remained constant and Canaan where the amount has decreased (Table 4-1). The constant per capita consumption level in Manyatta could be attributed to lower level of infrastructure provision compared to the service mains, on plot and dwelling unit connections provided in the other ten settlements (Table 4-1). In Manyatta, the

intervention involved provision of one community standpipe. Canaan residents attributed 56% of the decrease in per capita water consumption to intermittent supply, 14.3% to increase in number of household members and 13.1% to increased cost of water. It is notable that most of the settlements in Nairobi and Mombasa have higher per capita means compared to Kisumu. This is consistent with international trends documented by World Bank (2016) which indicate that access to services is generally better in more populous urban areas.

A one way Analysis of Variance (ANOVA) shows that there is a statistical significant difference in mean household water consumption among the eleven settlements  $F(10, 595)=3.992, p=0.000$  at  $p<0.05$  significance level. This difference could be attributed to the variation in intervention activities. However, settlements with similar water project interventions exhibit significantly different household water consumption means. Kayole KCC mean consumption differs significantly with Mkomani  $F(10, 595)=3.992, p=0.009$ ), Jomvu Kuu ( $F(10, 595)=3.992, p=0.012$ ) and Nyalenda B ( $F(10, 595)=3.992, p=0.036$ ) despite the similarity in project interventions (Table 4-1). This reveals that factors other than project interventions affect water consumption in upgraded informal settlements.

The variation in household water consumption is also marked across cities. There is a significant difference in water consumption between settlements within Nairobi and those in Kisumu (MD=20.179,  $p=0.008$ ) and between settlements in Kisumu and those in Mombasa (MD=26.732,  $p=0.001$ ). There is no significant difference between settlements in Nairobi and Mombasa (MD=6.553,  $p=0.407$ ). This implies that the

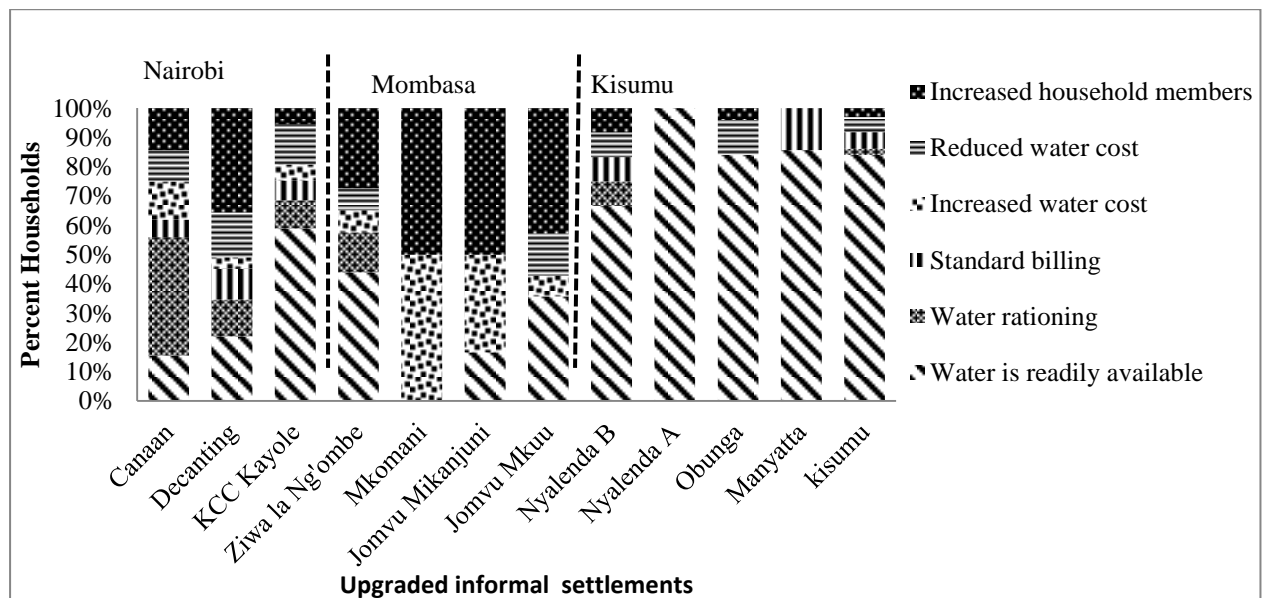
difference in mean household consumption between settlements could be attributed to factors related to a city's water delivery arrangements.

**Table 4-1: Water Consumption before and after upgrading of informal settlements in Kenyan Cities**

Settlement	Water Consumption (before)			Water Consumption (after)			Project intervention
	Per capita Mean (p/c/d)	Household daily mean	Household daily (L) SD	Per capita Mean (p/c/d)	Household daily mean	Household daily (L) SD	
<b>Nairobi</b>							
Canaan	37.09	147.00	82.03	34.15	136.19	71.98	Dwelling unit connection & Borehole
Decanting Site	28.89	116.00	112.65	37.05	148.17	67.63	Dwelling unit connection
KCC Kayole	25.52	89.09	58.64	34.30	106.38	49.38	Service mains
<b>Mombasa</b>							
Ziwa la Ngombe	27.61	111.53	82.7	32.86	114.94	90.07	Service Mains Ablution blocks with water outlet
Jomvu Kuu	28.48	105.80	110.78	31.71	163.83	108.31	Service Mains Ablution blocks with water outlet
Jomvu Mikanjuni	28.77	90.86	103.32	32.41	134.85	106.89	Service mains & Ablution blocks with water outlet
Mkomani	34.81	99.49	111.07	39.25	174.44	106.89	Service mains
<b>Kisumu</b>							
Nyalenda A	25.11	104.39	45.79	25.19	104.74	45.67	Service mains
Nyalenda B	30.30	141.81	61.98	32.41	151.70	80.998	Service mains
Obunga	23.99	99.88	71.29	24.14	100.50	70.89	Service mains
Manyatta	37.12	119.74	56.64	37.12	119.77	67.63	Ablution blocks standpipe
Total	29.2	119.73	83.52	31.85	119.73	83.52	

Regarding the determinants of changes in water consumption before and after upgrading, 40.7% is attributed to increased water availability, 20.2% to change in number of household members, 15.3% to water rationing and 11.1% to reduced water cost. These factors are variedly prominent in the three cities. Increased water availability was frequently mentioned in Kisumu, water rationing in Nairobi and increased household members in Mombasa (Figure 4.1).

Intermittent water supply presents the greatest obstacle towards realizing the minimum recommended per capita water consumption in upgraded settlements. The challenge is, however, more pronounced in Nairobi as 45.7% of the respondents mentioned this as the main reason for changes in amount of water consumed compared to 34.1% in Kisumu and 20.2% in Mombasa. Though the three settlements in Nairobi have the highest average mention of water intermittence, one of the settlements indicated the highest increase in water consumption among the eleven settlements. Household daily mean consumption in KCC Kayole has increased from 89.09 litres before upgrading to 106.38 litres after upgrading. Since 58.9% of the residents attributed this change to increased water availability, it implies that there are factors which facilitate water availability in this settlement that are lacking in the other two settlements in Nairobi. The water utility in Nairobi indicated that the intermittence in Canaan and Decanting is mainly as a result of estate management problems particularly failure to pay water bills on time leading to disconnection.



**Figure 4.1: Factors influencing changes in water consumption in the upgraded informal settlements**

The study revealed that 18.2% of the respondents consider change in cost of water as a key factor that has influenced household water consumption. Among these, increased cost of water was mentioned by 24.5% and 7.5% of the residents in settlements within Mombasa and Nairobi respectively. None of the residents in Kisumu cited this as the major determinant of changes in amount of water consumed. Reduced water cost was mentioned by 13.3% of the residents in Nairobi, 5.5% in Mombasa and 5.1% in Kisumu. The changes in cost of water is attributed to municipal water availability hence the greater concern over water availability and intermittency vis-a-vie the cost of water.

Respondents without household connection or yard taps indicated that they pay an average of Ksh 2 per 20 litre jerrycan from communal standpipes and private water vendors which they indicated is relatively affordable. However, when the municipal supply is not available, all the residents rely on water vendors who sell the water at Ksh 20 per 20 litre jerrycan.

Standard billing was only mentioned by 5.6% of the residents as a major determinant of changes in water consumption. The minimal influence of water billing method on water consumption further draws attention to water availability as the overarching factor.

Change in number of household members as a key factor of influence in water consumption was mentioned by 20.2% of the respondents. Out of these, 42.5% are in Mombasa while 18.4% and 3.1% in Nairobi and Kisumu respectively. The increase in

number of household members could be attributed to the population influx that is characteristic of development projects.

The performance of upgraded settlements in water consumption is not satisfactory as none of the upgraded settlements have attained the minimum per capita water consumption level. Taking into performance reveals significant barriers and enablers of sustainable water consumption. First, the variation in performance of settlements with similar project interventions indicates the existence of other key factors that influence sustainable water consumption beyond infrastructure upgrading. For instance, similar level of infrastructure was provided in Mkomani in Mombasa and Obunga in Kisumu but the two settlements have varied per capita mean consumption of 39.25 litres and 24.14 litres respectively. Similarly, KCC Kayole in Nairobi and Nyalenda A in Kisumu have a per capita consumption difference of 9.11p/c/d which is statistically significant,  $t(110)=1.67$ ,  $p<0.05$  despite having similar project interventions. The difference in consumption could be attributed to specific city influences but similar variations are also reflected in settlements within the same city e.g. Nyalenda A and Obunga in Kisumu and also Canaan and Decanting in Nairobi. However, factors related to a specific city cannot be overlooked since the performance of settlements in per capita water consumption is distinct within the three cities. Settlements in Nairobi have a comparatively high average per capita mean while those in Kisumu have the lowest. This is consistent with previous studies that indicate residents in larger cities have better access to infrastructural services compared to smaller cities (Troy & Holloway, 2006; Pierce, 2017).

Secondly, the key determinants of changes in amount of water consumed by a household before and after upgrading throw light on the key factors that influence sustainable water consumption in each of the three cities. Water intermittence is a common challenge in settlements within Nairobi compared to those in Mombasa and Kisumu (Figure 4.1). This problem is however more pronounced in Canaan and Decanting which are located in Kibra Sub County compared to KCC Kayole which is in Embakasi Central Sub County. Nairobi Water and Sewerage Company observed that there similar water delivery arrangements in all the administrative units in Nairobi. The variation in this case is due to estate management factors rather than differentiated regional service provision arrangements.

Residents in Kisumu observed that water availability had improved significantly but the average low performance in per capita consumption in this city compared to the other cities demonstrate the significance of other aspects of water access including cost, sufficiency and locational convenience. Since none of the residents in this city mentioned cost as a determinant of water consumption change, future infrastructure upgrading plans in this city should address the challenge of insufficient water supply and distribution of water points to enhance access. Similar issues were identified in a priority list of five aspects that required urgent intervention in a government led informal settlement upgrading project in Kisumu (Munala & Kainz, 2012). Distance to water points; prices; availability; quality; and sufficiency were mentioned on the list. Increased cost of water and changes in number of household members are conspicuous in settlements within Mombasa (Figure 4.1). Residents attributed the increase in cost of water after project intervention to the frequent intermittence, which

necessitates continued reliance on water vendors while paying the standard monthly water charges.

Thirdly, considered the socio-economic characteristics of a settlement, Spearman's correlation analysis establish that water consumption is not associated with income and education (Table 4-2). It is positively affected by household size and housing tenure. Khadam (2009) notes that positive influence of household size on water consumption is often at a decreasing rate. The findings are contrary to the common perception that income and education are the key drivers of resource use (Newton & Meyer, 2010; Waitt, *et al.*, 2012; Dong *et al.*, 2018). They are however consistent with Purshouse *et al.*(2017) on assessment of water consumption in middle income residential neighbourhoods in eastern Nairobi which found that education and household incomes are not significantly related to water consumption. Water consumption is also significantly correlated with housing tenure. The correlation coefficient  $r(605)=-1.54$ ,  $p \leq 0.05$  indicates that house owner occupiers consume significantly more compared to tenants and those subletting.

**Table 4-2: Results of Spearman's correlation between water consumption and household characteristics**

<b>Variable</b>	<b>Correlation coefficient (<i>r</i>)</b>	<b><i>p</i> value</b>
Income	82.59	0.7
Family size	10.74	0.00*
Education	-2.78	0.298
Housing tenure**	-1.54	0.000*
N	600	

\*Statistically significant at 5% level \*\*1-owner 2=Tenant 3=Subletting

Insignificant correlation between households' water consumption and their socio economic characteristics in most developing countries has been attributed to

substantially low supply which is below demand hence water is used sparingly by all households regardless of their income or education levels (Khadam, 2009) This could explain the significant impact of increased household size on household water consumption. Ramulongo et al. (2017) also established a similar correlation between household size and water consumption in a low-income town in South Africa.

Each city presents unique challenges including water intermittence in Nairobi, locational and service operation challenges in Kisumu and prohibitive water prices in Mombasa. Based on the system thinking approach, each of these specific challenges present the key intervention leverage points which could potentially yield optimal results in a city's sustainability loop.

#### **4.2.1.2 Water Conservation**

Resource use conservation is central to environmental sustainability as it addresses intra and intergenerational equity in development processes. Though water conservation is not explicitly mentioned in the informal settlement upgrading plans, there are considerable efforts at the community and household level. Among the respondents, 83.3% mentioned that they have adopted atleast one of the water conservation practices. Common practices include: water recycling (50.2%), reduced frequency of laundry activities (42.6%), rain water harvesting (30.7%), prompt response to leakage (6.3%) and installation of water saving devices (5.7%).

Though water recycling is generally a popular conservation practice, it is more common in settlements within Nairobi (61.6%) compared to those in Mombasa

(22.7%) and Kisumu (15.8%). Similarly, the use of water saving devices is popular in settlements within Nairobi (85.7%) compared to those in Mombasa (8.6%) and Kisumu (5.7%). Adoption of rainwater harvesting among the households is at 44.1%, 39.8% and 16.1% in Kisumu, Mombasa and Nairobi respectively. Settlements which have a comparatively high number of households using rain water have a characteristic high owner tenant ratio including: Jomvu Mikanjuni (73.5%), Mkomani (61.1%) and Ziwa la Ng'ombe (40%) (Table 4-3)

**Table 4-3: Rainwater harvesting and housing tenure arrangement in upgraded informal settlement**

<b>Settlement</b>	<b>Adoption of rainwater harvesting among households (%)</b>	<b>Tenant/owner occupancy ratio</b>
Canaan	12.5	1:0.63
Decanting	20.0	1:0
KCC Kayole	10.9	1:0.57
Ziwa la Ng'ombe	40.0	1:1.3
Mkomani	61.1	1:2.6
Jomvu Mikanjuni	73.5	1:3.3
Jomvu Mkuu	53.2	1:29
Nyalenda B	25.7	1:0.21
Nyalenda A	29.8	1:0.21
Obunga	38.8	1:0.25
Manyatta	29.0	1:0.15

Integration of rainwater harvesting in communal facilities is minimal. Though water storage tanks are provided in communal facilities such as ablution blocks, health facilities and waste recycling facility, they do not serve as rainwater reservoirs due to lack of a roof catchment system. Water harvesting was evident in one health centre and primary school in Ziwa la Ngombe settlement. The highrise apartments in Canaan and Decanting do not have a rainwater catchment system. The omission in these two settlements is contrary to Kenya's Building Code which provides for inclusion of rainwater catchment system in all new housing developments (Republic of Kenya,

2009). This minimal integration of rainwater harvesting system in upgrading plans demonstrates a parallel pursuit of two National Slum Upgrading and Prevention Policy goals: provision of standard adequate housing and promotion of environmental sustainability in informal settlements (Republic of Kenya, 2016).

Settlements where households experience water rationing have a high prevalence of households who have adopted water conservation measures (Figure 4.2). This could imply that most households have adopted water conservation measures primarily as water scarcity coping strategy as opposed to its inherent environmental value. Increased water availability in these settlements may therefore trigger a reduction in number of households that have adopted water conservation practices. This will consequently decrease the environmental sustainability performance of these settlements.

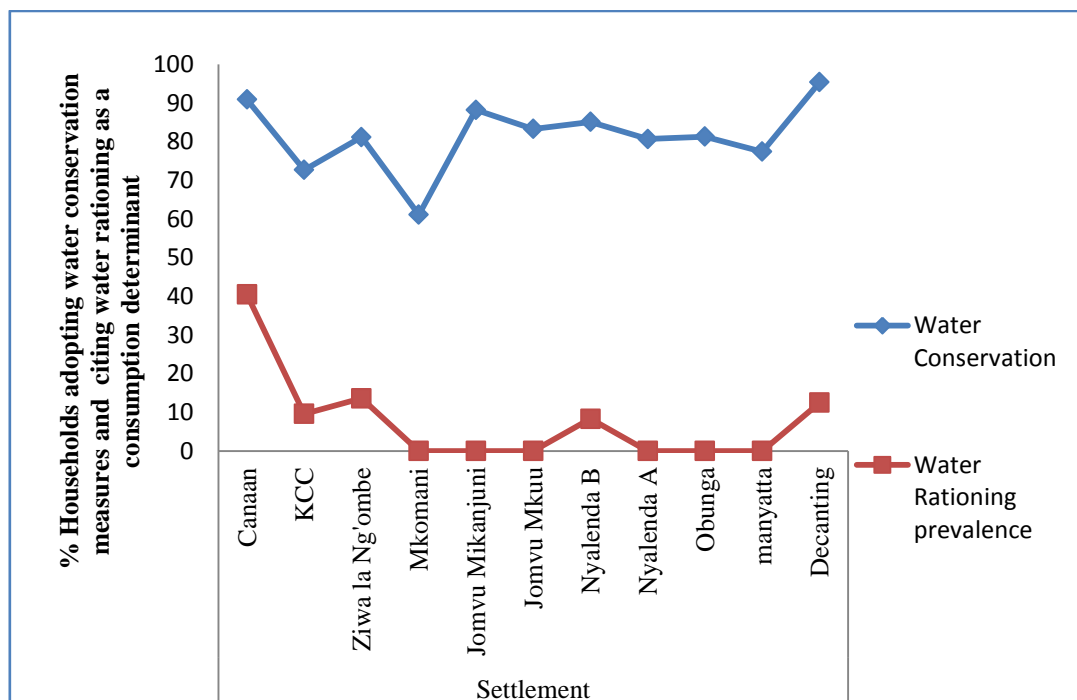


Figure 4.2: Water conservation practices and water rationing prevalence in upgraded settlements

The results of a Pearson’s correlation to establish whether there exists any relationship between household characteristics namely: education, income, housing tenure, household size and adoption of water conservation measures tested positive only with household size  $r(605)=-0.109, p=0.007$ . However, correlation of the same household characteristics with four dependent sub-variables; water recycling, prompt repairs of leakages, use of water saving devices and rainwater harvesting show more positive relationships (Table 4-4). There is a positive correlation between education and rainwater harvesting; income and use of water saving devices and prompt repair of leakages. The later could be attributed to cost implications of installing water devices and repairing the water pipes. Environmental values show a significant but negative relationship with water recycling and use of water saving devices. The results negate previous work showing more educated people to be more adoptive of water recycling practices (Toteng, 2008) and income to be strongly but negatively related to water recycling (Newton & Meyer, 2010). Specific recycling practices are motivated by varied household characteristics.

**Table 4-4: Relationship between adopted water conservation measures and household characteristics**

<b>Common Water Conservation measures</b>	<b>H/hold size</b>	<b>Education</b>	<b>Income</b>	<b>Tenure Arrangement</b>	<b>Environmental Values</b>
	<i>P-Values for Spearman Correlation N=600</i>				
Water Recycling	0.052	0.054	0.053	0.874	0.000*
Prompt repair of leakage	0.390	0.076	0.000*	0.767	0.105
Use of water saving devices	0.434	0.151	0.001*	0.110	0.001*
Rainwater harvesting	0.204	0.014*	0.070	0.871	0.138

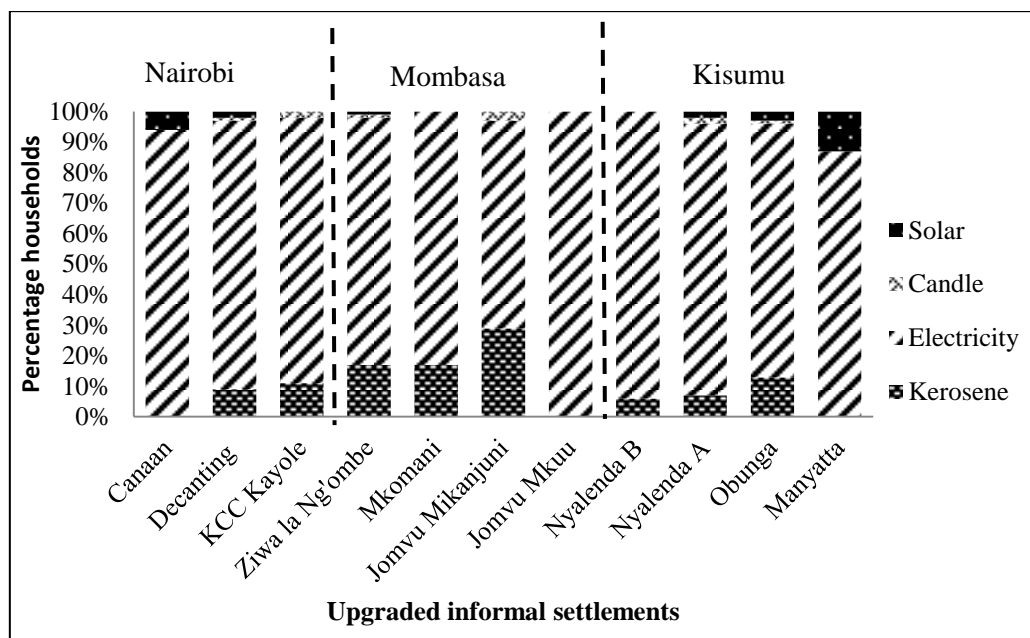
\*p value is statistically significant at 5% level

#### **4.2.1.3 Energy Consumption**

Energy consumption performance in the upgraded settlements is based on the number of households connected to the national electricity grid and the amount of electrical energy consumed by a household. Findings revealed that 89.6% of the households use electricity as the main source of energy for lighting; 8.1% use kerosene and 0.5% use candles. Jomvu kuu has the highest performance as all the households have electricity connection while Jomvu Mikanjuni has the lowest connection level (67.6%). These two settlements are located within the same location in Mombasa city. Therefore, the discrepancy in performance may not be attributed to size of an urban centre as indicated by KIPPRA (2010) but could be due to household characteristics such as housing tenure arrangement and income which have been noted in previous studies (Karekezi *et al.*, 2008; Toteng, 2009; Magambo, 2010). Apart from Jomvu Mikanjuni, all the other settlements have more than 80% of the residents connected to electricity (Figure 4.3). Prior to the upgrading process, electricity usage for lighting in informal settlements is estimated at 42% (Karekezi *et al.*, 2008). This presents positive progress towards national target of 100% household access to electricity for lighting by 2030 (Government of Kenya, 2016).

The average electricity consumption in the eleven settlements is 5.92 kWh/M<sup>2</sup>/month which is relatively low compared to 37.31 kWh/M<sup>2</sup>/month in the middle income neighbourhoods of Kenya (Magambo, 2010). Though the amount of electricity consumed is determined by electrical appliances used by a household, a relatively low average consumption may indicate inadequate consumption. This implies that despite

the connection to electricity, households do not fully utilize the service either due to high cost or intermittence.



**Figure 4.3: Main energy sources for lighting in upgraded settlements**

With regard to source of cooking energy, 52.4% of the residents in upgraded settlements use charcoal and woodfuel with a mean of 7.05 kilograms per month while 27.6% use LPG with a mean of 81.977 kilograms per month (Figure 4.4). The usage of LPG as the main source of fuel is common in settlements in Nairobi while charcoal and woodfuel are dominant in settlements in Kisumu and Mombasa. Kerosene is used by 20% of the households. Charcoal, wood fuel and kerosene are associated with indoor air pollution especially in informal settlements where 75% of the dwelling units have a total floor area of less than 120 square feet. A spearman's correlation to assess the main source of energy for cooking and household characteristics shows a significant relationship between type of energy and income and education level (Table 4-5). Tenure arrangement and size of the family have no relationship with the type of energy used by a household. Though these findings only

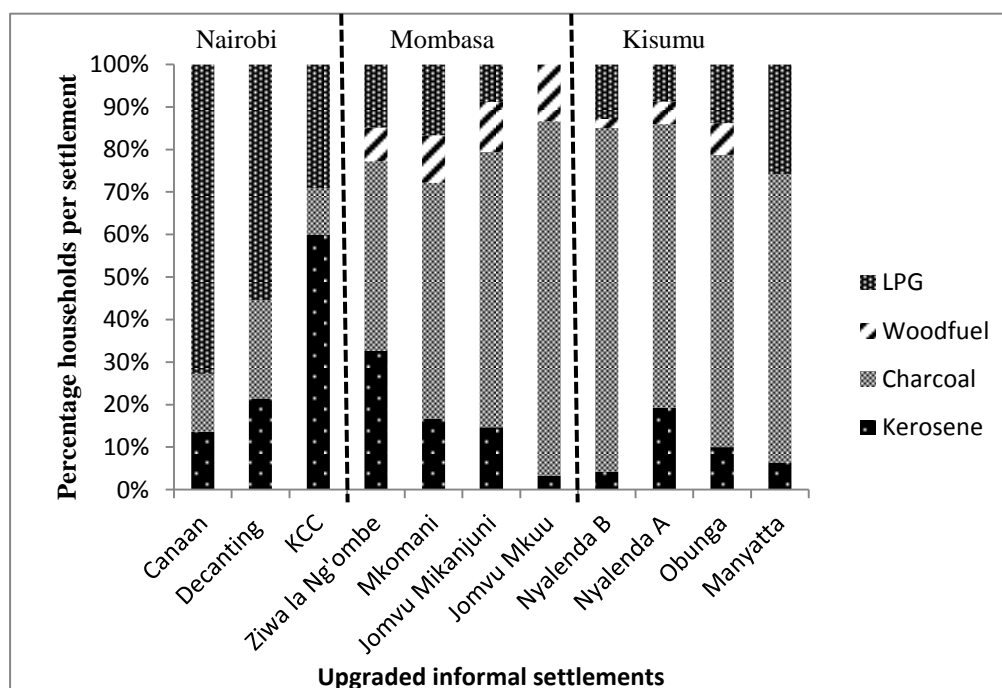
point out existing association between energy choice and income and education levels, they support previous studies that have established income level to be key determinant of energy choice among the urban poor (Karekezi *et al.*, 2008).

**Table 4-5: Results of Spearman’s correlation between choice of cooking energy and household characteristics**

Variable	Correlation coefficient ( <i>r</i> )	<i>p</i> Value
Income level	0.249	0.000*
Education	0.219	0.000*
Family size	-0.029	0.429
Housing tenure	0.04	0.321
<i>N</i>	600	

\*Statistically significant at 5% level

Settlements in Nairobi perform better compared to those in Kisumu and Mombasa in the progress towards the national target of 100% household access to modern energy sources (Republic of Kenya, 2016). Out of the 27.6% households that use LPG, 55.8% are in Nairobi while 14% and 11.5% are in Kisumu and Mombasa respectively. The performance of cities is reflective of the average income levels of Ksh 42,518 in Nairobi, Ksh 22,049 in Mombasa and Ksh 19,908 in Kisumu.



**Figure 4.4: Common energy sources for cooking in upgraded settlements in Kenyan cities**

#### **4.2.1.4 Energy Efficiency**

There are considerable attempts to adopt energy efficiency measures in the eleven upgraded settlements, which involve energy conservation mechanisms and the use of renewable energy sources to substitute or complement non-renewable sources. 88.8% of the households have adopted one or more measures to conserve energy use in lighting. Out of these, 66.9% use energy saving bulbs, 42.6% use natural lighting during the day and 2.2% use solar energy. A total of 42.1% households have adopted energy saving measures in cooking. Out of these, 68.2% use energy saving stoves, 3.5% use pooled cooking, 3% use biogas and 1.8% use briquettes as a charcoal substitute. 8.8% households use renewable energy in the form of solar and biogas for lighting and cooking respectively. 60% of those who use renewable energy are in Kisumu, 32% in Mombasa and 8% in Nairobi. The high performance in Kisumu is partly a result of efforts to promote the use of clean energy among households by Non Governmental Organizations (NGOs). Umande Trust and Practical Action in particular have been instrumental in encouraging the use of solar energy in Nyalenda A, Nyalenda B, Obunga and Manyatta settlements. Though a comparatively less percentage of households use renewable energy in Nairobi (8%), Canaan has all its common space and outdoor lighting powered by solar.

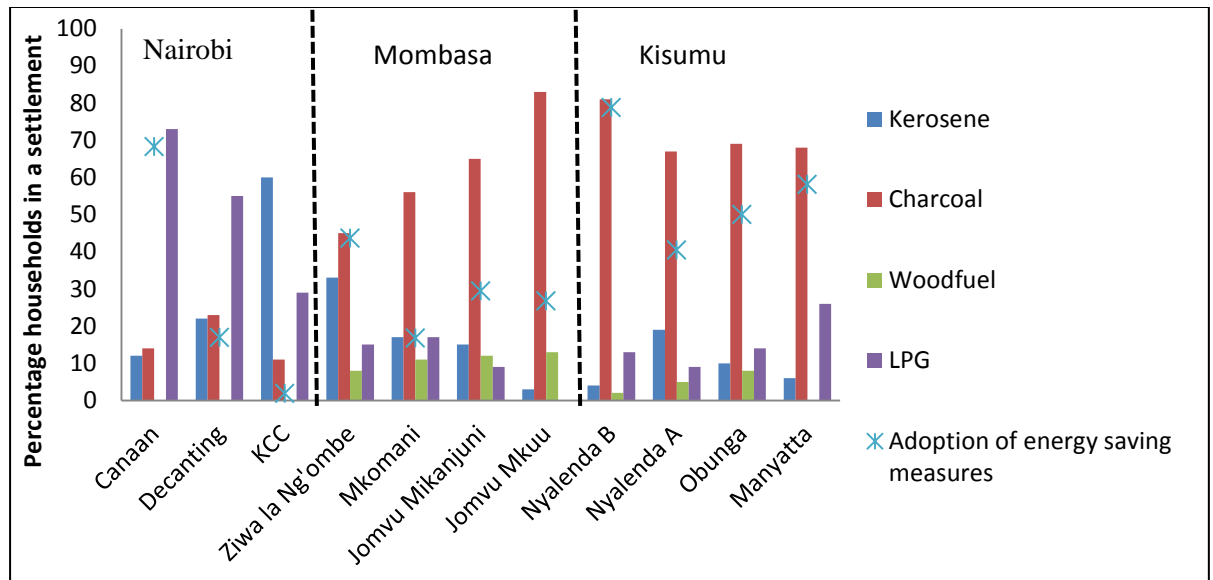
A spearman's correlation analysis between adoption of energy conservation measures in lighting shows that income level has a significant association with use of lighting energy conservation measures at  $r(605)=-0.192$ ,  $p<0.05$ . There is no significant association with education, housing tenure and family size. A linear regression

reveals a significant impact of income on adoption of conservation measure  $F(1, 604)=16.4$   $p<0.05$ , with an  $R^2$  of .026. This analysis shows that the number of households in a settlement who adopt energy conservation measure in lighting is equal to  $1.188 -0.018$  (average monthly income) in the settlement. Though the  $R^2$  value shows 2.6% variation in adoption level is attributed to income level, it is of concern that increased income levels bear a negative influence on sustainable energy use. This results provide a basis for targeted interventions in lighting energy efficiency.

The results of a spearman's correlation indicate that adoption of cooking energy conservation measures has a significant association with income and education. There is no correlation with household size, type of energy used and housing tenure. Linear regression shows that 3.2% variation in adoption levels within a settlement is attributed to average monthly income ( $F(1,604)=19.98$ ,  $p<0.05$ , with an  $R^2$  of .032) while 1.6% is attributed to education level ( $F(1, 604)=9.97$   $p<0.05$ , with an  $R^2$  of .016). Similar to lighting energy conservation measures, the regression equation shows a negative influence of increased income on adoption level. The level of adoption of cooking energy conservation is equal to  $1.71-0.03$ (income) when income is measured as average monthly income in a settlement. Progressive educational attainment also bears a negative influence on level of adoption as indicated by the regression equation which shows that adoption level is equal to  $1.77- 0.054$  (education level of household head) assuming a scale of 1-6 where 1 is no education and 6 is university degree.

ANOVA results show significant difference for conservation of lighting energy ( $F(2,603)=3.803$   $p=0.023$  and cooking energy ( $F(2,603)=11.6$ ,  $p<0.05$ . This implies

that locational factors may also affect the number of households adopting energy efficiency measures in a settlement (Figure 4.5). Similar findings were established by Mutua & Kimuyu (2015) using the tobit model to simulate the impact of socio economic factors on adoption of household energy conservation measures in Kenya. Their results highlighted the significance of employment, educational level and household location. They further established that increased educational attainment exhibited declining marginal effects.



**Figure 4.5: Adoption of cooking energy conservation measures and type of energy use in upgraded settlements**

Renewable energy usage is limited. 79% of those who use solar and biogas energy cited technical challenge in the use of renewable energy, 15% cited environmental challenges such as weather and 6% mentioned financial challenges. This implies that ease of use rather than affordability is the key barrier to the use of renewable energy sources at the household level. It is consistent with findings that show a negative

influence of income on adoption of energy conservation measures in the eleven upgraded settlements.

#### 4.2.1.5 Non-Motorized Transport

The study established that 53.8% of the residents walk to the market, 41.7% use matatus and motorcycles, 3.1% cycle, 1% use private vehicles while 0.3% car pool with neighbours and friends. This is similar to findings by Tanaka *et al* (2014) on travel behaviour in African cities using school as a reference point that established that walking is the most common mode of transport (46.7%) while cycling is rarely used (4.1%).

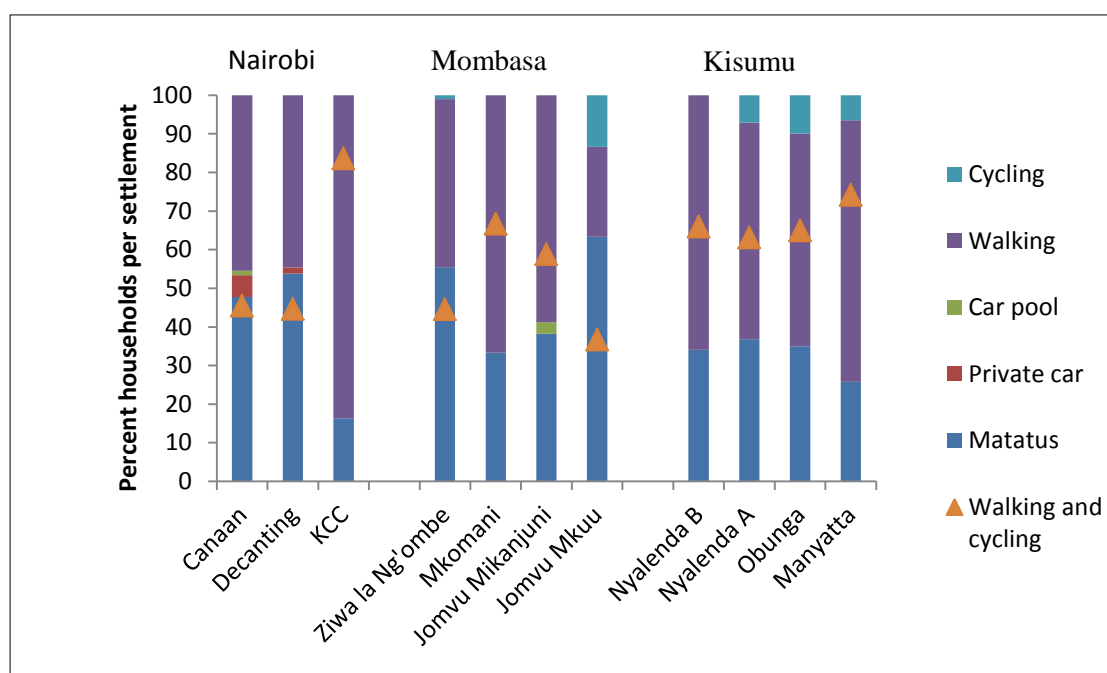


Figure 4.6: Transport modes used by residents to the market in upgrading settlements

KCC Kayole has the highest number of residents using non motorized transport at 83.6% while Decanting and Ziwa la Ngombe have the lowest at 44.6% (Figure 4.6).

Settlements in Kisumu have more people walking and cycling to the market (67.1) compared to Nairobi (57.9%) and Mombasa (51.7%). However, the results of

ANOVA show that there is no significant mean difference among residents using non motorized transport in the three cities ( $F(2,8)=1.188$ ,  $p=0.353$ ). This implies that the influence of a city on resident's mode of transport to the market is minimal. The insignificant difference could also be the impact of an even intervention in the form of footpath provision.

The findings indicate that the use of non motorized transport is not significantly associated with most household characteristics namely: education, household size, tenure and period lived in the settlement but has a significant relationship with income. Simple regression analysis indicates a negative impact of increased income levels on use of non motorized transport. This could be partly attributed to the perception towards walking and cycling as a depiction of poverty hence the strong negative correlation between walking and income. This influence is stronger on walking compared to cycling (Figure 4.7).

The infrastructure upgrading plans of all the eleven settlements allowed for provision of footpaths that link the settlement to amenities such as markets and schools. Despite this, 41.7% of the residents in these settlements prefer to use motorized transport to access neighbourhood amenities. This points to the need to augment footpath provision with other significant leverage factors. The significant impact of income on mode of transport could be a pointer to the key drivers of non motorized transport use.

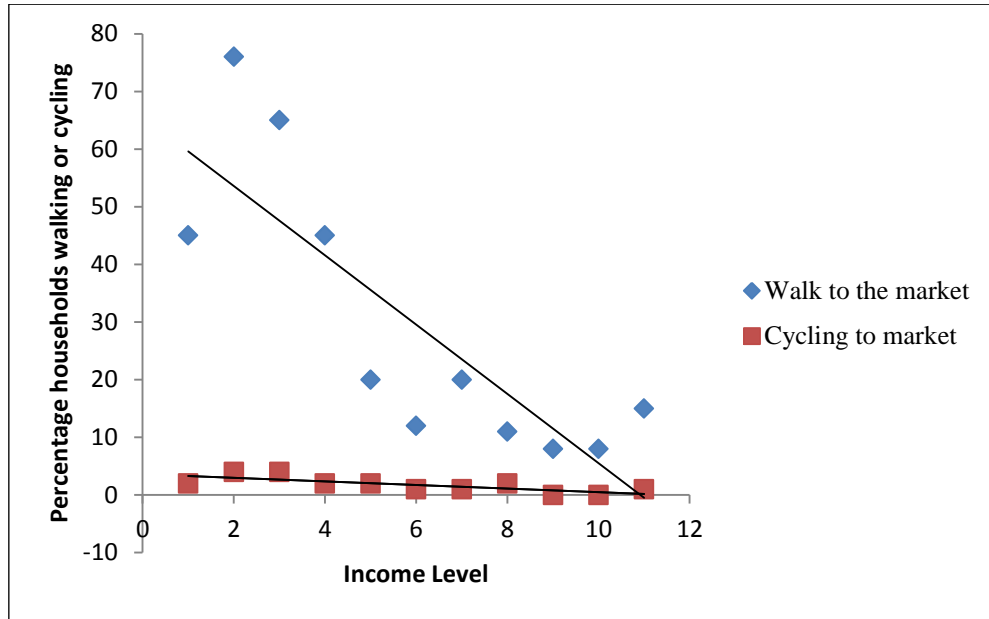


Figure 4.7: Income levels and household’s common mode of transport in upgraded settlements

#### 4.2.2 Waste Management in Upgraded Settlements

Indicators in this category deal with issues associated with solid waste recycling at the household level, number of recycling facilities in a settlement, frequency of waste collection and adequacy of toilet facilities. 27.2% of the households use city county services for waste disposal, 20.1% use community based organizations, 43.2% use open dumping, 3.1% use burning while 6.3% use mixed disposal methods. With regard to waste recycling, 2% households recycle their biodegradable waste (Figure 4.8). The highest performance is in Mkomani while the lowest is in Manyatta, Jomvu kuu, Jomvu Mikanjuni and Canaan where none of the interviewed households recycle their biodegradable waste. Among those who recycle biodegradable waste, 41.7% are in Kisumu, 33.3% in Nairobi and 25% in Mombasa. These differences are however not significant as the ANOVA test revealed a p value greater than 0.05 ( $F(2,8)=0.023$ ,  $p=0.977>0.05$ ). This could imply household level factors have a greater influence on household recycling practices compared to city level factors.

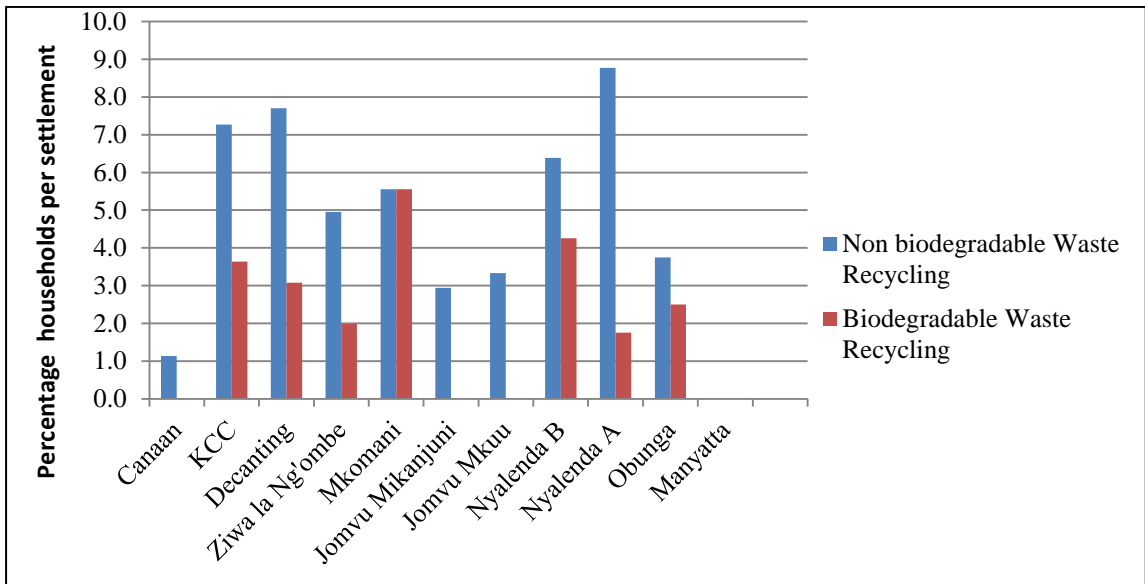


Figure 4.8: Level of waste recycling in upgraded settlements

Considering the socio economic characteristics of households who recycle biodegradable waste, the frequency trends show that less households recycle their waste as monthly income, education level and household size increases.

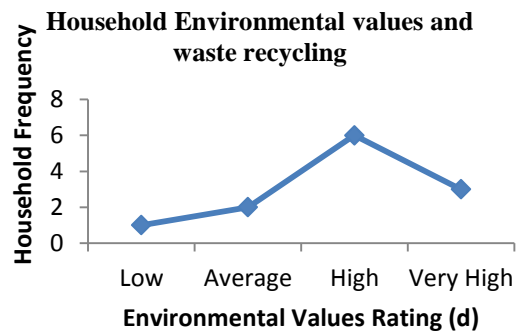
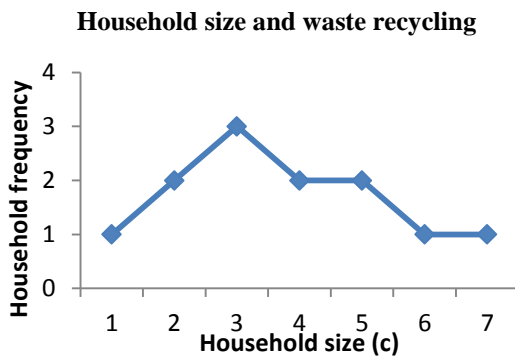
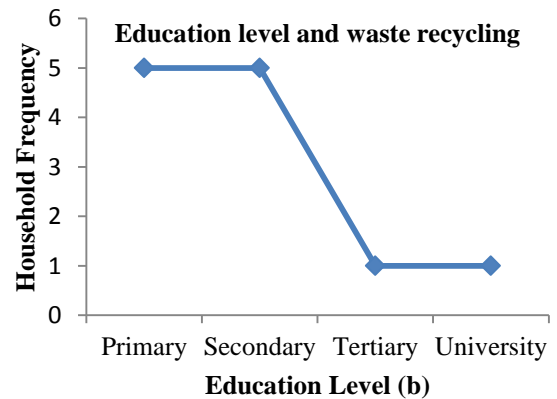
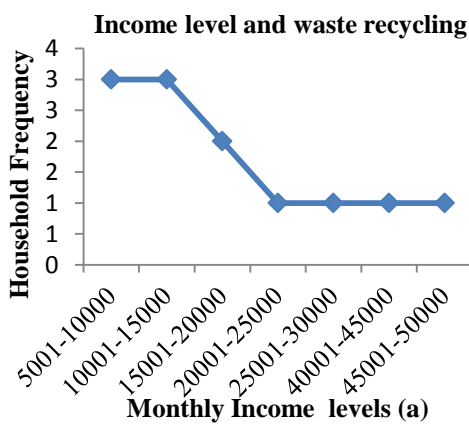


Figure 4.9 a,b,c). More households recycle their waste as the environmental value rating increases (

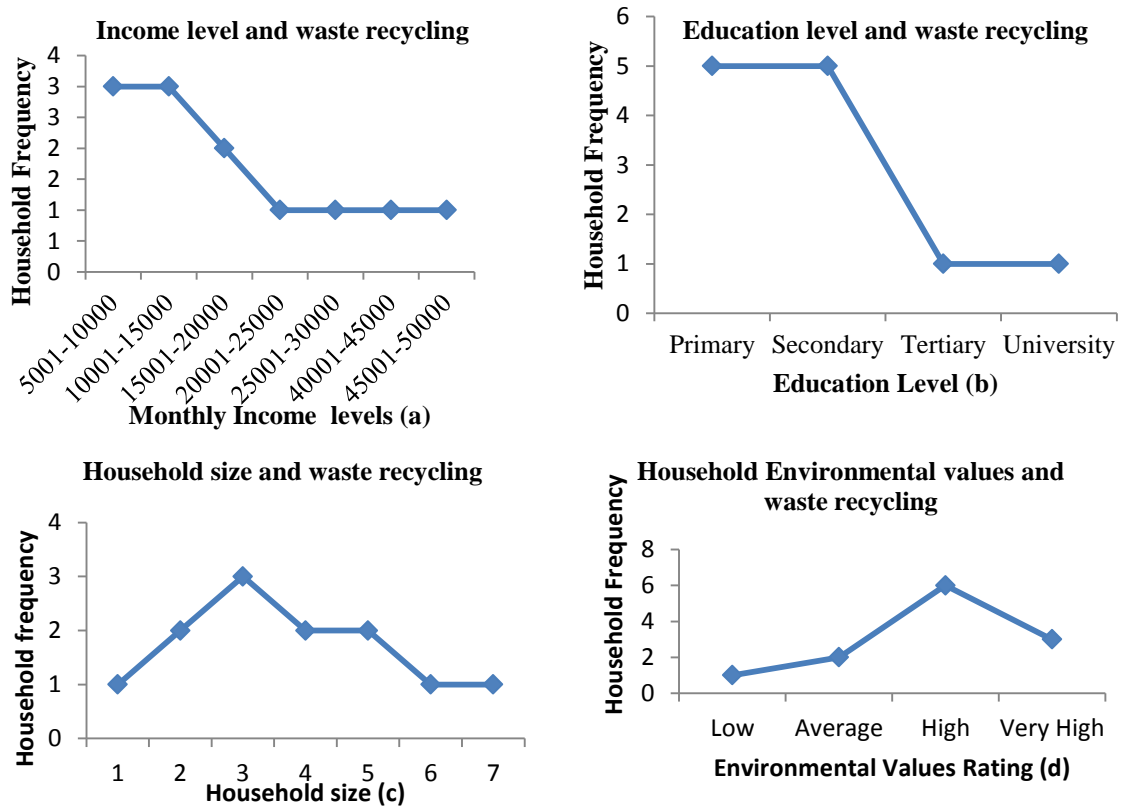
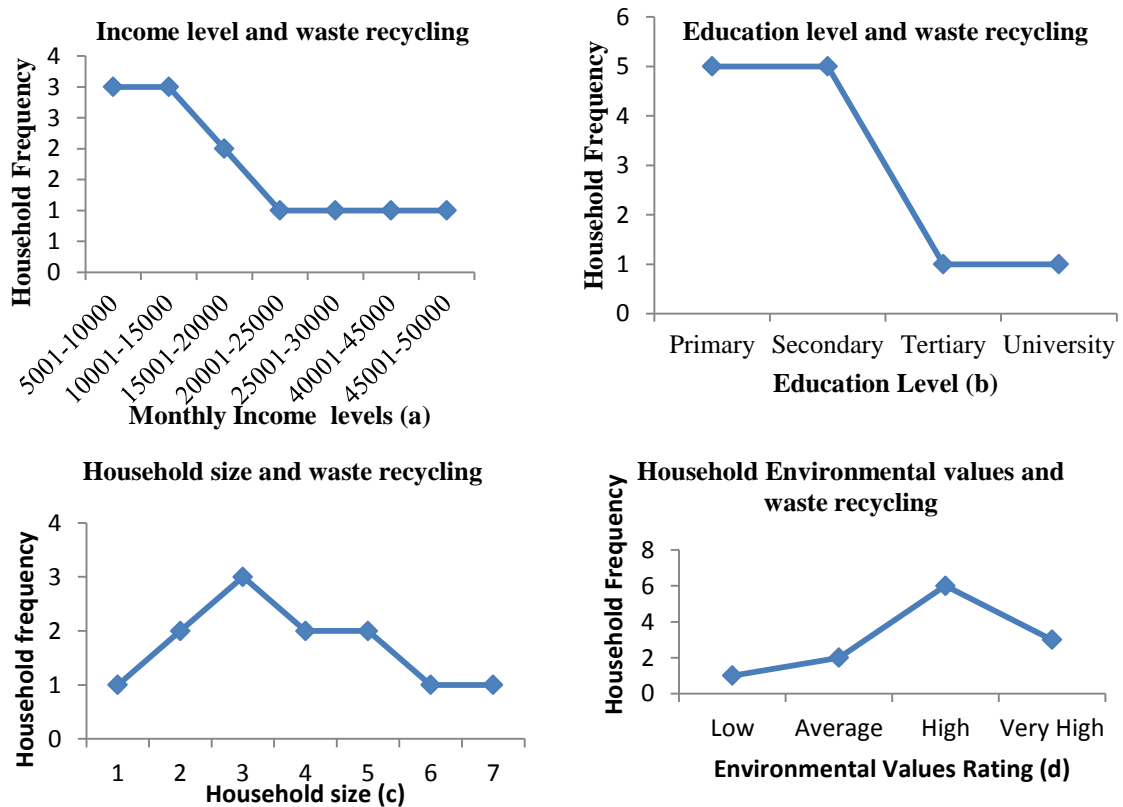


Figure 4.9 d). 58.3% tenants recycle their waste compared to 41.7% owner occupants. 33.4% of households with very high level of environmental awareness recycle their waste compared to 16.7% of those with low levels of environmental awareness. The household had environmental values and level of environmental awareness therefore present significant entry points in promoting biodegradable waste recycling. Though Afroz et al (2010) did not disegregate findings based on nature of waste, they identified environmental conciousness as a dominant factor of influence in household recycling behaviour in Dhaka city.

4.8% of the residents in upgraded settlements recycle non biodegradable waste. Most of these residents are in Nyalenda A (8.8%), Decanting (7.7%), KCC (7.3%) and

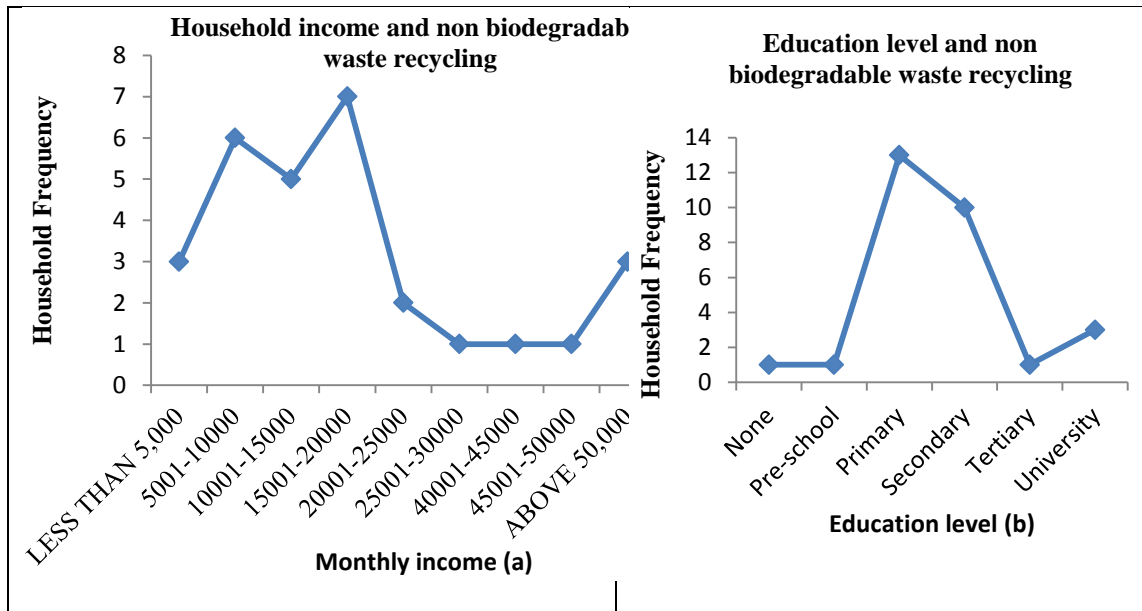
Nyalenda B (6.4%) (Figure 4.8). None of the residents interviewed in Manyatta recycles non biodegradable waste. Notably, Canaan and Manyatta exhibit comparatively low levels of recycling in both biodegradable and non biodegradable waste. Out of those who recycle their non biodegradable waste, 34.5% are in Nairobi, 37.9% in Kisumu and 27.6% in Mombasa. The difference between the three cities is insignificant as revealed by ANOVA test ( $F(2,8)=0.128$ ,  $p=0.881>0.05$ ). The p value of the test result is above the significance level of 0.05 implying that the city level influence is insignificant.

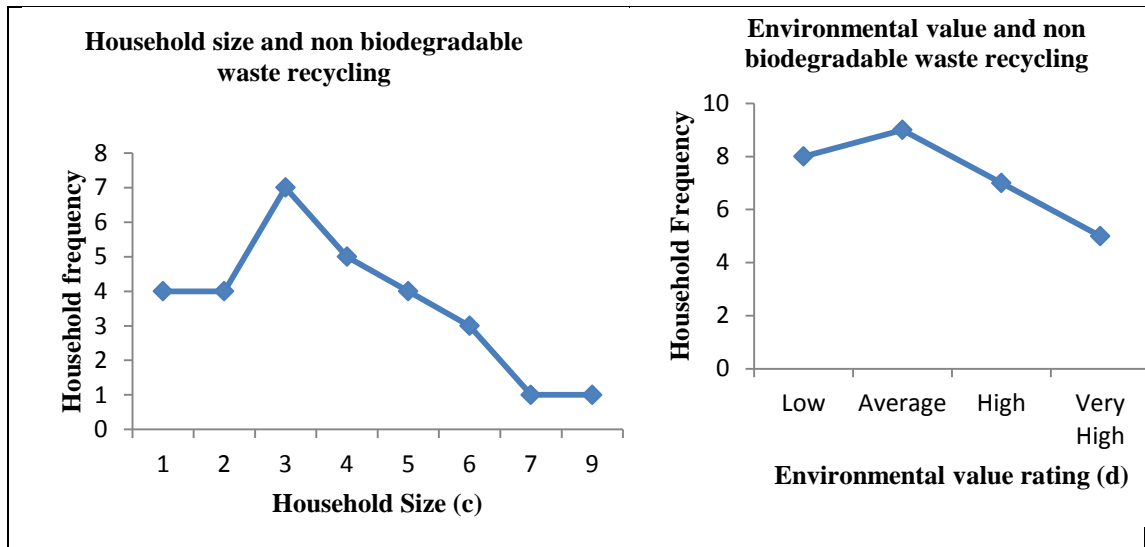


**Figure 4.9: Frequency trends in socio economic characteristics of households involved in biodegradable waste recycling**

The frequency trends on household characteristics show that majority of households who recycle their non biodegradable waste are in the lower monthly income bracket

of Kshs 5,000-20,000, they have basic education having completed either primary or secondary level, less than 3 household members and a below average environmental value rating (Figure 4.10 a,b,c,d). Similarly, Afroz et al (2010) established that majority of the households who recycle waste in Dhaka city have a monthly income range of ksh 3,700-18,000. 58.6% of these households are tenants while 41.4% are owner occupants. Similar to biodegradable waste recycling, more tenants recycle non biodegradable waste compared to owner occupants. This implies that tenant occupancy and the inherent lack of sense of ownership is not a deterrent in household waste recycling.





**Figure 4.10: Frequency trends in socio economic characteristics of households involved in non bio degradable waste recycling**

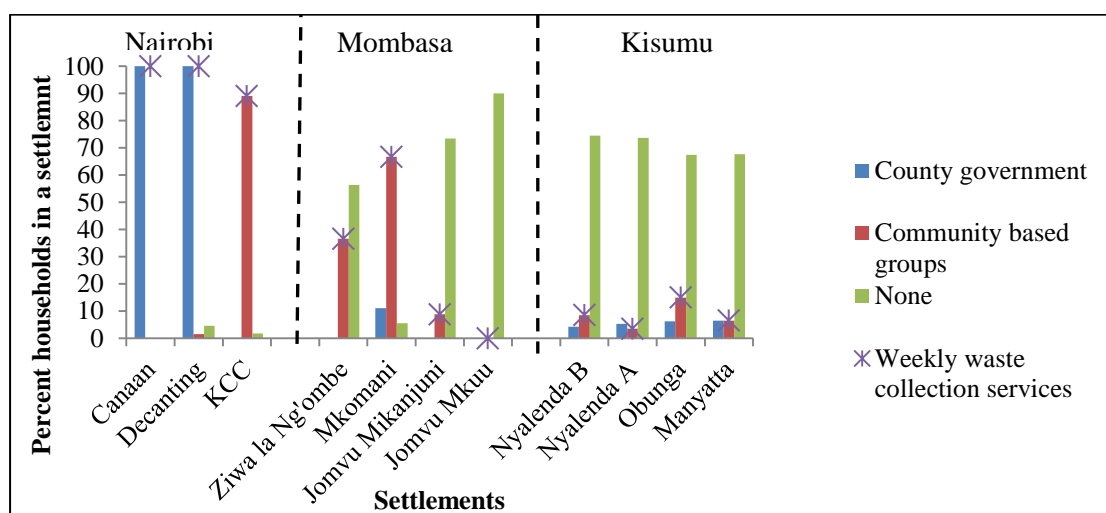
With regard to environmental awareness, 34.5% and 31% of those who recycle this waste have an average and low awareness level respectively while 24.1% have very high and 3.4% have high awareness level. These trends reveal limited dominance of household socio economic factors in influencing non biodegradable recycling practices. Having established an insignificant city level influence, it appears that there could be other household characteristics outside the scope of this study or settlement factors that influence non biodegradable waste recycling. The later could be supported by the existence of recycling facilities in settlements with higher number of households involved in recycling namely: Nyalenda A, KCC and Nyalenda B. Previous studies on non bio degradable waste recycling have shown that recycling facilities are better stimulants of recycling among households compared to socio economic characteristics such as income, education and environmental awareness (Balaban, 2013; Fiorillo, 2013; Briguglio *et al.*, 2016).

Three of the the eleven settlements including: Nyalenda A, Nyalenda B and Kayole KCC have recycling facilities. There are two recycling facilities in Kayole KCC while

each of the other settlements have one facility each. Apart from one of the facilities in KCC which is used to recycle both bio degradable and non biodegradable waste, the other three facilities are used to recycle non biodegradable waste only. This could explain why the three settlements have a higher performance in non bio degradable waste recycling compared to the other settlements.

The formalization of the eleven settlements through planning and provision of tenure security was expected to facilitate inclusion of previously informal settlements into the city's service delivery arrangements. However, 72.8% of the residents are still not served by the municipal garbage collection services (Figure 4.11). All the households in Canaan and Decanting have access to municipal garbage collection services while none of those interviewed in KCC, Jomvu Mikanjuni and Jomvu Kuu has access to this service. In the other settlements, a section of the residents have their waste collected by the city county including Mkomani (11%), Obunga (6%), Manyatta (6%), Nyalenda, A (5%), Nyalenda B (4%) and Ziwa la Ngombe (4%). The study established that this selective service provision in the six settlements is as a result of informal waste collection arrangements between settlement leaders and the county government officials. In this case, the waste is collected in sections of the settlement outside the planned city collection routes. In some instances, the resident associations request to fuel the municipal vehicles to facilitate waste collection in these settlements. These local negotiations, though spontaneous and inconsistent, have been modelling service delivery arrangements in cities facing inadequate municipal services (Gandy, 2007).

In the absence of municipal services, 43.2% of the households dispose their waste in open dumpsites, 20.1% use community based organizations services, 7.4% burn their waste while 2% recycle all their waste. 94.7% of the residents in settlements within Nairobi have access to waste collection services by the city county or CBOs compared to 31.7% in Mombasa and 14.9% in Kisumu. Similar findings by Mberu *et al* (2017) established that twice as many low income households in Nairobi (92.1%) were served with waste collection services compared to 49% in Mombasa.



**Figure 4.11: Waste collection services in upgraded informal settlements**

The frequency of waste collection in the eleven settlements is determined by the service provider (Figure 4.11). Settlements which have a wide coverage of collection services by City County such as Canaan and Decanting have a higher collection frequency than those that are largely served by community based groups such as Ziwa la Ngombe and Mkomani. All the residents in Decanting and Canaan have access to weekly waste collection services, 89.1% in KCC, 66.7% in Mkomani, 36.6% in Ziwa la Ngombe and 15% in Ziwa la Ngombe. The other seven settlements have less than

10% of the residents accessing weekly waste collection services. Residents who do not have regular access to the service resort to disposal of waste in informal designated collection points in the neighbourhood such as open spaces, river banks and ocean creeks, along the roadside and in open storm water drains. This waste is collected by the city county on an irregular basis.

Sanitation improvement is a priority objective in any upgrading project according to the National Slum Upgrading and Prevention Policy (GoK, 2016). Interventions in sanitation within the eleven settlements included: construction of trunk sewers and service mains in KCC, Ziwa la Ngombe, Mkomani, Jomvu Mikanjuni, Jomvu Kuu, Nyalenda A, Nyalenda B and Obunga; house sewer connection in Canaan and Decanting and provision of ablution blocks in Canaan, Ziwa la Ngombe, Jomvu Mikanjuni and Jomvu Kuu. The interventions are aimed at increasing safely managed sanitation service which is defined as the use of a toilet or improved latrine which is not shared with other households and one that has a system in place to ensure safe disposal of excreta (WHO, 2017). The adequacy in terms of number of people sharing a toilet facility is used as the main proxy sanitation indicator for two reasons. First, the settlement upgrading process inherently provides for development of safe systems for excreta disposal hence the need to assess their adequacy given the dense population. Secondly, shared toilet facilities significantly influence safe excreta disposal due to the associated user safety concerns (Munala, 2012).

The findings indicate that 70.1% of the households in the upgraded settlements use shared toilets. Out of those sharing, 11.9% use a toilet shared by more than seven

households (Table 4-6). None of the households interviewed in Canaan use shared facilities. Nyalenda A, Manyatta and Mkomani have the highest portion of residents sharing a toilet. The three settlements also rank high among the settlements with more than seven households sharing a toilet (Table 4-6). Based on ANOVA test, the percentage of household using shared toilet facilities in Nairobi, Kisumu and Mombasa is significantly different since the p value is less than 0.05 ( $F(2,8)=5.29$ ,  $p=0.03$ ). Social economic factors at the city level can be attributed to the difference in performance of settlements.

**Table 4-6: Sanitation characteristics in upgraded settlements**

Sanitation characteristics	Canaan	KCC	Ziwa la Ng'ombe	Mkomani	Jomvu Mikanjuni	Jomvu Mkuu	Nyalenda B	Nyalenda A	Obunga	manyatta	Decanting	Total
<b>Toilet facility used by households (%)</b>												
Common pit latrine	0.0	20.0	70.3	44.4	58.8	66.7	89.4	89.5	92.5	93.5	0.0	54.5
VIP latrine	0.0	23.6	14.9	33.3	23.5	20.0	4.3	3.5	1.3	0.0	0.0	9.2
Flush toilet connected to sewer	100	52.7	1.0	0.0	0.0	13.3	6.4	3.5	5.0	6.5	100.0	30.9
Flush toilet connected to septic	0.0	3.6	13.9	22.2	17.6	0.0	0.0	3.5	1.3	0.0	0.0	5.1
<b>Households sharing a toilet facility (%)</b>												
Sharing	0	78.2	74.3	88.9	64.7	70	85.1	98.2	88.7	93.5	41.5	70.1
Not sharing	100	21.8	25.7	11.1	35.3	30	14.9	1.8	11.3	6.5	58.5	29.9
2-3	0	40.14	34.7	61.1	1	60	36.2	33.3	33.8	41.9	38.5	37.3
4-5	0	5	13.9	5.6	8.8	6.7	21.3	17.5	25	9.7	1.5	12
6-7	0	9.1	9.9	16.7	2.9	3.3	8.5	21.1	17.5	9.7	1.5	8.9
>7	0	14.5	15.8	5.6	8.8	0	19.1	26.3	12.5	32.3	0	11.9
<b>Interventions</b>												
House sewer connection	✓											✓
Trunk sewer & Connection to service mains		✓	✓	✓	✓	✓	✓	✓	✓			
Ablution Blocks			✓		✓	✓						✓

Settlements with similar interventions seem to have varied performance with regard to number of households sharing a toilet. For instance, 41.5% of the residents in Decanting use a shared toilet while in Canaan which has a similar house sewer connection none of the interviewed household uses a shared toilet. This difference is attributed to housing design which in the case of Decanting provides for a shared toilet and bathroom between two dwelling units. Variations are also evident between Nyalenda A and Nyalenda B with 98.2% and 85.1% households sharing respectively despite both having been supplied with a trunk sewer and service mains.

Though trunk sewer is provided in all the settlements apart from Manyatta, 54.5% of the residents in all these settlements still use a pit latrine (Table 4-6). This is particularly common among residents in Kisumu namely: Nyalenda A (89.5%), Nyalenda B (89.5%) and Obunga (92.5%). A housing officer at the MoHLUD attributed pit latrine preference among households to cultural influences which are more pronounced in Kisumu because residents do not perceive their settlements as part of the urban space.

### **4.2.3 Environmental Quality of Upgraded Settlements**

Performance of upgraded informal settlements in environmental quality is based on residents' perceived environmental quality, disease incidence associated with environmental risk factors and existence of open spaces. The findings show that 8.3% of the residents perceive the environmental quality to be very desirable while 39.9% perceive it to be desirable. 31.2% perceive the environmental quality to be fair, 15.8% perceive it as undesirable while 4.5% as very undesirable. Jomvu Kuu in Mombasa has the highest number of residents who rated the environmental quality as very desirable or desirable. The highest number of residents who deem the environmental

quality to be undesirable and very undesirable are in Nyalenda A and Jomvu Mikanjuni respectively. A spearman correlation test to establish the relationship between perceived environmental quality and household characteristics reveals that such perception is not correlated with income level, education level, age of household head and number of years lived in the settlement but has a significant correlation with housing tenure  $r(605)=0.184, p<0.05$ . Out of those who perceive their environment to be very desirable and desirable, 66% are owner occupants while 34% are tenants. On the other hand, 55.6% of those that deem their environment to be of very poor quality and poor quality are tenants while 44.4% are owner occupants. The level of satisfaction with physical conditions of the settlement could therefore be fueled by one's sense of place ownership as has been cited in similar studies (Kearns & Mason, 2007; Clark & Kearns, 2013).

The study revealed that in settlements with a high owner-tenant ratio, residents have devised means to improve service delivery in addition to the project interventions, hence improving their environmental quality. For instance, in Canaan, waste collection, payment for water supply and maintenance of green spaces and common areas are coordinated by a voluntary settlement based estate management team. In Jomvu Kuu and Mkomani, residents contribute Ksh 50 per month towards the maintenance of storm water drains. On the other hand, settlements with low owner-tenant ratios have limited environmental improvement initiatives.

Disease incidences associated with unsafe water and sanitation is used as a proxy indicator in assessing impact of environmental quality on residents' health. 81.8% of all the households had been treated for typhoid, cholera, malaria and other related

diseases in the last one year. However, some settlements have low disease incidences, Mkomani (55.6%), Kayole KCC (60%) and Canaan (61.4%). In Jomvu Kuu and Manyatta, all the respondents mentioned that they had been treated for either of these diseases in the last one year. It is notable that settlements that are perceived to have a desirable environmental quality by most of the residents do not necessarily have lower level of disease incidences. In Jomvu Kuu where 96.7% of the residents perceive the environmental quality to be very desirable or desirable had 100% level of disease incidences. On the other hand, Kayole KCC which had the highest number of residents who perceive their environmental quality to be poor or very poor had the second lowest disease incidences of 60% (Table 4-7). This implies that there exist other factors that inhibit the risk posed by poor environmental quality such as community based health programs which provide preventive health care.

The study established that most of the upgraded settlements lack open spaces. Performance rating for this sub variable is therefore limited to open space availability and access vis a vie the percentage coverage in a settlement. The later had been suggested as one of the open space indicator measures. Four out of the eleven settlements have areas designated as open space (Table 4-7). Apart from Canaan and Decanting the open spaces in Jomvu Mikanjuni and Jomvu Kuu are inaccessible. They are characterized by overgrown grass and heaps of waste. In Canaan and Decanting however, the open spaces are well maintained and are utilized by the residents for relaxation and holding meetings. The maintenance is undertaken by the estate management team.



a) An open space between estate blocks in Decanting, Nairobi



b) A Section of an open space in Canaan, Nairobi



c) A section of an open space in Jomvu Kuu, Mombasa



d) A section of an open space in Jomvu Mikanjuni, Mombasa

**Plate 4.1: Sections of open spaces in upgraded informal settlements of Nairobi and Mombasa**

Open spaces in Canaan and Decanting were provided during the settlement redevelopment process. This exemplifies the numerous opportunities that a redevelopment upgrading approach offers with regard to improved environmental performance compared to infrastructure based upgrading. However, the observed open space degradation in Jomvu Mikanjuni and Jomvu Kuu and reported cases of

open space misuse in Canaan (Figure 4.12) point to challenges beyond open space provision in these upgraded settlements.

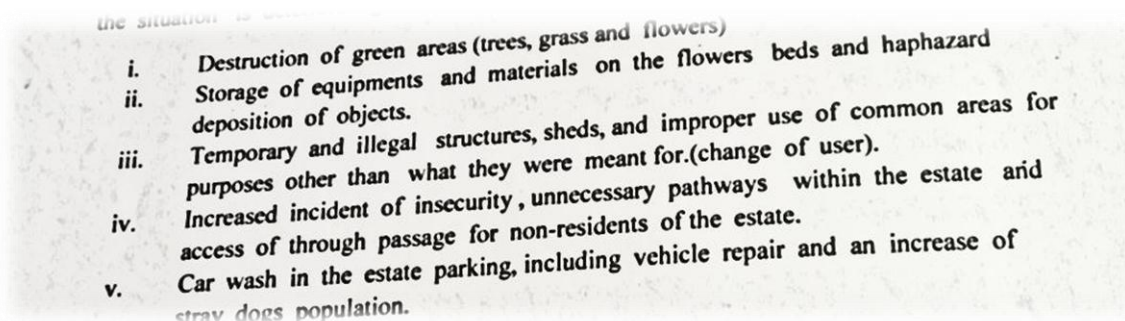


Figure 4.12: Section of a compliant letter from Canaan SEC to the estate management

Whether implementing a redevelopment plan that allows for provision of open space or upgrading a settlement with an existing one like Jomvu Kuu and Mikanjuni, management of these spaces should be given critical consideration. Open spaces are indicative of social health in urban areas as they facilitate physical activity, social cohesion and improve functioning (Lestanet *et al.*, 2014; Huang *et al.*, 2017). Their availability and access within a sociospatial area contributes to the societal wellbeing (Huang *et al.*, 2017).

Table 4-7: Environmental Quality of upgraded settlements

Environmental Quality	Canaan	KCC	Ziwa la Ng'ombe	Mkomani	Jomvu Mikanjuni	Jomvu Mkuu	Nyalenda B	Nyalenda A	Obunga	manyatta	Decanting	Total
<b>Perceived Environmental Quality (Households %)</b>												
Very Desirable	19.3	10.9	8.9	11.1	0.0	26.7	6.4	0.0	0.0	0.0	7.7	8.3
Desirable	60.2	27.3	36.6	44.4	41.2	70.0	31.9	26.3	43.8	35.5	30.8	39.9
Fair	20.5	43.6	26.7	44.4	32.4	3.3	36.2	28.1	32.5	51.6	38.5	31.2
Undesirable	0.0	12.7	15.8	0.0	11.8	0.0	25.5	36.8	22.5	9.7	23.1	15.8
Very undesirable	0.0	5.5	11.9	0.0	14.7	0.0	0.0	8.8	1.3	3.2	0.0	4.5
<b>Households treated for waterborne disease in the last one year (%)</b>												
Yes	61.4	60.0	82.2	55.6	88.2	100.0	95.7	93.0	90.0	100.0	84.6	81.8
<b>Open Space Availability</b>												
Availability	●	X	X	X	○	○	X	X	X	X	●	

#### 4.2.4 Community Organization in Upgraded Settlements in Kenyan Cities

Existence of environmental management plans, participation in upgrading activities, membership in community based organizations and active organizational partnerships in the community are used to establish the organizational landscape in each settlement. Findings indicate that community based environmental management plans are not common management tools in ISUPs as only one out of the eleven settlements has developed an environmental management plan. The Ziwa la Ngombe settlement management plan was developed by the SEC in consultation with residents during the final stages of the upgrading plan. This plan was developed primarily to promote sustainable management of the upgraded infrastructure including sewer lines, storm water drains, ablution blocks and street lighting. However, the plan is yet to be implemented since residents perceive SEC's mandate to be limited to the construction period.

With regard to participation, 45.7% of the residents have been involved in informal settlement upgrading activities. Decanting has the highest number of residents that have been involved in the upgrading process while Manyatta has the lowest with 80% and 12.9% participation level, respectively. Out of those that have participated in the process, 47.7% are in Nairobi, 28.2% in Mombasa and 24.1% in Kisumu. The difference in performance between the three cities is insignificant based on ANOVA,  $F(2, 8) = 3.263$ ,  $p = 0.09$ . This implies a minimal influence of city level factors on resident participation in upgrading. The variation in performance between the eleven

settlements could be attributed to multiplicity of upgrading activities in a settlement and level of community organization. In Decanting and Canaan where multiple upgrading activities have been undertaken, more residents are involved compared to Manyatta and Obunga where fewer activities have been implemented (Table 3-2). However, in Mkomani minimal upgrading has been done compared to KCC; yet more residents (61.1%) participated in upgrading compared to KCC (45.5%). This implies that there are other factors that override the multiplicity of upgrading activities. Such factors could be related to the socio economic characteristics of households.

Spearman's correlation analysis shows that there exists a significant relationship between residents' participation in informal settlement upgrading activities and family size, age of household head, income level, housing tenure and number of years lived in a settlement (Table 4-8). Education level is not correlated with participation level. The correlation coefficient reveals a weak influence of value increase on number of residents who participate in upgrading for family size, years lived in the settlement, age of household head, housing tenure and income. This implies that household characteristics have minimal effect on level of resident participation in informal settlement upgrading activities. This could point to factors inherent to a project which impact the nature and level of community involvement. Frequencies show that 61.4% of those who have been involved in upgrading activities participated through the KISIP while 38.6% participated through KENSUP. Since the two projects are broadly implemented through the same institutional framework, there could be specific elements that render one more participatory than the other. It could also be attributed

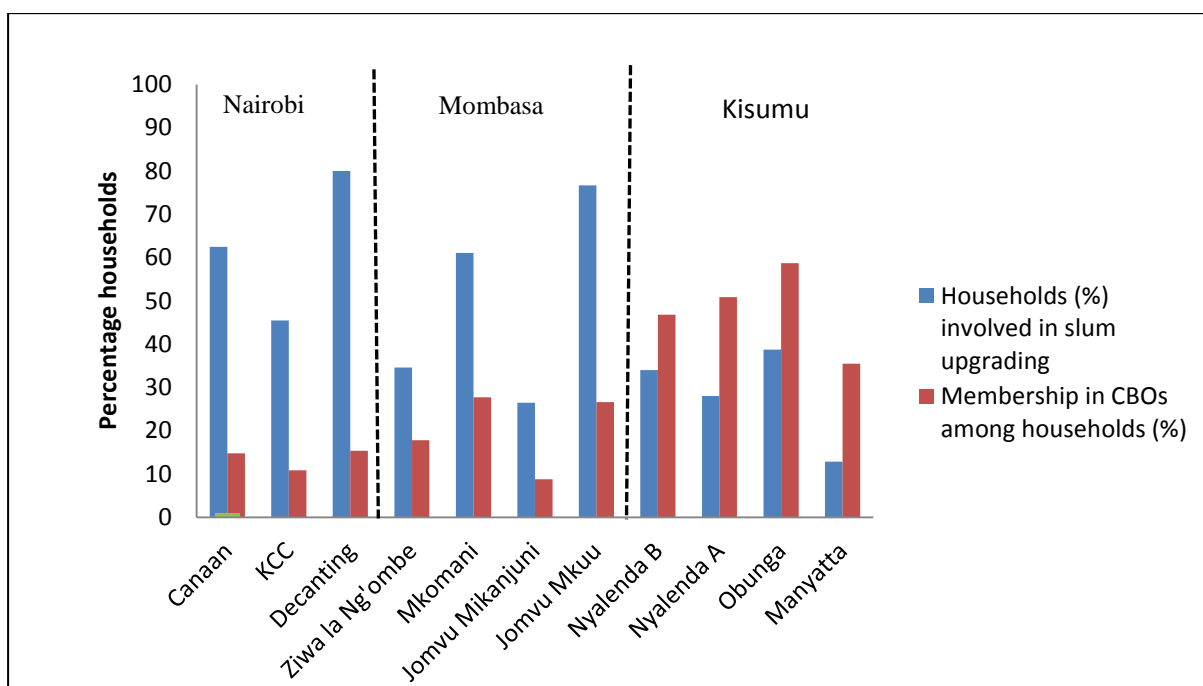
to the change in governance system since KISIP projects have been implemented within the devolved governance system.

**Table 4-8: Spearman’s correlation between household characteristics and resident participation in upgrading activities in Kenyan Cities**

<b>Household characteristic</b>	<b>Correlation Coefficient (<i>r</i>)</b>	<b>Significance level (<i>p</i>-Value)</b>
Family Size	-0.208	0.000*
Age of household head	-0.184	0.000*
Education level	0.001	0.976
Income Level	-0.071	0.000*
Years lived in the settlement	-0.183	0.000*
Housing tenure	0.210	0.000*
<i>N</i>	600	

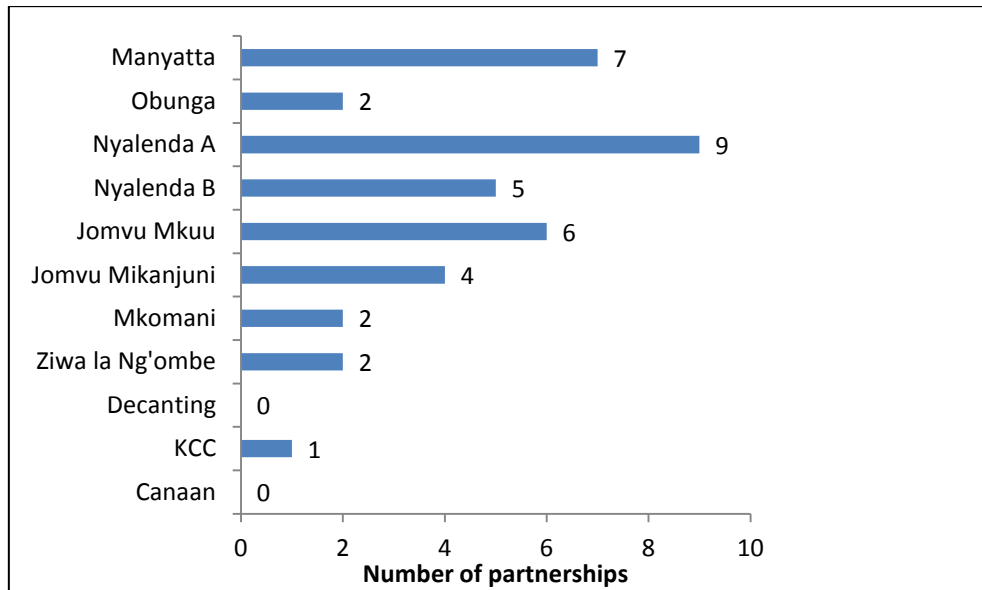
\*Household characteristic are correlated

Membership in community based organizations in the eleven settlements is 28.4%. Nyalenda B has the highest number of households who are members of CBOs (58.8%) while Jomvu Mikanjuni has the lowest (8.8%) (Figure 4.13). 63% of the residents who are members of a CBO are in settlements within Kisumu, 20% in Mombasa and 17% are in Nairobi. Such significant differences could imply that city level factors may have a substantial influence on residents’ participation in CBOs. The findings reveal that membership in community based organizations is not correlated with household characteristics including: education, age of household head, income and tenure arrangement but it has a significant negative correlation with the period one has lived in the settlement  $r = (604) = -0.15, p < 0.05$ . This evidence suggests that participation in CBOs is less of a household characteristic function. It is largely influenced by settlement and city level factors.



**Figure 4.13: Community organization in upgraded settlements in Kenyan cities**

Partnership between local community and business entities is an emerging neighbourhood upgrading avenue. The eleven upgraded settlements apart from two have active partnerships between community and business entities such as microfinance, communication firms and industrial firms. Respondents in Nyalenda A mentioned the highest number of active partnerships (9) while none was mentioned by respondents in Canaan and Decanting (Figure 4.14). These partnerships are aimed at increasing access to business and personal credit facilities, facilitating purchase of household assets such as LPG gas cylinder and solar home systems, improving environmental quality through tree planting and conducting regular clean ups. Partners include: Kenya Women Microfinance Bank, Faulu Kenya, Barclays Bank, Kenya Commercial Bank, Safaricom, Ecluf, Kenya Revenue Authority and IGAS. The partnerships are more prevalent in Kisumu compared to Mombasa and Nairobi cities. This could be attributed to the active participation of residents in CBOs which provides a potent space for collaboration with business entities (Figure 4.13).



**Figure 4.14: Number of active local based partnerships in upgraded settlements in Kenyan Cities**

#### **4.2.5 Environmental Sustainability Performance of upgraded settlements in Kenyan cities**

The overall sustainability value is calculated based on the scores of 16 indicators within four categories: resource consumption, waste management, environmental quality and community organization.

##### **Resource consumption**

Among the eleven settlements, Decanting has the best performance in the resource consumption category with a score of 42 points out of the total possible score of 55 points (Table 4-9). Other than the frequency in use of non motorized transport, all the indicator scores in this settlement are within the 75<sup>th</sup> percentile. Nyalenda A and Obunga have the lowest score of 20 points with all the indicators' scores falling below the 75<sup>th</sup> percentile. Settlements in Nairobi perform better in this category compared to those in Kisumu and Mombasa. They however score poorly in the use of non motorized transport apart from Kayole KCC which has the highest score in this indicator (Table 4-9).

**Table 4-9: Performance of upgraded settlements in resource consumption category**

Indicators	Water(pc/l/d)		Water		Energy		Energy		Non Motorized		Total	Categor
	Consumption	Rank	Efficiency	Rank	Consumption	Rank	Efficiency	Rank	transport	score		
Settlements	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank		Rank
<b>Nairobi</b>												
Canaan	34.2	5	90.9%	2	100%	1	79.5%	2	45.5%	8	42	2
Decanting	37.1	3	95.4%	1	98.5%	3	90.8%	1	44.6%	9	43	1
Kayole	34.3	4	72.7%	10	87.3%	6	70.9%	4	83.6%	1	35	3
KCC												
<b>Mombasa</b>												
Ziwa	32.9	6	81.2%	7	81.2%	10	57.4%	6	44.6%	9	22	9
Mkomani	39.3	1	61.1%	11	83.3%	8	66.7%	5	66.7%	3	25	8
Mikanjuni	32.4	7	88.2%	3	67.6%	11	50.0%	8	58.8%	7	35	3
Jomvu	31.7	9	83.3%	5	100%	1	76.7%	3	36.7%	11	31	7
<b>Kisumu</b>												
Nyalenda A	25.2	10	80.7%	8	89.5%	5	26.3%	11	63.2%	6	20	10
Nyalenda B	32.4	7	85.1%	4	93.6%	4	42.6%	9	66.0%	4	32	6
Obunga	24.1	11	81.3%	6	83.8%	8	37.5%	10	65.0%	5	20	10
Manyatta	37.1	2	77.4%	9	87.1%	7	54.8%	7	74.2%	2	33	5

**Hypothesis testing for performance variation in resource consumption category**

The ANOVA results indicate a significant variation of scores in resource consumption category between the three cities ( $F(2,8)=4.876$ ),  $p=0.04 <0.05$ ). The F test is

significant with a p value of 0.04 which is lower than 0.05, an indication of significantly varied means scores (Table 4-10). The null hypothesis is therefore rejected. It is evident that city level factors have a significant influence on household consumption patterns. Similar conclusions have been drawn in comparative studies on consumption behaviour in multiple neighbourhoods across different cities by Holden & Norland (2005); Mansvelt (2008) and Wang (2017).

**Table 4-10: Summary of ANOVA results for mean score difference in upgraded settlements in Kenyan cities on resource consumption**

<i>Source of Variation</i>	<i>SS</i>	<i>Df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	362.681818	2	181.3409	4.876394	0.041238	4.45897
Within Groups	297.5	8	37.1875			
Total	660.181818	10				

Significance level at 0.05

## Waste Management

The maximum total score in this category is 44 points. Kayole KCC has the highest score of 35 points while Manyatta has the lowest score of 8 points. There are four settlements, Manyatta, Obunga, Jomvu Kuu and Jomvu Mikanjuni that have a score below the 50<sup>th</sup> percentile (Table 4-11).

**Table 4-11: Performance of upgraded settlements in waste management category**

Indicators	Households recycling waste		No of recycling facilities		Households accessing waste collection services		Households sharing toilet facility		Total score	Category Rank
	Value	Rank	Value	Rank	Value	Rank	Value	Rank		
<b>Nairobi</b>										
Canaan	1%	10	0	4	100.0%	1	0.0%	1	24	5
Decanting	8%	2	0	4	95.4%	3	41.5%	2	29	3
Kayole KCC	7%	3	2	1	98.2%	2	81.8%	6	35	1
<b>Mombasa</b>										
Ziwa	5%	6	0	4	43.6%	5	75.8%	5	20	7

Mkomani	6%	4	0	4	94.4%	4	70.0%	4	33	2
Mikanjuni	3%	8	0	4	26.5%	8	68.8%	3	17	8
Jomvu	3%	8	0	4	10.0%	11	88.9%	7	10	10
<b>Kisumu</b>										
Nyalenda A	9%	1	1	2	26.3%	9	100.0%	11	25	4
Nyalenda B	6%	4	1	2	25.5%	10	93.0%	9	23	6
Obunga	4%	7	0	4	32.5%	6	91.0%	8	15	9
Manyatta	0%	11	0	4	32.3%	7	93.5%	10	8	11

'0' Value is ranked but scored 0 in total category score

### Hypothesis testing for performance variation in waste management category

The study sought to establish whether there exists waste management performance variations in upgraded informal settlements in Nairobi, Mombasa and Kisumu. ANOVA results show that there is no significant variation in settlement scores between the three cities ( $F(2,8)=1.91$ ,  $p=0.21$ ) since the p value is greater than 0.05 (Table 4-12). The null hypothesis is therefore accepted.

**Table 4-12: ANOVA test results for significant difference in upgraded settlements in Kenyan cities on waste management**

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	248.7652	2	124.3826	1.908379	0.210071	4.45897
Within Groups	521.4167	8	65.17708			
Total	770.1818	10				

### Environmental Quality

Canaan has the highest total score of 30 points out of the maximum possible score of 33 points in this category. It ranks high in all the three indicators including perceived environmental quality, disease incidence and open space availability and access (Table 4-13). Manyatta and Nyalenda A have the lowest total score of 5 points.

**Table 4-13: Performance of upgraded settlements in environmental quality category**

Indicators Settlements	Perceived environmental quality		Disease incidence		Open spaces availability and access		Total Score	
	Value	Rank	Value	Rank	Value	Rank	Score	Rank
<b>Nairobi</b>								
Canaan	79.60%	2	38.60%	3	2	1	30	1
Decanting	38.50%	7	15.40%	5	2	1	23	2
KCC	38.20%	10	40.00%	2	0	5	12	7
<b>Mombasa</b>								
Ziwa	45.50%	4	17.80%	4	0	5	16	6
Mkomani	55.60%	3	44.40%	1	0	5	20	4
Mikanjuni	41.20%	6	11.80%	6	1	3	21	3
Jomvu	96.70%	1	0.00%	10	1	3	20	4
<b>Kisumu</b>								
Nyalenda A	26.30%	11	7.00%	8	0	5	5	10
Nyalenda B	38.30%	9	4.30%	9	0	5	6	9
Obunga	43.80%	5	10.00%	7	0	5	12	7
Manyatta	38.50%	7	0.00%	10	0	5	5	10

\*0\* Value is ranked but scored 0 in total category score

The settlements in Kisumu have a total score below the 50<sup>th</sup> percentile. Settlements in Nairobi, apart from Kayole KCC, perform better than all the other settlements in Mombasa and Kisumu. All the settlements in Kisumu, apart from Obunga, have scores below the 25<sup>th</sup> percentile. The performance of settlements in this category is comparable to their performance in resource consumption category. Though the Driver Pressure State Impact Response (DPSIR) sustainability framework implies that

this category is a function of all the other categories, environmental quality scores do not show any significant relationship with any other categories apart from resource consumption.

### **Hypothesis testing for performance variation in environmental quality between cities**

The ANOVA test result on whether there is a significant difference in total settlement scores between the three cities is ( $F(2,8)=8.61, p=0.01$ ). Since the p value 0.01 is less than 0.05, the null hypothesis is rejected with a conclusion that there exists significant variations in settlement scores between Nairobi, Kisumu and Mombasa on environmental quality. This provides an indication that the city environment has a significant impact on the environmental quality of a settlement. Similar observation was made in the resource consumption category.

**Table 4-14: ANOVA test result for significant difference in upgraded settlements in Kenyan cities on environmental quality**

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	459.3106061	2	229.6553	8.6087	0.010129	4.458970108
Within Groups	213.4166667	8	26.67708			
Total	672.7272727	10				

### **Community Organization**

Ziwa la Ngomb'e has the highest score of 27 points out of the total possible score of 44 points. However, all the indicator scores in this settlement apart from management plans are below the 50<sup>th</sup> percentile (Table 4-15). Jomvu Mikanjuni ranks the lowest with a score of 10 points. All the settlements apart from Ziwa la Ng'ombe have a zero

score against the environmental management plan indicator. Notably, this is the only category that all the settlements in Nairobi have total scores below the 50<sup>th</sup> percentile.

**Table 4-15: Performance scores of upgraded settlements in community organization category**

Indicators	Environmental management plans (No)		Participation in upgrading activities (% households)		Membership in community based groups (% households)		Active partnerships with private sector (Nos)		Category Total score	Category Rank
	Value	Rank	Value	Rank	Value	Rank	Value	Rank		
<b>Nairobi</b>										
Canaan	0	2	62.50%	3	14.8	9	0	10	12	9
Decanting	0	2	80.00%	1	15.4	8	0	10	15	8
KCC	0	2	45.45%	5	10.9	10	1	9	12	9
<b>Mombasa</b>										
Ziwa	1	1	34.7%	7	17.8	7	2	6	27	1
Mkomani	0	2	61.1%	4	27.8	5	2	6	21	5
Mikanjuni	0	2	26.47%	10	8.8	11	4	5	10	11
Jomvu	0	2	76.67%	2	26.7	6	6	3	25	2
<b>Kisumu</b>										
Nyalenda A	0	2	28.07%	9	50.9	2	9	1	24	3
Nyalenda B	0	2	34.04%	8	46.8	3	5	4	21	5
Obunga	0	2	38.75%	6	58.8	1	6		23	4
Manyatta	0	2	12.90%	11	35.5	4	7	2	19	7

### **Hypothesis testing for performance variation in community organization**

The ANOVA test on significance of difference in total settlement scores between Nairobi, Kisumu and Mombasa shows a *p* value that is greater than 0.05 (Table 4-16). This means that there is no significant difference in these scores hence the null

hypothesis is accepted. The impact of city level factors on overall performance in community organization is minimal.

**Table 4-16: ANOVA test results for difference in means of settlement scores in Nairobi, Kisumu and Mombasa**

Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	150.5	2	75.25	3.1111111	0.1001129	4.45897
Within Groups	193.5	8	24.1875			
Total	344	10				

Significance level at 0.05

### **Overall Sustainability Performance of Upgraded Informal Settlements in**

#### **Kenyan Cities**

Based on the overall sustainability performance scores, Decanting has the highest total score of 110 points while Manyatta has the lowest total score of 65 points (Table 4-19). The maximum possible score in a settlement is 176 points. The three settlements in Nairobi ranked first (Canaan), second (Decanting) and fourth (Kayole KCC) with 61.4%, 62.5% and 53.4% of the total score respectively. In Mombasa, the total score percentage ranges from 56.3% in Ziwa la Ngombe, 48.9% in Jomvu Kuu, 48.3% in Ziwa la Ngombe to 47.2% in Jomvu Mikanjuni. The percentage of total scores in Kisumu is 46.6% in Nyalenda B, 42% in Nyalenda A, 39.8% in Obunga and 37% in Manyatta. Overall, settlements in Nairobi have the highest mean score while Kisumu has the lowest. The study hypothesized that there is no significant difference between mean scores of settlements in Nairobi, Mombasa and Kisumu.

H0: There is no significant difference in environmental sustainability performance between upgraded settlements in Nairobi, Mombasa and Kisumu

The mean scores of the three cities exhibit significant differences based on the ANOVA test results ( $F=(2,10)=18.37$   $p=0.001$ ) since the  $p$  value is less than the 0.05

significance level (Table 4-17). This implies that among the three cities, at least one of the mean scores is significantly different.

**Table 4-17: Analysis of Variance for environmental sustainability performance scores in Nairobi, Mombasa and Kisumu**

<i>Source of Variation</i>	<i>SS</i>	<i>Df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	2071.182	2	1035.591	18.36968	0.001022	4.45897
Total	2522.182	10				

A two tailed t-test is used to establish which mean scores are different among the three cities. The results revealed that the significant difference in mean scores is between Nairobi (M=104, SD=9.54) and Kisumu (M=70, SD=6.16);  $t(3)=5.39$ ,  $p<0.05$  and between Kisumu (M=70, SD=6.16) and Mombasa (M=90.5,SD=7.19;  $t(6)=4.32$ ,  $p<0.05$ . The study therefore rejects the null hypothesis. This implies that there are certain attributes in Kisumu city that substantially influence environmental sustainability performance in upgraded settlements but do not have significant impact on settlements in Nairobi and Mombasa or such attributes are inexistent in these two cities.

All the categories apart from community organization have a positive correlation with the overall sustainability scores as indicated by the R value in linear regression analysis (Table 4-18). Community organization scores have a negative association with the overall scores. This does not necessarily imply that high performance in community organization affects overall settlement sustainability negatively, but it indicates that community organization does not have a significant positive association on resource consumption, waste management and environmental quality (Appendix).

**Table 4-18: Summary of linear regression between category scores and the overall environmental sustainability scores**

<i>Sustainability categories</i>	<i>R(multiple coefficient)</i>	<i>Intercept</i>	<i>Coefficient x</i>	<i>P-value</i>
Resource Consumption	0.626	52.2	1.3	0.03
Waste Management	0.656	63.1	1.1	0.02
Environmental Quality	0.793	65	1.4	0.003
Community Organization	-0.457	108.62	-1.14	0.15

. \*Environmental sustainability score =Intercept +Coefficient X at p significance level

The analysis shows that 62.6% of the variation in overall environmental sustainability scores in the upgraded settlements can be attributed to resource consumption scores; 65.6% variation is attributed to waste management scores, 79.3% to environmental quality and 45.7% to community organization. The latter is however not significant.

Based on these results, environmental quality scores have the highest predictive ratio of 79.3% for environmental sustainability scores in a settlement. This does not imply that environmental quality indicators are the most critical sustainability measures but they can serve as a rapid and effective way of rating the environmental sustainability of multiple settlements. The indicators in this category are perceived environmental quality, level of disease incidences and available and accessible open spaces.

**Table 4-19: Category and overall environmental sustainability in eleven upgraded settlements in Kenyan cities**

Settlement	Resource Consumption		Waste Management		Environmental Quality		Community Organization		Overall performance**	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
<b>Nairobi</b>									104*	
Canaan	42	2	24	5	30	1	12	9	108	2
Decanting	43	1	29	3	23	2	15	8	110	1
KCC	35	3	35	1	12	7	12	9	94	4
<b>Mombasa</b>									88.25*	
Ziwa	22	9	20	7	16	5	27	1	85	6

Mkomani	25	8	33	2	20	4	21	5	99	3
Mikanjuni	35	3	17	8	21	2	10	11	83	7
Jomvu	31	7	10	10	20	6	25	2	86	5
<b>Kisumu</b>									72.75*	
Nyalenda A	20	10	25	4	5	11	24	3	74	9
Nyalenda B	32	6	23	6	6	10	21	5	82	8
Obunga	20	10	15	9	12	7	23	4	70	10
Manyatta	33	5	8	11	5	9	19	7	65	11

\*Average scores per city

\*\*Maximum possible score is 176

The overall environmental sustainability score reveal distinct environmental sustainability performance between settlements within the redevelopment mode of upgrading and those upgraded through infrastructure provision. The former, Decanting and Canaan, have an overall higher performance compared to those upgraded through infrastructure provision (Table 4-19). They perform well in resource consumption, environmental quality and waste management categories but score low in community organization category. The characteristic low performance in community organization could imply that the redevelopment process either destroys community institutional arrangements such as neighbourhood associations or it does not foster their establishment. It is however notable that despite Canaan and Decanting scoring 27.2% and 34.1% in community organization category, the two settlements rank first and third in community participation in upgrading projects respectively (Table 4-15). This implies that the community participation indicator has a greater impact on environmental sustainability than the other community organization indicators. There is a very strong correlation between community participation in upgrading and overall settlement scores ( $r(604) = 0.706, p < 0.05$ ). Similarly, Kusakabe (2013) tested positive a hypothesis that where community planning for sustainability involves more citizen participation, the progress towards

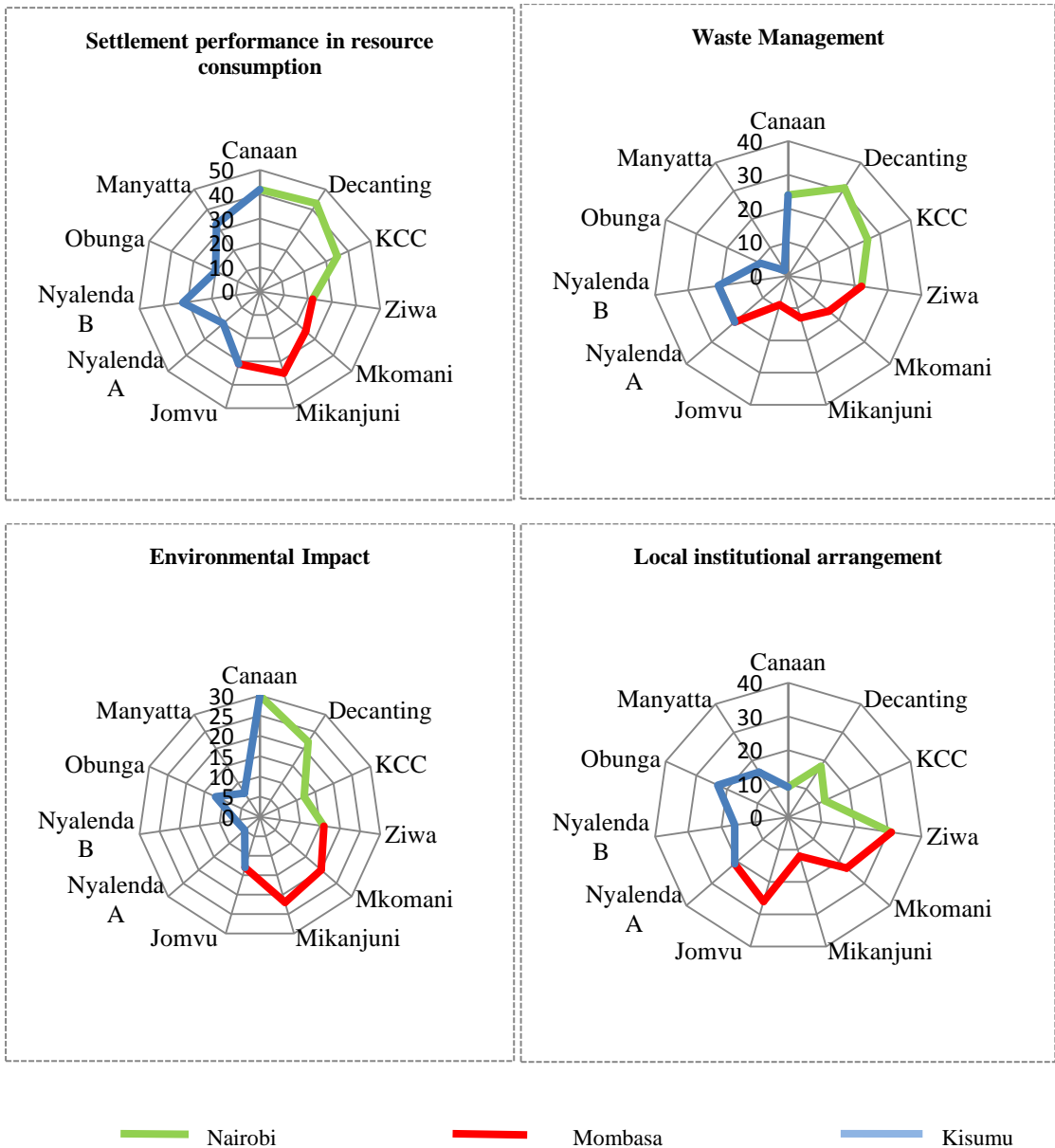
environmental sustainability is greater. Sustained community participation is however threatened by low performance in local environmental management plans, community based organization and active partnerships

### Reliability Test

Questions related to one’s knowledge on environmental sustainability were used to determine the reliability of data collected. Respondents were asked to rate their level of environmental awareness, environmental consideration in daily activities and the extent to which the environmental quality affects one’s quality of life. Cronbach’s alpha for the three items was 0.7 (Table 4-20). This implies that this data was reliable since  $\alpha \leq 0.7$ .

**Table 4-20: Reliability test**

	Mean	Std. Deviation	N	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of items
Q10	2.6304	1.06732	606	0.689	0.697	3
Q11	2.1535	1.00801	606			
Q12	2.4538	1.16719	606			



**Figure 4.15: Category and overall environmental performance of upgraded settlements in Kenyan cities**

## **4.3 Environmental Integration Pathways in Informal Settlement Upgrading**

### **Programs**

The analysis of eight environmental sustainability pathways identified in Chapter 2 is presented in this section. These are environmental infrastructure, clean technology, alternative processes, green enterprises, local institutions and housing tenure. This section analyses the configuration of these pathways and its implication on environmental sustainability domains including: resource consumption, waste management, environmental quality and community organization

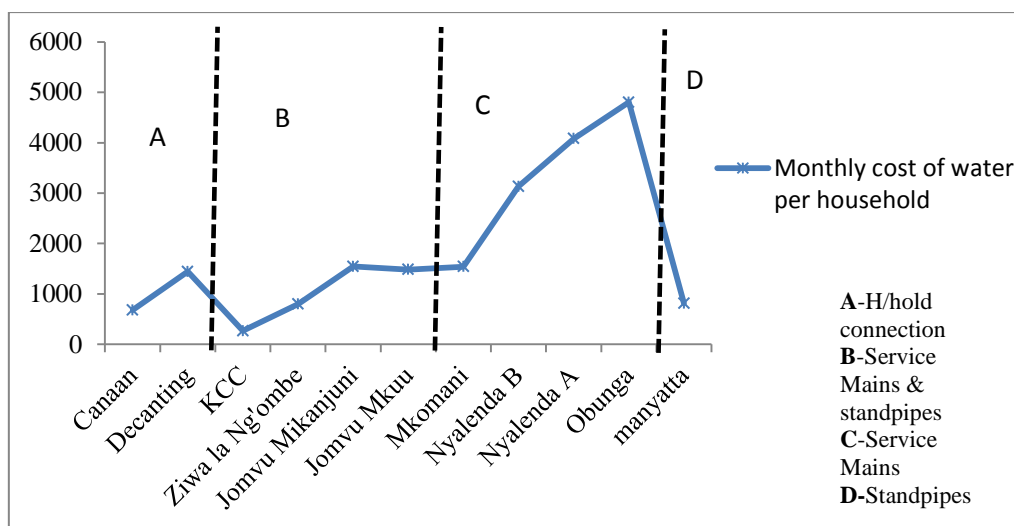
#### **4.3.1 Environmental Infrastructure**

Progress towards urban environmental sustainability is significantly hinged on the existence and adequacy of environmental infrastructure. Though infrastructure upgrading is the primary intervention in the eleven settlements, the expected environmental outcomes are varied. The nature and level of infrastructure provision emerges as a central theme in the analysis of environmental infrastructure.

##### **4.3.1.1 Water Supply**

The level of water supply infrastructure in the eleven upgraded settlements include connection of water to the dwelling unit, provision of service mains, community water kiosks, water storage tanks in communal facilities and borehole water supply (Table 4-21). Two out of the eleven settlements have water supply connection to dwelling units. A standard monthly billing system is applied in the two settlements by the estate management. Each household pays a monthly service charge of Ksh 1000 in Canaan and Ksh 500 in Decanting which includes the cost of water, waste collection and estate maintenance. This supply is however intermittent and hence residents have

to augment this source with water vendors. This explains the variation between monthly service charge and average monthly water costs in Canaan and Decanting (Table 4-21). Though the standard billing system acts as a disincentive for adoption of water conservation measures among households, the two settlements have high scores on the water conservation indicator as 90.9% and 95.4% of the households in Canaan and Decanting respectively have adopted water conservation measures. These conservation efforts however are driven by intermittent water supply rather than individual environmental value. This implies that improved water supply in the settlements will lower the incentive to conserve water.



**Figure 4.16: Monthly cost of water in settlements with different levels of water infrastructure upgrade**

Water supply mains have been provided in eight out of eleven settlements. The plot connection is 81% in settlements within Mombasa (Ziwa la Ngombe, Mkomani, Jomvu Kuu, Jomvu Mikanjuni), 93% in Nairobi (Kayole KCC) and 70% in Kisumu (Nyalenda A, Nyalenda B, Obunga). The intermittent supply in these settlements results in continued reliance on water vendors who charge an average of Ksh 2 per 20 litre jerrycan. In addition to this amount, households also have to pay the utility's

monthly standing charges. This implies that cost of water increases after the infrastructure upgrade. The monthly cost of water in settlements with this level of provision (A & B) is higher compared to those with other levels of provision (Figure 4.16). The cost is comparatively higher in settlements where provision of service mains was the only intervention (C) (Figure 4.16). As a result, the per capita water consumption in these settlements has remained below the minimum WHO recommended amount of 50 l/c/d (Table 4-1).

Community standpipes and water storage tanks are provided in four out of eleven settlements. The community stand pipes are managed by Community Based Organizations and are characterized by intermittent supply and unregulated water prices. The later increases the vulnerability of residents to high water charges. The prices vary between Ksh 2 and Ksh 20 per 20 litre jerrycan. The water storage tanks, which are provided at the water kiosks, provide an opportunity to significantly minimize water shortage. Their capacity is, however, low considering the high population in the four settlements. Each water kiosk with one 10000 litre tank serves approximately 2,000 households. In case of a water shortage, the tank can only serve residents for a day assuming the current 119.73 litres daily household mean. In addition, since none of the kiosks has a roof catchment, the potential to augment rainwater with municipal water supply is not utilized.

**Table 4-21: Water supply infrastructure provision in Upgraded Settlements in Kenyan Cities**

<b>Settlement</b>	<b>Provision level</b>	<b>Coverage</b>	<b>Management</b>	<b>Monthly cost of water (Ksh)</b>
Canaan	Distribution pipeline connected to dwelling unit	100% connection to dwelling units	Nairobi Water & Sewerage Company	679.45
	Borehole	100% connection to dwelling units	Canaan Estate Management	
Decanting	Connection to dwelling unit	100% connection to dwelling units	Nairobi Water & Sewerage Company	1444.10
Kayole KCC	Water supply mains	93% plot connections	Nairobi Water & Sewerage Company	268.57
Jomvu Mikanjuni	Water supply mains	81% plot connections	Mombasa Water & Sewerage Company	1544.53
	Standpipes Water storage tanks	3 standpipes each with a 10000 litre tank	Community Based Organization	
Jomvu Kuu	Water supply mains	81% plot connections	Mombasa Water & Sewerage Company	1483.75
	Standpipes Water storage tanks	1 standpipe with a 10000 litre tank	Community Based Organization	
Mkomani	Water supply mains	81% plot connections	Mombasa Water & Sewerage Company	1542.06
Ziwa la Ngombe	Water supply mains	81% plot connections	Mombasa Water & Sewerage Company	797.50
	Standpipes Rainwater harvesting unit	3 standpipes each with a 10000 litre tank	Community Based Organization	
Nyalenda A	Water supply mains	70% plot connections	Kisumu Water & Sewerage Company	4081.92
Nyalenda B	Water supply mains	70% plot connections	Kisumu Water & Sewerage Company	3132.90
Obunga	Water supply mains	70% plot connections	Kisumu Water & Sewerage Company	4802.56
Manyatta	Standpipes Storage tank	1 standpipe with a 10000 litre tank	Community Based Organization	815.40

#### **4.3.1.2 Sanitation**

There are three levels of sanitation provision in the upgraded settlements, sewer connection to dwelling unit in two settlements, provision of sewer trunk and mains in four settlements and ablution blocks in five settlements. There is no sanitation intervention at Mkomani in Mombasa. In Canaan and Decanting where all the housing units are connected to the sewer system, regular maintenance is undertaken by the Nairobi Water & Sewerage Company. System breakdown and sewer overflow are promptly repaired. The estate management in the two settlements observed that sewer overflows particularly those caused by blocked drains are infrequent. They attributed this to extensive resident training on use of flush toilets during project implementation since they had been using pit latrines prior to the upgrading project. The minimal sewer overflow occurrences could be attributed to the high scores against the environmental quality sustainability category, with Canaan and Decanting ranked first and second respectively.

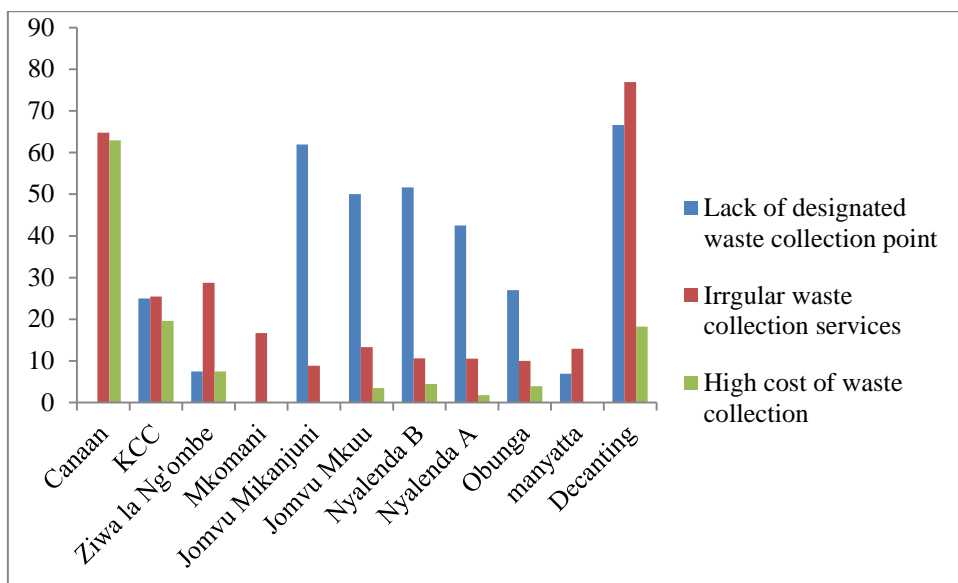
Sanitation upgrade through provision of sewer mains in KCC, Nyalenda A, Nyalenda B and Obunga is characterized by high plot connections and frequent sewer overflows. The average plot connection in the four settlements is 93% (KISIP, 2019). A project officer mentioned that the sewer overflows are as a result of system blockage which is attributed to low awareness on the use of flush toilets among residents. This has led to poor environmental quality and increased health risks, which is reflected in the low performance of the four settlements in the environmental quality category (Table 4-13).

The ablution blocks are managed by CBOs who determine the cost of using the facilities and operation hours based on water availability. Each ablution block has three flush toilets and one bathroom. When municipal water supply is available the cost of using the toilet and the bathroom is Ksh 5 and Ksh 10 respectively. In the event of intermittence resulting to use of the reserve water in the storage tanks, the prices increase to Ksh 10 and Ksh 20 for toilet and bathroom use respectively. The irregular price limits residents use of communal ablution blocks hence their potential to reduce the number of people sharing existing toilet facilities is not fully realized. Improved water supply in these settlements is therefore a key determinant of the efficacy of the ablution blocks. Additional toilet blocks are not likely to yield significant sustainability outcomes in upgraded settlements if the challenge of water intermittence is not addressed.

#### **4.3.1.3 Waste Management**

Interventions in solid waste management include provision of waste receptacles in Canaan and Decanting and recycling facility in KCC Kayole. There are three receptacles in Canaan each located strategically to serve four blocks of flats with a total of 144 households. In Decanting, the three receptacles are located at the main entrance which is about 500 meters from the furthest end of the estate. As a result, some opt to dispose off their waste in undesignated spaces between estate blocks. Therefore, locational convenience is a significant determinant of a settlement's performance in solid waste management. One receptacle is provided for all types of waste in both settlements and consequently, the households have low incentive to segregate their waste. This is contrary to the provisions of EMCA Cap 387 and Nairobi County Solid Waste Act of 2015 that require waste generators to separate

their waste into four categories; organic, plastics, paper and metal. Residents observed that though waste receptacles have been provided, collection by the city county is irregular and unsatisfactory. 76.9% of the residents in Decanting and 64.8% in Canaan mentioned irregular waste collection as the main challenge in solid waste management (Figure 4.17). In other settlements where receptacles are not provided, residents cited lack of a designated waste collection point as one of the main waste management challenges (Figure 4.17). Proper waste management therefore entails provision of waste collection facilities, convenient location of these facilities and a regular waste collection schedule.



**Figure 4.17: Waste management challenges in the upgraded settlements**

Waste recycling facilities are available in Kayole KCC and Nyalenda B. The facility in Kayole KCC comprises of a segregation area, biodigester to generate biogas and a community hall. The facility is managed by a CBO that provide waste collection services. The weekly collection fee is Ksh 20 per household. At the facility, the waste

goes through a process of segregation to allow for recovery of metals, plastics and electronics. The biodegradable waste is collected into the biodigester while any other waste is transported to the county disposal site. Despite these multiple benefits, the facility's operations are threatened by management hiccups. The current management model does not provide a resident benefit sharing mechanism. The residents feel that the benefits accruing from the facility are not equitably shared and have proposed a 50% reduction in waste collection fee as one of the benefits sharing strategies though this has not yet been effected. In Nyalenda B, waste plastics bought from the residents is sold as raw material to large industries. The facilities promote recycling among residents as evidenced by the high performance of KCC Kayole and Nyalenda B in the per cent of residents who recycle waste (Figure 4.15).

#### **4.3.1.4 Storm water management**

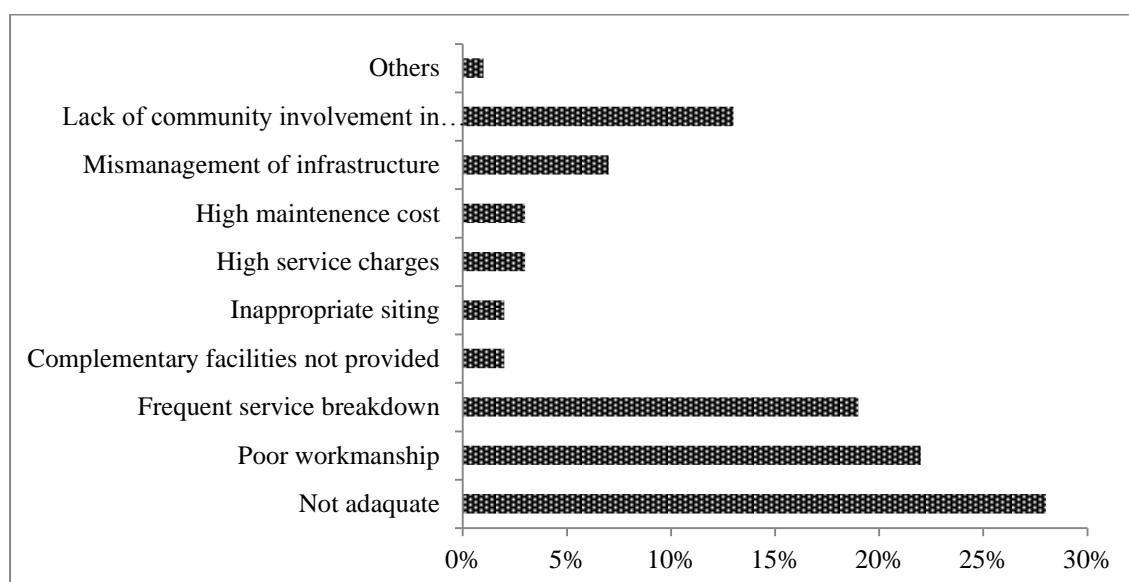
Storm water drains are provided along access roads in the eleven settlements. However, the size of most of the drains contravenes the provisions in the building code. Adaptive planning was used in designing the drains due to space limitation and consideration of funding conditions that require minimal displacement of residents. The drains are open apart from those in Kayole Soweto and Canaan. The open drains are clogged with waste resulting to flooding during the rainy season.

#### **4.3.1.5 Open spaces**

Open spaces are provided in the Canaan and Decanting settlements where the mode of upgrading is redevelopment. The open spaces are used for recreation and parking. At least 50% of the open space in Canaan and 75% in Decanting is vegetated. The open space is maintained by the estate management. However, inappropriate use and open dumping negatively affects the functionality of these spaces.

#### 4.3.1.6 Resident perception of infrastructure upgrading

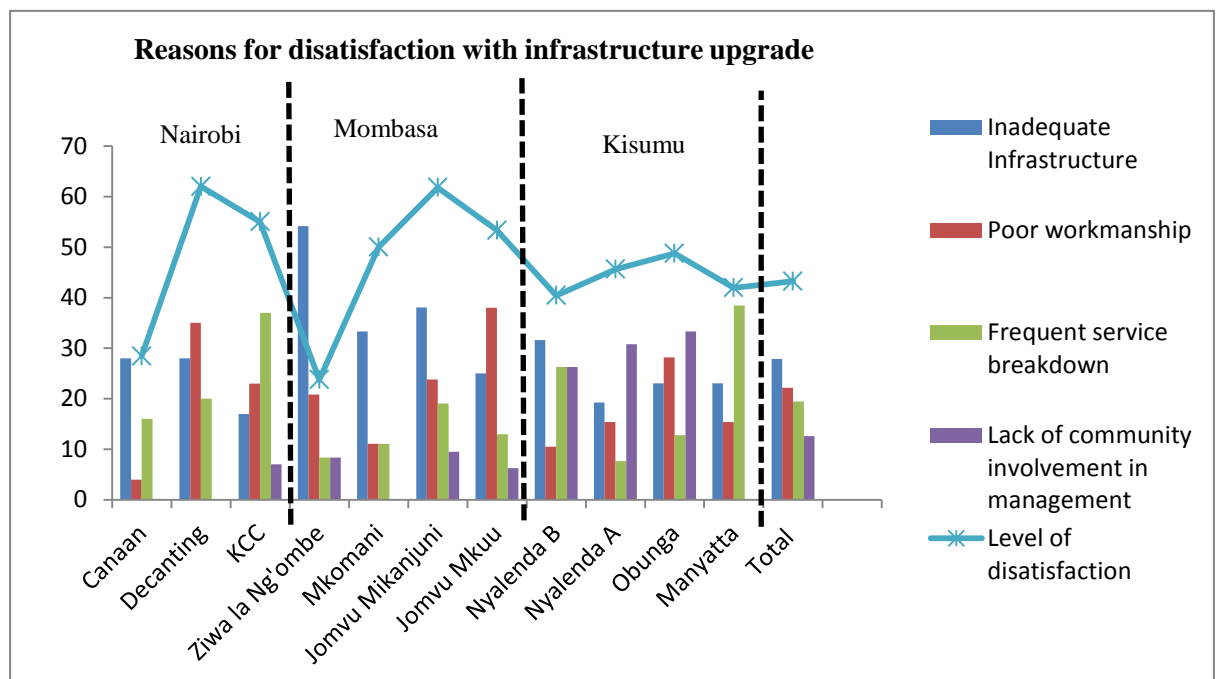
Most of the residents (56.8%) are satisfied with the infrastructure upgrade in their settlements. These are mostly in Ziwa la Ngombe (76.2%), Canaan (71.6%), Nyalenda B (59.6%) and Manyatta (58.1%). However, in Decanting and Jomvu Mikanjuni, more than 60% of the residents do not find the infrastructure upgrade satisfactory. Dissatisfaction with infrastructure upgrade is attributed to inadequate infrastructure provision (27.9%), poor workmanship (22.1%) and frequent service breakdown (19.5%) (Figure 4.18).



**Figure 4.18: Reasons for dissatisfaction with infrastructure upgrade in informal settlements**

Ziwa la Ngombe and Jomvu Mikanjuni have the highest number of residents that mentioned infrastructure inadequacy at 58% and 38% respectively. The inadequacies include low number of ablution blocks in populous settlements such as Ziwa la Ngombe and partial coverage of access roads and storm water drains. Poor workmanship is a major concern among residents in Jomvu Kuu (38%) and Decanting (35%). Frequent service breakdown evidenced through sewer overflow, clogged storm water drains and non-operational water kiosks, ablution blocks and street lights

is particularly a concern to residents in Manyatta (38%) and Kayole KCC (37%). This may explain why the two settlements score very low in environmental quality sustainability category (Table 4-13). Lack of community involvement in management of infrastructure is noted by residents in Nyalenda A (33%) and Obunga (31%) due to limited involvement in establishing the level of provision, location and management of infrastructure services.



**Figure 4.19: Reasons for dissatisfaction with infrastructure upgrade among residents in upgraded settlements in Kenyan cities**

The challenges mentioned by residents regarding infrastructure upgrading are largely engrained in the design process. First, the infrastructure design process does not allow for adequate community participation; with 54.3% of the residents having not participated in upgrading activities. Among those who have participated, 23.1% residents have attended an infrastructural design meeting. As a result, the residents'

aspirations are not sufficiently reflected in the infrastructure upgrading plans. Residents in Mkomani and Ziwa la Ngombe settlements attribute the inadequacy of existing storm water drains to lack of community consultation and inappropriate siting leading to increased flooding incidences in some areas within the settlement. Residents in Ziwa la Ngombe and Jomvu Kuu are not able to access the communal toilet facilities as they are located at the periphery of the settlement. In Decanting where waste collection facilities are placed at the periphery of the settlement, open dumping of waste is more pronounced around blocks that are further away from these facilities. It is notable that in most cases the inappropriate siting is due to space limitation in the settlement. Adebayo & Iweka (2014) similarly established siting as the major barrier to sustainable infrastructure upgrading in the informal settlements of Lagos.

Secondly, there is limited consideration of facilities that complement the upgraded infrastructure. Ablution blocks are closed frequently due to intermittent water supply as adequate water storage tanks are not provided. In Kayole KCC, though provision was made for a waste recycling facility, there are no waste receptacles in the settlement which impede waste recycling in the settlement. Lack of adequate waste disposal facilities impair proper functioning of other infrastructure such as footpaths and storm water drains since they are used by residents as alternative disposal areas. As a result, the drains are often clogged with waste posing a health hazard and also exacerbating flooding during the rainy season.

### 4.3.2 Clean Technologies

A total of 15% of the households in the eleven upgraded settlements have adopted one or more clean technologies. The highest number of households who have adopted clean technologies is in Canaan (37.5%) while the lowest is in Mkomani (5.6%) (Figure 4.20). The difference in clean technology adoption among households in the three cities is significant based on ANOVA results,  $F(2, 603) = 7.154$ ,  $p = 0.001$ . This points to city level factors that influence the level of adoption at the household level. Since settlements in Nairobi have the highest level of adoption, it could imply that populous cities provide an environment which allows for permeation of new technologies.

Clean technologies adopted by households in upgraded settlements are those that enhance energy consumption efficiency such as energy saving bulbs, energy saving cookstoves and briquettes and those that promote water use efficiency including water saving taps and showers. Decanting has the highest level of adoption in energy saving technologies for lighting (90.8%) while Nyalenda A has the lowest (26.3%). Canaan has the highest number of households using energy saving technologies in cooking (56.8%) while KCC has the lowest (9.1%). Both settlements are in Nairobi city. The highest use level of water saving devices is in Canaan (22.7%) while in Mkomani, Jomvu Mikanjuni, Nyalenda A and Manyatta none of the respondents have adopted these devices.

41.9% of those that use any clean technologies mentioned that they had not experienced any challenge in their use. Technical, environmental and financial

challenges were mentioned as the major challenges encountered in the use of clean technologies by 37.1%, 14.5% and 6.5% of the respondents respectively (Figure 4.21). This implies that lack of adoption could be due to awareness of challenges experienced by users and perceived difficulties in their use. Programs to promote the use of these technologies in informal settlements are mainly geared towards providing information and innovative financial solutions to the residents. This is mainly on solar home systems, cookstoves and energy saving bulbs.

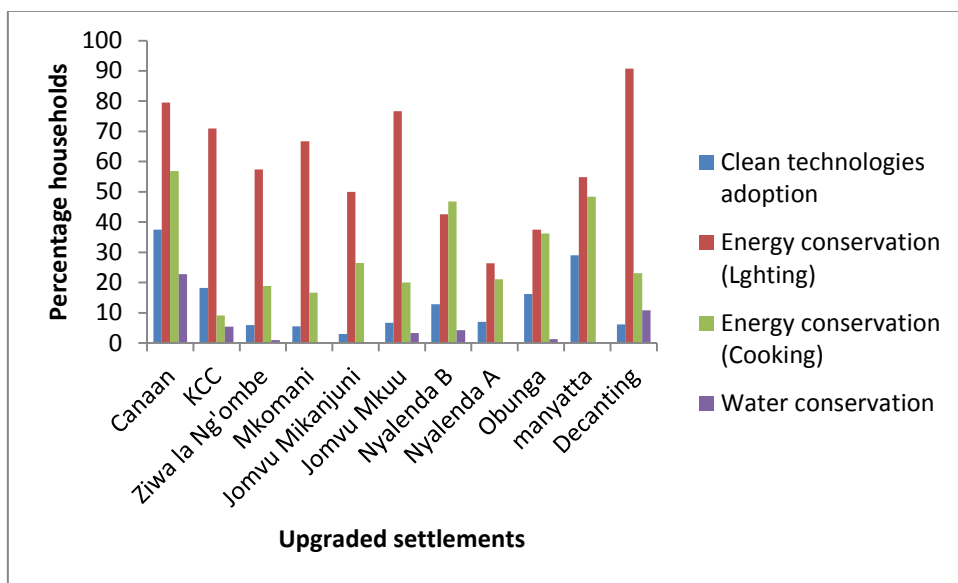
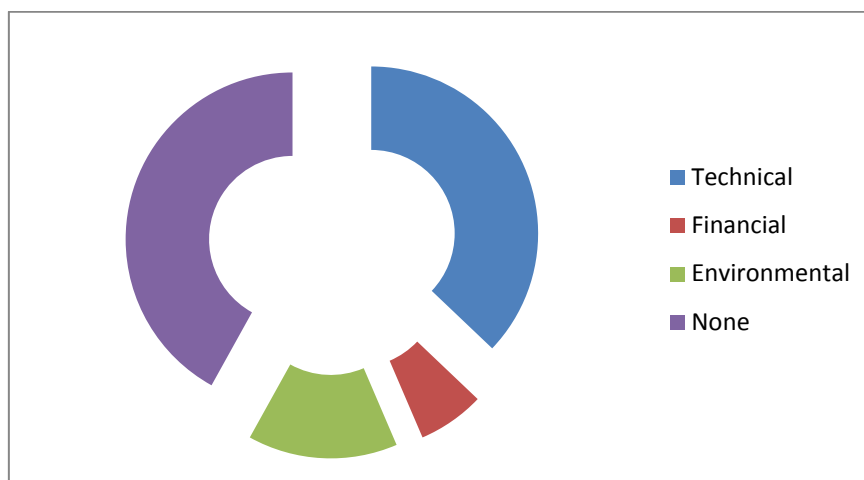


Figure 4.20: Adoption of clean technologies in upgraded settlements in Kenyan cities

At the settlement level, solar power system has been integrated in provision of outdoor lighting in one of the eleven upgraded settlements. Six solar panels are installed in each of the twelve blocks in Canaan. Though this intervention was only made in one settlement, it provides an indication of the potential of ISUPs to propagate the use of clean energy. In addition to providing a clean source of energy, solar power offers an affordable alternative to the national grid supply. This evidence

from the non-operational street lights in nine upgraded settlements where the utility has disconnected power due to unpaid electricity bills.



**Figure 4.21: Challenges related to use of clean technologies among households**

A biodigester has been integrated into a waste recycling facility as an innovative means of promoting sustainable waste management in Kayole KCC. The underground masonry biodigester allows for segregation and recycling of biodegradable waste collected from the settlement by CBOs. Biogas generated from the anaerobic decomposition process is used as a source of cooking energy in the community kitchen. The community kitchen is attached to a community social hall and the recycling facility. The biogas powered kitchen provides a competitive edge in marketing of this social hall as a venue for social events and meetings. It is expected that proceeds from the hire of social hall are used in the maintenance of the upgraded infrastructure and facilities. However, it is not clear how this is currently effected since there is no documented management model for income generating activities. The KCC Kayole SEC chairperson who is also the facility manager observed that the settlement upgrading project did not make provision for training on facility management. This poses a threat to the sustainable functioning of the biodigester.

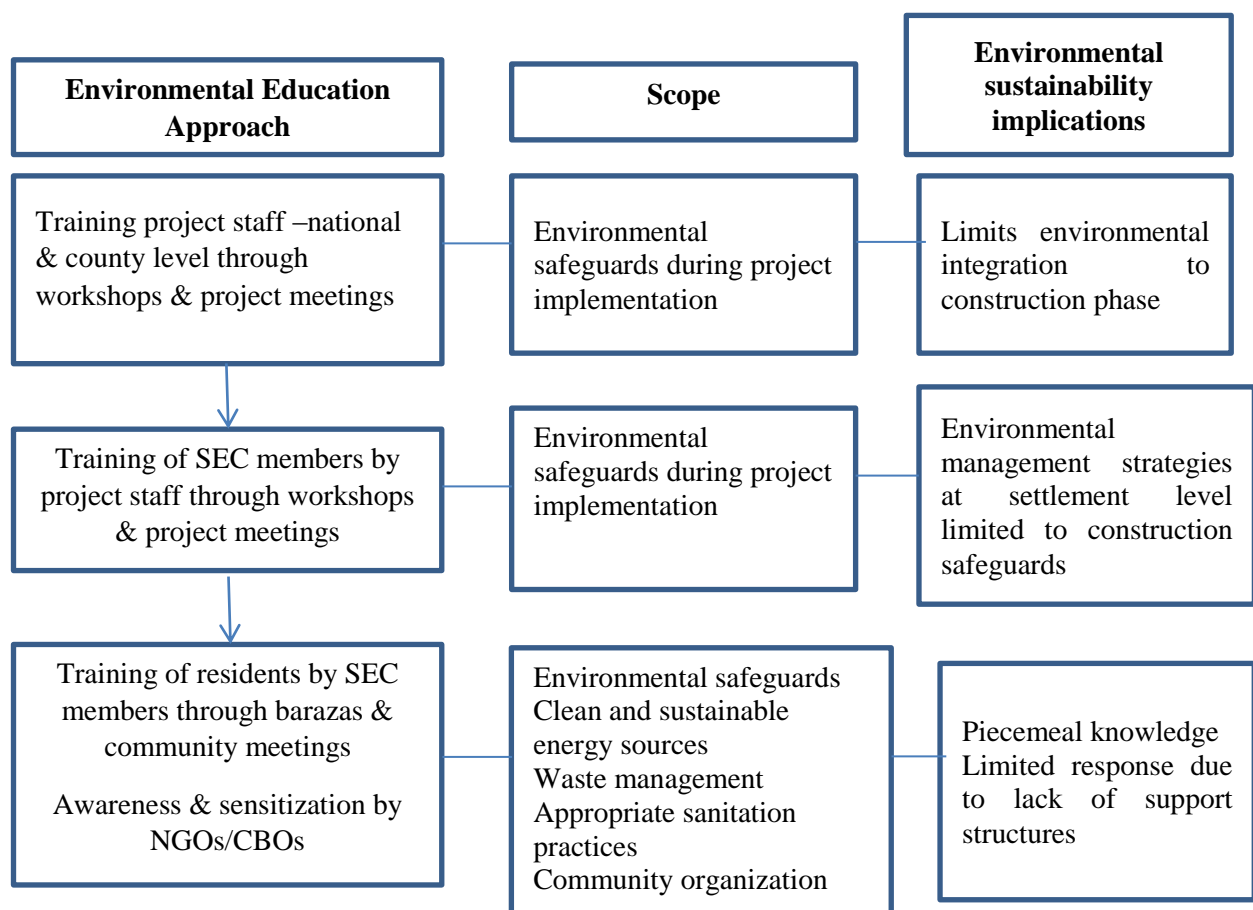
The adoption of clean technologies at the household and settlement level in upgraded settlements demonstrates a number of innovative ways to improve energy and water use efficiency and waste management. Clean technologies as a sustainability pathway is limited by financial, technical and environmental barriers at the household level and organizational management barriers at the settlement level.

### **4.3.3 Environmental Education Programs**

Environmental education as a sustainability pathway aims at creating attitudinal and behavioural changes that instigate environmentally sustainable actions (Nhamo & Inyang, 2011). At the institutional level, workshops and meetings are used to build staff capacity on management of environmental issues related to informal settlement upgrading. The training workshops target project officers at the national and county level ( Figure 4.22). The donor facilitated workshops are tailored towards safeguarding the ecosystem and human health during the project construction phase. Participants are also trained on environmental reporting techniques. Though safeguarding the environment during the construction phase is important, this approach limits the scope of environmental integration to one phase rather than the entire project life cycle. In addition, the training is conducted after the program design phase and hence the trainees are not able to use the acquired knowledge to make significant contribution in the project plans.

Members of SEC are trained by the project staff on environmental safeguards during project implementation phase. This is done in a two day workshop and subsequent project implementation meetings. The limitation of training scope to environmental

safeguards in one project phase influences the nature of environmental management strategies that are devised at the settlement level. An assessment of Ziwa la Ngombe environmental management plans reveals a strong focus on management of project construction impacts such as dust mitigation, resettlement grievances and construction safety management. Progressive environmental sustainability performance at the settlement level requires a holistic training approach beyond environmental safeguards.



**Figure 4.22: Multi levelled environmental education approaches in ISUPs**

At the household level, residents in upgraded settlements receive information and training on environmental management from the SEC, NGOs and CBOs working in these settlements. These multiple sources expose residents to a wider scope of

environmental information including environmental safeguards in project construction, clean energy sources, waste management, sanitation practices and community organization. Though the information delivery is piecemeal, it is likely to influence individual and collective household decisions. The response to this information could however be limited by lack of physical and social structures through which certain actions have to be carried out. Training on appropriate waste disposal for instance can only be effected by residents based on the availability of waste receptacles, collection services or recycling facilities. ISUPs present a case of higher infusion of environmental information towards the lower project management scale ( Figure 4.22). The sustainability performance of the eleven settlements demonstrates that environmental knowledge towards the lower project scale is effective to the extent that similar knowledge is borne at the highest level. The later allows for structuring of project elements to facilitate the exercise of practices learnt.

#### **4.3.4 Housing Tenure Arrangement**

Tenure regularization and improved land administration is one of the key objectives of informal settlement upgrading projects. The National Slum Prevention and Upgrading Policy (NSPUP) recognizes land and housing tenure regularization as a prerequisite to any upgrading intervention (Republic of Kenya, 2016). Housing tenure regularization processes in the eleven upgraded settlements include: planning, survey and securing titles in nine settlements; house purchase arrangement in Canaan; and legal tenant occupancy in Decanting settlement.

Land titles in KCC, Jomvu Mikanjuni, Jomvu Kuu, Mkomani, Ziwa la Ngombe, Nyalenda A, Nyalenda B, Obunga and Manyatta are issued to structure owners hence

the variation in owner tenant ratio in these settlements (Figure 4.23). As a result of titling, the nine settlements have become vulnerable to gentrification. This is particularly evident in Mkomani. Gentrification in this settlement is attributed to its close proximity to Nyali, one of the high income estates in Mombasa. The boundary between Mkomani and Nyali estate is blurred as investors are purchasing land from the settlement peripheries for development of residential flats and luxury hotels.

House purchase arrangement in Canaan provides an opportunity for residents to become house owners through a mortgage scheme. A household can either occupy the house or rent out. The later explains why the owner occupier accounts for 61.4% of the residents. Though sale of housing units is discouraged by the ministry in charge of housing, the SEC members observed that some of the residents have sold the allocated houses.

**Table 4-22: Housing tenure arrangements in upgraded settlements in Kenyan cities**

<b>Housing regularization process</b>	<b>tenure</b>	<b>Settlement</b>	<b>Settlement Characteristics</b>
Land titling		Kayole Soweto, Jomvu Mikanjuni, Jomvu Kuu, Mkomani, Ziwa la Ngombe, Nyalenda A, Nyalenda B, Obunga, Manyatta	45.1% owner occupants; 54.6% tenants; 0.3% subletting tenants*  Gentrification evidenced through increased number of flats particularly in Mkomani
House purchase scheme	Canaan		Renting out and sale of allocated houses  61.4% owner occupant; 30.7% tenants and 7.9% subletting tenants
Public housing tenancy	Decanting		100% tenant occupancy

\*Average of the nine settlements

In Decanting, which is a public housing estate, all the occupants are legal tenants.

This public housing arrangement is characterized by low involvement of residents in

estate management meetings, high number of rent defaulters and poor waste management despite the existence of waste disposal facilities.

The study established significant correlations between housing tenure arrangement and two out of the fifteen measured indicators. This shows that housing tenure arrangement is not major determinant of environmental sustainability in upgraded settlements. Spearman correlation test reveal significant correlation between housing tenure and water consumption  $r(605)=-1.54$ ,  $p \leq 0.05$  and perceived environmental quality  $r(605)=0.184$ ,  $p \leq 0.05$ .

House owner occupiers perform better in water consumption and perceive environmental quality compared to tenants and those subletting. Higher performance in water consumption may be attributed to lower household expenditure as they do not pay house rent. This allows for increased expenditure on water. Based on this, improved water access in upgraded settlements is likely to render the correlation between housing tenure and water consumption insignificant. Housing tenure arrangement is therefore not an important lever in the environmental sustainability loop. It does not present a significant environmental sustainability pathway in ISUPs. This also implies that the observed gentrification in settlements like Mkomani does not bear direct impact on environmental sustainability.

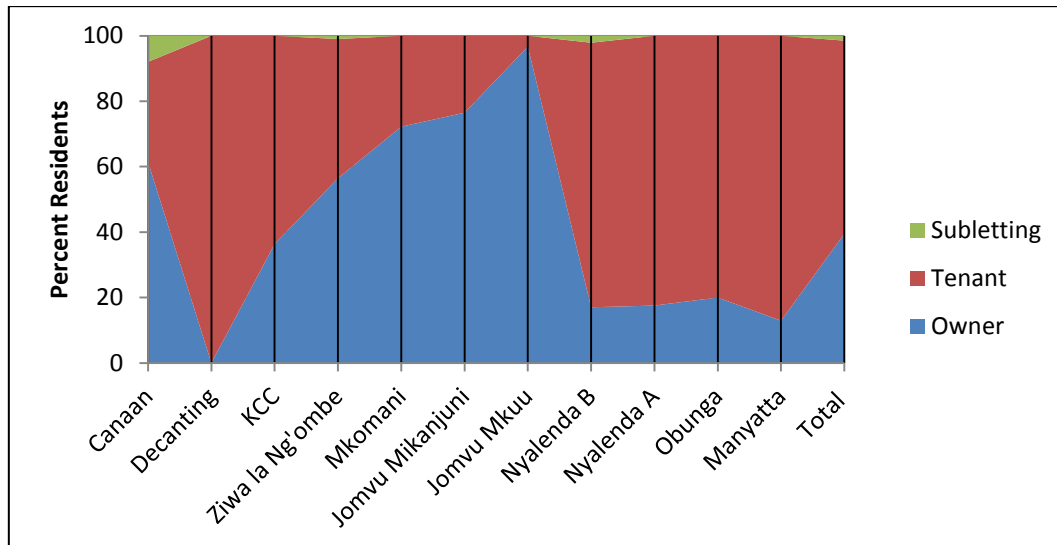


Figure 4.23: Housing tenure in upgraded settlements in Kenyan cities

#### 4.3.5 Local institutions

The National Slum Upgrading and Prevention Policy and KENSUP implementation strategy frame the manner in which local institutions link to informal settlement upgrading processes. There are two main avenues: provision for establishment of Settlement Executive Committee (SEC) and Grievances and Redress Committee (GRC) and strengthening of existing CBOs.

The SEC provides a platform through which residents in a settlement can actively participate in the decision making processes. Members are mainly leaders of active community based groups in the settlement. They bear significant influence in the settlement which can be leveraged in propagation of environmental sustainability goal. GRC reports day to day project related concerns to SEC who then report to the project coordinating unit. The GRC records issues related to residents' safety during construction of infrastructure such as uncontrolled dust in construction sites, uncovered drains and manholes and compensation grievances. The regular

documentation of grievances and an established community based redress mechanism presents an opportunity through which environmental problems such as inappropriate waste disposal and misuse of open spaces can also be addressed.

The potential of SEC to influence progress towards environmental sustainability in upgraded settlements can be demonstrated through existing adhoc initiatives. In Ziwa la Ngombe, the SEC has developed a settlement environmental management plan to ensure a coordinated approach to environmental management. The plan has not been validated by stakeholders at the county level. Validation is paramount in mobilizing county administrative and political support. The Canaan SEC, influenced the inclusion of a borehole in the settlement redevelopment plan. Similarly, Ziwa la Ngombe SEC proposed inclusion of underground water harvesting tanks in the infrastructure plans during the stakeholder consultation process. Though the later was not considered, the SEC demonstrated their capacity to engage with planning experts at the project design stage. In Kayole KCC, the SEC mentioned the need to extend the sewer works beyond laying of trunk sewer to plot connection to mitigate sewage overflows due to poor workmanship that results when the responsibility is left to individual residents. The plot owners had agreed to contribute towards this arrangement. However, this has not been implemented due to program inflexibility and poor communication among agencies involved. As a result, the settlement is characterized by low standard plot connections and malfunctioning connections which allow sewer overflow into storm water drains. These recommendations point to existing capacity which can be harnessed to influence environmentally sustainable outcomes at the planning stage of a settlement upgrading project. In Canaan, the SEC

plays an oversight role over the estate management decision which is evident through one of their communication to the management team citing problems that need to be addressed in the settlement (Appendix 4).

The SEC and GRC are constructed within the informal settlement upgrading framework. Active involvement of these local institutions at different levels of settlement upgrading process which is evidenced through community environment plans, local redress mechanism, and participation in infrastructure planning and management exemplify their potential to act as agents of environmental sustainability integration. There is need to coordinate these efforts so as to enhance their overall impact.

CBOs in the upgraded settlements are involved in a wide range of socio economic activities (Figure 4.24). 60.3% of the households belong to CBOs whose main aim is to provide a savings and credit scheme, 13.5% are involved in waste management groups while 6.3% are in security related groups. The popularity of the savings and credit scheme groups could be attributed to the characteristic low income levels of the residents in these settlements hence the need for informal financial support structures. It provides the most effective entry point for settlement improvement interventions.

The multiplicity of activities undertaken by CBOs demonstrates their potential to provide a platform for implementation of environmental management plans. However, such potential is limited by low level of resident participation in CBO activities. The current level of CBO membership among the households is 28.4%. As

a result, the efforts of these CBOs bear minimal impact on environmental performance.

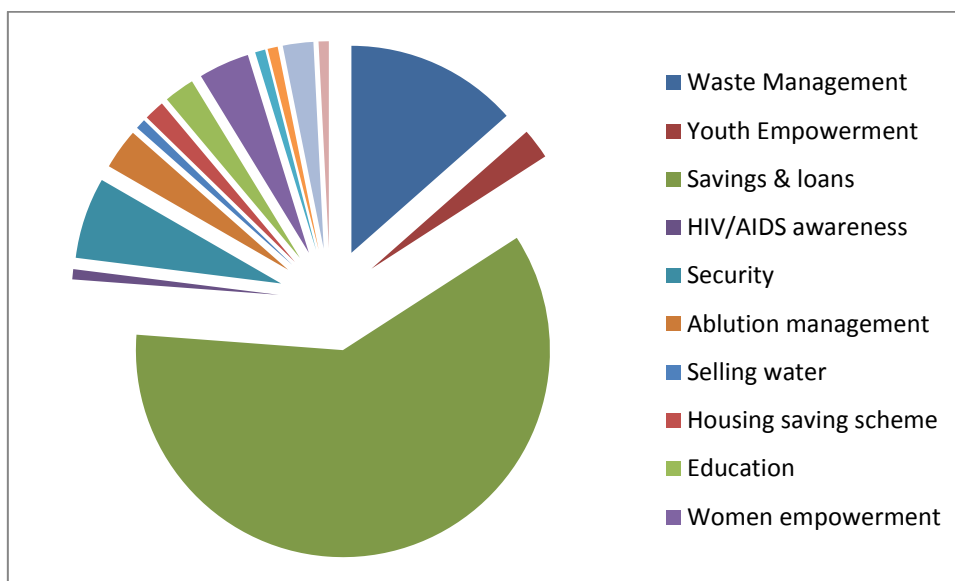


Figure 4.24: CBOs activities in upgraded settlements in Kenyan cities

#### 4.3.6 Environmental Management tools

Environmental Impact Assessment (EIA) is the legal and statutory environmental management tool that is utilized in ISUPs. The Environmental Management and Coordination Act (EMCA) cap. 387 requires all infrastructure development projects to undertake an integrated environmental assessment with the primary aim of mitigating potential negative environmental impacts that could emanate from the development at the construction and operation phase (Republic of Kenya, 2015). The Act also requires environmental auditing and monitoring to ensure effective implementation of the environmental management plan developed during the environmental impact assessment.

Upgrading activities in all the settlements apart from Decanting were subjected to an environmental impact assessment. Decanting estate was developed prior to the enactment of EMCA, 1999 which provided for EIA as a mandatory tool in such developments. In the other settlements, EIA was undertaken during the initial project planning stage. This was done through a planning consultancy which entailed other activities such as spatial plan development, land surveying, resettlement action planning and infrastructure plan development. The procurement process required single entity bidding for the consultancy in each of the targeted town and city to allow for a coordinated planning approach. This is critical in ensuring the environmental management plan is integrated in the social, spatial and infrastructural plans. Four EIA project reports were available for review including: KCC Kayole in Nairobi; Nyalenda and Obunga in Kisumu settlements; Ziwa la Ngombe, Jomvu Kuu, Jomvu Mikanjuni and Mkomani in Mombasa and Canaan in Nairobi.

The KCC Kayole settlement report shows the highest level of environmental sustainability consideration while Canaan report demonstrates the least consideration (Table 4-23). Canaan and Kisumu reports do not mention any implication of the proposed upgrading on resource consumption. KCC Kayole report takes cognisance of the impact of the project on increased water and electricity demand. Rainwater harvesting at household level, adoption of solar systems and sensitization on resource use efficiency are highlighted as appropriate mitigation measures. Waste management particularly recycling of waste at the household level is mentioned in all the four reports. One report mentions the need for regular waste collection. Provision of

recycling facilities also appears in one report. None of the reports mentions adequacy of toilet facilities as a cause or effect of sustainability in an informal settlement.

**Table 4-23: Environmental sustainability considerations in informal settlement upgrading project EIA**

Environmental sustainability indicators	EIA Reports			
	KCC Kayole	Kisumu settlements (Nyalenda , Obunga)	Mombasa settlements (Ziwa la Ngombe, Jomvu Kuu, Jomvu Mikanjuni, Mkomani)	Canaan
<b>Resource Consumption</b>				
Water consumption	✓	×	✓	×
Water conservation	✓	×	×	×
Energy consumption	✓	×	×	×
Energy conservation	✓	×	×	×
Non motorized transport	×	×	×	×
<b>Waste management</b>				
Solid waste recycling at household level	✓	✓	✓	✓
Waste collection	×	✓	×	×
Recycling facilities with the settlement	✓	×	×	×
Adequate toilet facilities.	×	×	×	×
<b>Environmental Quality</b>				
Environmental quality	✓	✓	✓	✓
Open space	×	×	×	×
Waterborne diseases	×	×	✓	×
<b>Community Organization</b>				
Participation in upgrading activities	✓	✓	✓	✓
Environmental management plan	✓	✓	✓	✓
Community Based Organizations	✓	✓	✓	×
Partnerships with public/private entities	×	×	×	×

✓Included    ×Not included

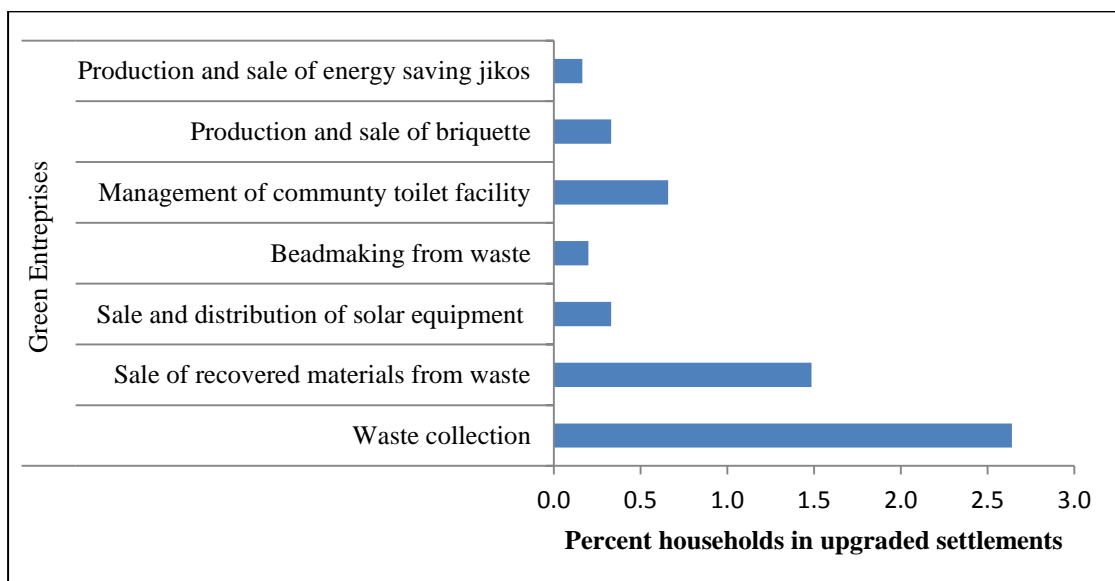
The four reports have highlighted the need for good environmental quality through maintenance of storm water drains, provision of waste receptacles, regular maintenance of sewer system to prevent overflows and sensitization of residents on infrastructure maintenance. None of the reports mentions the need for creation or improved maintenance of open space. One report provides measures to mitigate exacerbation of waterborne diseases as a result of clogged storm water drains and inadequate water to sustain the sewer system. All the reports state the need for resident participation in environmental management and development of environmental management plans. CBOs are mentioned in all reports apart from Canaan as vehicles through which community environmental management plans can be implemented. None of the reports identifies partnerships which the project could leverage on in the implementation of the Environmental Management Plan (EMP).

The EIA reports place more emphasis on mitigating nuisance such as dust, noise and hazards compared to improving existing environmental quality. This is aggravated by sectoral laws which focus on environmental mitigation measures during the construction phase. As a result, the EIA does not offer a solid pathway through which environmental sustainability can be integrated into ISUPs. In addition, even if the environmental sustainability indicators were to be comprehensively considered during EIA, the resultant EMP is not legally binding. This means that its implementation is dependent on the commitment of the Ministry of Housing to environmental goals.

#### **4.3.7 Green enterprises**

Green business enterprises have emerged as a critical pathway for instigating and sustaining environmental management activities at the local level (Creech, *et al.*,

2014). Common green enterprises in upgraded settlements include waste collection, recovery of waste materials, management of communal toilet facilities, production and sale of briquettes and energy saving jikos and beadmaking using recovered waste materials (Figure 4.25). Waste management and sanitation present the most common avenues for establishment of these enterprises. 5.8% of the residents have atleast one household member who is engaged in green entrepreneurship. Out of these, 2.6% are involved in waste collection enterprises, 1.5% in sale of recovered waste materials and 0.7% in management of community toilet facilities. 1% of the household members are engaged in either sale, distribution of solar equipment, bead making, production of briquettes or energy saving jikos. There are 7.4% residents involved in green enterprises in Kisumu, 5.8% in Nairobi and 4.4% Mombasa.

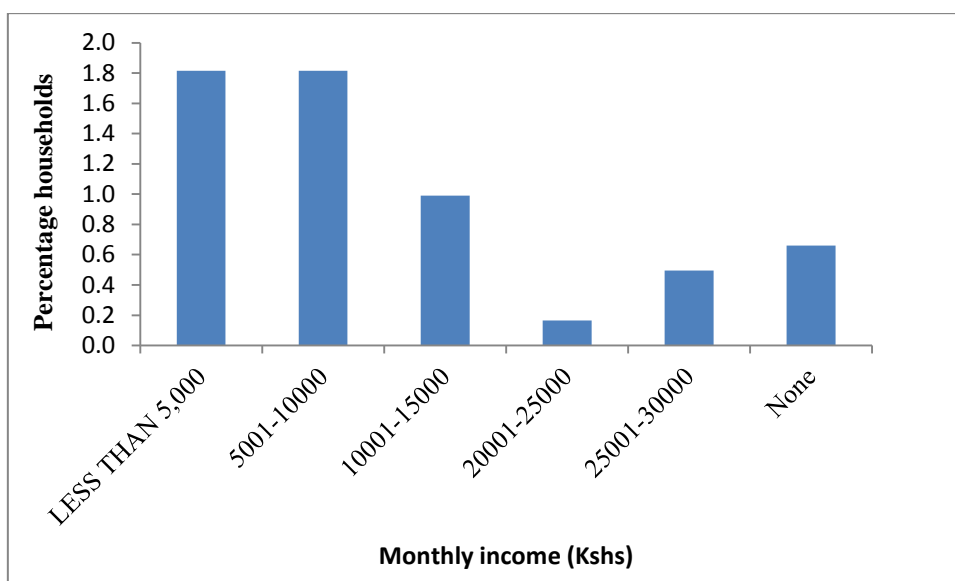


**Figure 4.25: Households involved in green enterprise activities in upgraded settlements**

The enterprises leverage on the absence of municipal services, the characteristic high population density and community cohesion. They mostly operate as CBOs with one of the mandates being environmental management. The broad mandate allows the

CBOs to be fluid with regard to different types of enterprises. Their structure and functionality is easily shaped by emerging entrepreneurial opportunities in the settlements. The price of the product or service provided is determined and regulated by group members. Proceeds from the business are used to cover the operating costs. The profit is used in community development activities such as provision of micro credit to members and upgrading of existing settlement facilities. This is in line with the Public Benefits Organizations Act of 2013 which compels CBOs to use income generated from their activities for the sole benefit of the community (Republic of Kenya, 2013). The dominance of CBOs as business entities could explain why cities that have higher CBOs membership also have higher number of residents participating in these enterprises. Kisumu has the highest number of CBO membership with 63% compared to 20% in Mombasa and 17% in Nairobi. It also has the highest number of resident involvement in green enterprises. Apart from the CBOs, the other enterprises are operated as private entities.

The highest monthly income from green enterprises is Ksh 30,000 per household (Table 4-24). Out of the 5.8% residents involved in green enterprises, 1.8% earn less than Ksh 5,000 while a similar percentage earns Ksh 5,001- 10,000 per month. 0.6% earn between Ksh 10,001-30,000. 0.7% indicated that they do not earn anything from the enterprise since the proceeds are directed to communal projects.



**Figure 4.26: Monthly income from green enterprises in upgraded settlements**

Waste collection and management of communal toilets are the dominant enterprises in upgraded settlements. Each household that uses CBO waste collection services pays an average of Ksh 20 per week. Total revenue generated from waste collection in a settlement ranges between Ksh 4,948 to 270,732 per month (Table 4-24). No revenue is recorded in Canaan, Decanting and Jomvi Kuu due to availability of municipal waste collection services in Canaan and Decanting existence of a waste disposal site at the periphery of Jomvu Kuu settlement. Though this enterprise contributes significantly to increased household income and creation of employment among residents in the upgraded settlements, its impact on solid waste management is still low. This is because most of the CBO that provide waste collection services are disconnected from the formal solid waste value chain.

**Table 4-24: Income generated by CBOs through waste collection in upgraded settlement in Kenyan cities**

Canaan	KCC kayole	Ziwa la Ng'ombe	Mkomani	Jomvu Mikanjuni	Jomvu Mkuu	Nyalenda B	Nyalenda A	Obunga	Manyatta	Decanting

No of sampled households using CBO services	0	49	37	12	3	0	4	2	12	2	0
Percentage households using CBO services	0	89	37	67	9	0	9	4	15	6	0
Total No of households using CBO services <sup>1</sup>	0	1737	3384	153	82	0	139	62	37	400	0
Amount collected per week (Kshs)	0	34,732	67,683	3,069	1,632	0	2,783	1,237	738	7,998	0
Amount collected per month (Kshs.)	0	138,927	270,732	12,276	6,529	0	11,132	4,948	2,953	31,993	0

<sup>1</sup>percentage households using CBO services\*settlement population

Provision of waste receptacles and recycling facilities is therefore one of the immediate strategies of transforming this activity into a green enterprise. This is clearly demonstrated in two settlements where innovative waste recycling has been employed. In KCC Kayole, the recycling facility allows for sorting of waste, recovery of materials for re use and production of biogas from the biodegradable waste. The biogas is then used to power a community hall that doubles up as a hotel. In Nyalenda B, the recycling facility processes plastic waste for sale to factories that use grinded plastics as raw material. The facility records an average of Ksh 100,000 per month and has employed 10 fulltime staff.

The communal toilets are operated by CBOs identified through a competitive bidding process. Business license fee against these enterprises is waived by county government. Currently, an average of between Ksh 3,000-5,000 per month is collected from each ablution block.

Since income from these green ventures provides an incentive for resident involvement in environmental management; ISUPs should utilize this market pathway

to spur multiple environmental sustainability outcomes. Lessons can be drawn from a K-WATSAN project in a settlement within Kibera outside the study area where 50% of the money collected from sanitation blocks and water sale is deposited in housing cooperatives so that members of the CBOs that run the project will eventually own a house. Similarly, the revenue can be used to secure micro credit to pay utility connection fee or improve housing structure. Market institutions are increasingly influencing environmental management trends in both developed and developing countries (Nilsson *et al.*,2009). Policy implementation processes should therefore respond to this emerging force to create a convergence between market aspiration and the environmental policy values.

Based on the Importance Performance Analysis (IPA) matrix, no pathway can be categorized into the low priority quadrant (Figure 4.27). Housing tenure presents an overkill because it is not an important environmental sustainability enabler but it has high performance. The study established that housing tenure does not have a significant correlation with environmental sustainability indicators apart from environmental quality. It does not activate environmentally sustainable practices though it is the primary objective of ISUPs.

Environmental infrastructure and environmental impact assessment are in the third quadrant which implies that they are very important but they demonstrate low performance. The use of these two pathways is facilitated by national environmental and sectoral laws. However, the performance of the upgraded informal settlements shows that the infrastructure provided is inadequate. In addition, the methodology and

framework within which EIA is used does not facilitate environmental sustainability outcomes. This quadrant draws attention to priority areas which decision makers should focus on. Green enterprises, clean technologies, local institutions and environmental education are in the fourth quadrant which implies that they have high importance and high performance. Strategies in this case aim at sustaining and enhancing the performance of these four pathways.

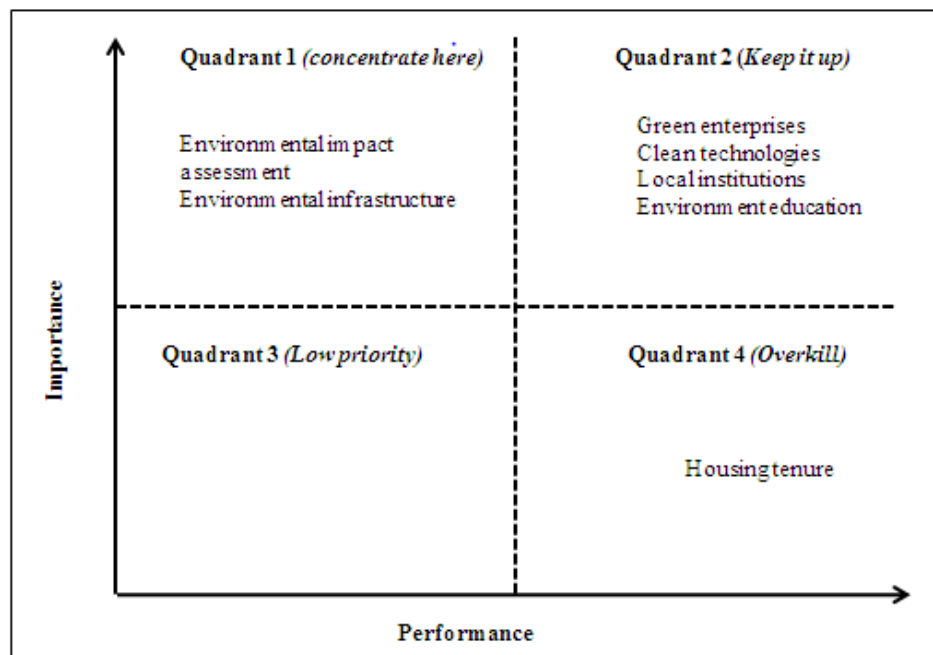


Figure 4.27: Importance Performance Analysis for environmental sustainability pathways in ISUP

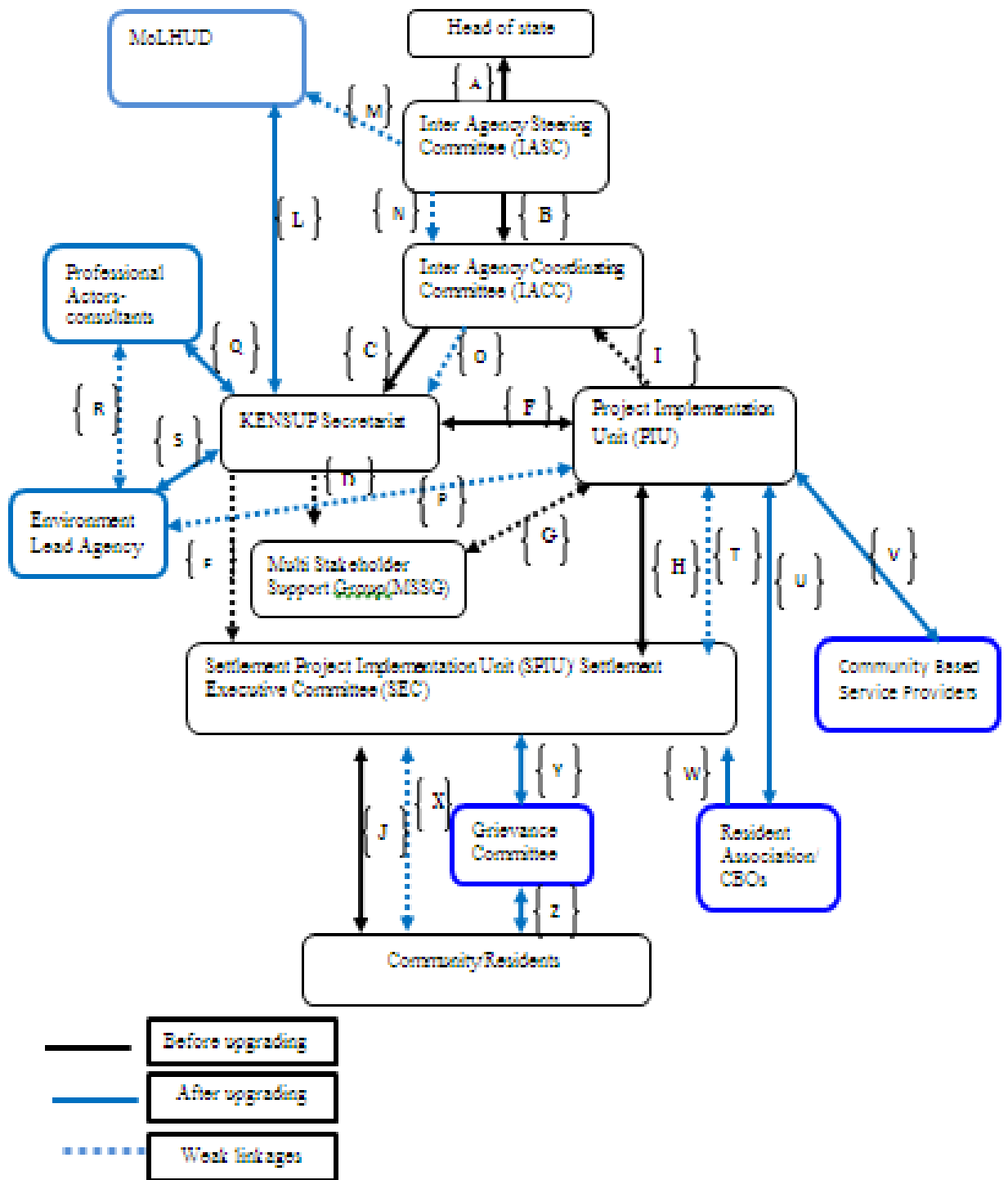
#### 4.4 Assessment of the Effect of Institutional Arrangements on Environmental Sustainability in Informal Settlement Upgrading Projects in Kenyan Cities

The current institutional arrangement for upgrading informal settlements is a double edged system that offers both opportunities and limitations for environmental integration in almost equal measure. This section discusses the institutional arrangements through which government led informal settlement upgrading projects are implemented. It also establishes the implications of these arrangements on environmental sustainability performance of upgraded informal settlements. The discussion is centred around key themes that emerged from literature review including: institutional structure and functional linkages, multi-level institutional coordination, stakeholder participation, project management, organic networks and actor agency.

#### **4.5 Structural arrangement and functions of actors in national informal settlement upgrading projects**

Government led informal settlement upgrading projects in Kenya are implemented through a multi agency program based approach. The agency mandate and relationship with other institutions is defined by the 2005-2020 KENSUP Implementation Strategy (

**Figure 4.28).** Though the National Slum Upgrading and Prevention Policy (NSUPP) (2016) lays a new institutional framework, it is yet to be operationalized. The multi agency approach is a shift from previous sectoral based system in which the ministry in charge of housing development was solely responsible for upgrading informal settlements (GoK, 2004).



**Figure 4.28: Institutional framework for informal settlement upgrading in Kenya (word version of the image in appendix)**

Source: Modified from GoK, 2005

The supreme decision making body is the Inter Agency Steering Committee (IASC) (GoK, 2005). It draws membership from relevant ministries, county governments and development partners. It links KENSUP with the Head of State {A}. This link allows for mobilization of financial and political support towards informal settlement upgrading programs. However, it started assuming dormancy in 2011 when the Head of State patronage was curtailed and the Kenya Slum Upgrading Program (KENSUP) was restructured into a department within the Ministry of Lands, Housing and Urban Development (MoLHUD).

The IASC primary role of approving policy decisions on informal settlement upgrading was assumed by the Ministry of Lands Housing and Urban Development. The linkage between AISC and Head of State {A} became defunct. This restructuring had a negative effect on the level of funding and political interest in informal settlement upgrading projects. As a result, there was a decline in government led upgrading initiatives which consequently constricted the conduit through which environmental sustainability is diffused into informal settlements. In 2012, donor funding revamped informal settlement upgrading activities.

The link between IASC and Head of State {A} was replaced by {M} which is a link between the MoLHUD and the IASC. Having lost one of its primary roles, the engagement between IASC and MoLHUD became minimal and adhoc. As a result, the IACC lost an instrumental function of diffusing policy and program recommendations from IASC into the program cycle. The other primary role of providing technical expertise at the program design phase is still valid to date.

However, the mode of association {C} has changed from regular to adhoc engagement. The entities in the IACC vary based on the expertise required.

New networks have emerged to reinforce the role of IACC. Partnership between the KENSUP secretariat and professional organizations {Q} could be attributed to the weakening of the IACC-KENSUP secretariat association {C}. Similarly, the emergence of a link between the National Environment Management Authority (NEMA) {S}, and KENSUP secretariat has further lowered the significance of IACC as the repository of technical expertise in environmental management. Associations with all the technical agencies are periodic and limited to the project planning and construction phase. It is however not self-reinforcing as it tends to become weak as the project cycle advances.

The KENSUP secretariat provides administrative support during program development and project implementation. Therefore, it bears direct link with all the actors apart from IASC. It was initially domicile in the MoLHUD as a program support unit but in 2011 it was restructured into a ministerial department. As a department, a direct link between the secretariat and the MoLHUD {L} was created. It lost its operational flexibility as it is subject to the bureaucratic systems of a public organization. The extent to which it can propel environmental policy integration in ISUPs is determined by existing organizational constructs and channels (Lee & Pan, 2014)

The Project Implementation Units (PIUs) are established within the county government and are responsible for the design and construction of infrastructure.

Membership is drawn from relevant departments within the county government. This facilitates active participation of actors at the local level and sustainable infrastructure management. The PIUs bear direct linkage with many of the existing actors through {F}, {G}, {H}, {I} ({P}, {T}, {U} and {V}). They provide a focal point through which majority of the actors in the institutional structure can be influenced towards realization of environmental outcomes in ISUPs.

The Multi Stakeholder Support Group (MSSG) is positioned below the secretariat {D} and the PIUs {G} to play a project monitoring role and provide feedback to the two actors. It has a broad stakeholder representation including: government agencies, development partners, civil society and community representatives. However, it does not have any linkage with the institutions at the settlement level. Despite its essential role, the group has become inactive. As in the case of IACC, the mode of engagement has changed from regular to adhoc association. Its monitoring role is also being delivered through contract based partnerships with professional organizations. A project officer indicated that the minimal engagement of MSSG is due to budgetary constraints. However, critical assessment of the structural reconstruction process reveals a shift from regular to adhoc participation of multistakeholder actors such as IACC and MSSG. This trend could point to either efficiency in project management or manipulation of actors.

The Settlement Executive Committee (SEC) links the community to the KENSUP Secretariat {E} and Project Implementation Unit {H}. Its primary role is to mobilize the community to participate in upgrading activities within their settlements. The

study however established that the level of household participation in settlement upgrading is low since 55% of the respondents in the three cities had never been involved in any upgrading activity. Further, 47.6% of these mentioned lack of information as the reason for non involvement. The SEC members argued that their capacity to mobilize residents is limited by inadequate facilitation, political interference and resident scepticism towards government projects. The community mobilization and project monitoring roles are also undertaken by Resident Associations, Community Based Organizations and Community Based Service Providers (

Figure 4.28).

#### **4.6 Implications of Institutional Structure and Functional Reconstruction on Environmental Sustainability in informal settlement upgrading projects**

The findings of this study indicate that reconstruction of IS upgrading institutional structure and functions presents significant implications for environmental sustainability integration in ISUPs. The termination of Head of State patronage has led to a decline in budgetary allocation and political interest in informal settlement upgrading projects. Consequently, project activities decreased significantly and hence stifled the vehicle through which environmental sustainability would be propagated. A project officer observed that the reduction in financial allocation has drawn the focus of MoLHUD from mainstreaming issues such as environmental management to the primary institutional objective of facilitating housing development. Runhaar (2015) however notes that the latter is mainly due to poor conceptualization of the

environmental sustainability agenda within the housing development sector. Synchronization of environmental sustainability with sectoral objectives eliminates the need for a parallel budget.

The shift in policy and program decision making role from IASC to MoLHUD implies that the informal settlement upgrading agenda has to compete with other multiple housing development agendas in the boardroom. This limits the consideration of informal settlement upgrading sub components such as environmental sustainability. As a result, there are limited strategic recommendations to address environmental sustainability in upgrading processes. Diffusion of environmental agenda is rendered weak at this policy level.

The role of the Inter Agency Coordinating Committee (IACC) as the repository of technical expertise has not changed. The mode of engagement has however shifted from regular to adhoc. On one hand, this form of engagement provides an urgent response mechanism for specific project matters arising during planning, construction and infrastructure operation. On the other hand, it is difficult to mobilize actors who are irregularly engaged. This could lead to a gap in a certain technical area. In addition, this mode of engagement is not suitable for supporting a long term mainstreaming agenda such as environmental sustainability. This is because the adhoc arrangement does not offer a sense of legitimacy to actors involved hence creating a disincentive for sustained active participation (Thoenig, 2012). Based on the actor network theory, the lack of a sense of legitimacy lowers the significance of the IACC as a node through which system changes such as environmental mainstreaming in

ISUP planning can be effected. Successful integration is therefore hinged on re-establishing a regular mode of association between the secretariat IACC and MSSG.

It is notable that the Project Implementation Units (PIUs) have acquired additional roles as a result of institutional reconstruction. The PIU which is primarily the implementing organ has acquired a new role of coordinating and devising mechanisms for uptake of technical input from new actors including the professional consultants and NEMA. Initially this information was transmitted through a single channel from IACC to the PIUs. This could imply an overload on the PIUs which negatively affects its performance.

The Multi Stakeholder Support Group has retained in its project monitoring role without any additional functions. Its composition however varies along the project cycle based on project need. Despite its porosity, the institution has not attracted vibrant environmental players. This is mainly because the project design has not triggered a substantial demand for environmental monitoring. Uittenbroek et.al (2013) agrees that mainstreaming is often easier and most effective at the planning level and becomes increasingly problematic at the implementation and monitoring stage.

The Settlement Executive Committee has adopted new roles in addition to the previous functions including: development of community based plans to guide infrastructure maintenance; negotiation for service provision and estate management oversight. These new roles have been taken up in response to emerging project needs. They are instrumental in propagating environmental management in upgraded settlement. For instance, estate management oversight in Canaan settlement allows for

establishment of mechanisms to promote waste management and proper maintenance of open space (Appendix 4). New actors that have emerged at the community level including residential associations, grievances redress committee, CBOs and community based service providers have taken up some of the functions of SEC such as community mobilization and project monitoring. The active participation of new actors at this level provides an opportunity through which progressive environmental sustainability can be realized through increased resident participation and additional project feedback loops.

Institutional structural dynamism in ISUPs is driven by emerging needs and perceived or actual inefficiency of existing institutions. Its implication on environmental management in upgraded settlements is twofold. On one hand, the emergence of new actors increases information flow conduits which facilitate broad stakeholder participation in planning, implementation and monitoring. It also minimizes the risk of patronage by some actors who have control over resources (Osborne, 2007). On the other hand, the numerous centres of power that result from the organic networks pose coordination challenges. The latter impairs efforts to diffuse environmental sustainability goals in the ISUP cycle.

The National Slum Upgrading and Prevention Policy recommends establishment of an Inter Government Agency for Slum Upgrading and Prevention at the national and county level. The agency will carry out all the functions related to informal settlement upgrading including policy development, project coordination, and implementation and monitoring. The agency will work with relevant sectoral government agencies,

NGOs, research institutions, professional bodies and the Settlement Executive Committees. The role of each of these actors is clearly defined but their structural linkage is not illustrated.

#### **4.6.1 Environment Policy Integration**

The National Environmental Policy of 2013 provides a comprehensive policy framework for consideration of environmental sustainability within all sectors including housing development (Republic of Kenya, 2013). It empowers the Directorate of Environment in the Ministry of Environment & Natural Resources and the National Environmental Management Authority to formulate policies, coordinate and monitor the implementation of these policies across all development sectors. It is therefore the mandate of these two agencies to ensure environmental considerations are made in the development of informal settlement upgrading policies and programs. The initial ISUP institutional structure provided the Inter Agency Steering Committee (IASC) as an entry point for these agencies to mainstream environmental policy at the program formulation stage. The IASC allowed for membership from all relevant ministries including the Ministry of Environment and NEMA. Its redundancy therefore posed a barrier for environmental policy consideration at the highest decision making level. The new linkage between NEMA and KENSUP secretariat does not adequately fill this gap because NEMA's role is to ensure ISUP implementation process adheres to existing environmental regulations not to provide policy and strategic recommendations.

The housing policy of 2004 and National Slum Upgrading and Prevention Policy of 2016 provide a window for consideration of environmental matters in ISUP. They

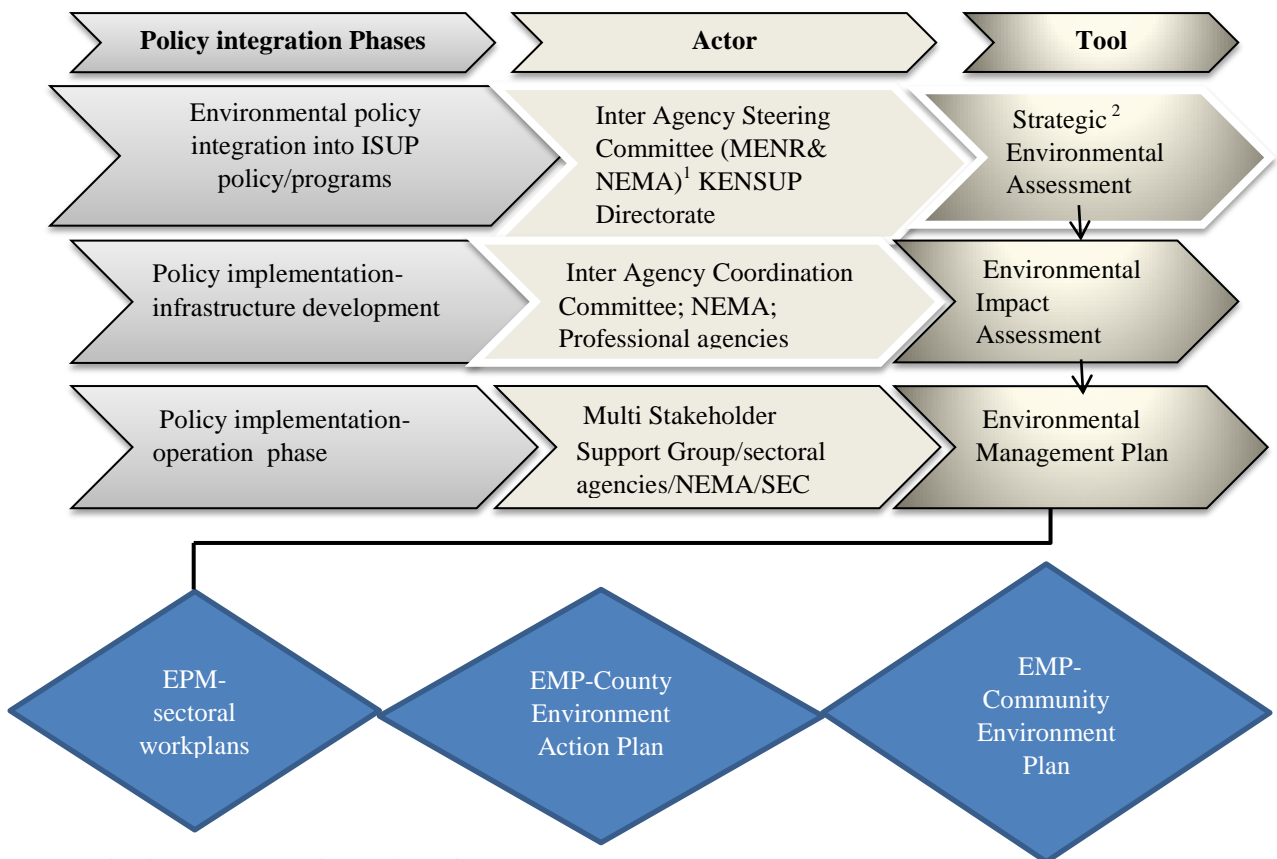
point out the need for informal settlement upgrading projects to address waste management, green space establishment and sustainable resource consumption in the residential space. The translation of these recommendations from policy to practice is however constrained by the institutional restructuring. The dormancy of IASC which would transmit broad policy strategies to the project implementing vehicles presents a policy diffusion gap (Figure 4.29). The new link between KENSUP secretariat and the Cabinet Secretary that replaced the IASC is characterized by bureaucracy which limit the extent to which strategic environmental decisions can be made.

Environmental issues are infused into the ISUP at the infrastructure development phase rather than policy level. Environmental Impact Assessment (EIA) is used as the primary environmental management tool. This is contrary to the Environmental Management and Coordination Act (EMCA) cap 387 which provides for Strategic Environmental Assessment (SEA) to allow for consideration of broad environmental policy aspects at program formulation level (Republic of Kenya, 2015).

Integration of environmental policy recommendations during the infrastructure development phase is coordinated by NEMA through the KENSUP-NEMA linkage. The previous structure provided for an Inter Agency Coordinating Committee where environmental players from government agencies and civil society would propagate environmental mainstreaming at this level. NEMA would coordinate decision making at this level. The inactive participation and limited engagement of IACC leaves NEMA as the sole player in coordination and provision of technical support in ISUP. The new link between KENSUP and professional agencies provides a multi

disciplinary pool of experts hence bridging the policy integration gap created by IACC.

Policy implementation during the operation phase is a multi stakeholder responsibility. Initially the Multi Stakeholder Support Group played a critical role in ensuring that the environmental strategies and actions established at planning stage are implemented during infrastructure development and operation phase. This role has now been left to the sectoral agencies who are required to monitor ISUP performance using the Environmental Management Plan.



1-Redandunt 2-Has not been adopted

**Figure 4.29: Environmental policy integration process in ISUPs**

The agencies are required to incorporate the EMPs into their workplans to allow for monitoring and feedback into the program. However this does not happen since none

of the sectoral agencies interviewed had a copy of the project EMP, a demonstration of poor coordination among agencies in the ISUP network. Similarly, the NEMA county offices and the County Environment Committees are required to integrate the EMP into the County Environment Action Plans (CEAPs) as a practical way of coordinating and monitoring environmental management in projects that undertook EIA. The current isolation of these institutions from ISUP activities explains why this process has not been effected. At the community level, one out of the eleven settlement has developed a Community Environment Management Plan (CEMP). The Ziwa la Ngombe SEC observed that the CEMP seeks to maintain and improve environmental quality in the settlement. Though it represents 9% of the upgraded settlements with CEMP, it points to a positive trend in policy integration at the grassroots level.

The process of policy integration through the ISUP institutional framework demonstrates that institutional restructuring could have unintended impacts on secondary objectives such as environmental sustainability. Policy integration and institutional coordination are largely intertwined and the later can address or aggravate negative implications of institutional restructuring. When institutions that were critical in environmental policy diffusion are rendered redundant or dormant, proper coordination of new structures can effectively bridge the resultant gap.

#### **4.6.2 Stakeholder Participation**

The initial institutional structure allowed for broad stakeholder participation in ISUPs through IASC at the policy level, IACC at the planning and implementation level and MSSG as a monitoring instrument. The SEC allows for adequate community

involvement in all project phases. The redundancy of IASC, changes in mode of engaging IACC from regular to adhoc, lack of vibrant environmental players in the MSSG and inadequate capacity within SEC then presented a barrier for multi stakeholder participation. In response to this challenge, new actors emerged to provide platforms for increased participation including: professional consultants, community based service providers, estate management committees, CBOs and grievances and redress committee. Previous actors like NEMA restructured to form new linkages.

Though multiplicity of actors in an institutional framework does not necessarily imply active participation of players, it provides an environment through which actor involvement can be activated. The IASC for instance provided for inclusion of an environmental lead agency in its membership though the later remained inactive. Despite the inactive participation, new strategies would have been sought to stimulate their involvement. Its redundancy now presents a more daunting challenge for environmental stakeholder involvement at the policy level.

The new actors have presented opportunities for mainstreaming environmental considerations in ISUPs. This is particularly conspicuous at the community level where the new actors are making significant contribution to environmental sustainability through complementing municipal services, facilitating co production of services, waste recycling and community organization. Their nature and level of participation is however varied across different settlements. Residential associations and estate management committee are prominent in settlements within Kisumu and

Nairobi respectively. Lessons can be drawn from successful participation cases to inform stakeholder involvement approaches in similar projects.

In addition to institutional structure limitations, active stakeholder participation is also barred by poor coordination of actors in the network and involvement of actors in the later stages of the project cycle. County environmental departments in Nairobi, Mombasa and Kisumu indicated that they are mostly involved in the project at the operation phase when infrastructure maintenance is required. The water and sewerage service utilities are often looped into the projects at the implementation stage and are therefore unable to provide design recommendations to enhance service delivery.

Effective stakeholder participation in ISUPs requires a holistic approach that addresses structural gaps, functional efficacy of actors in the framework and inherent institutional weaknesses in actor coordination and capacity.

#### **4.6.3 Horizontal Institutional Coordination**

The ISUP environmental unit is domiciled in the Community Engagement and Livelihood Improvement section of KENSUP Directorate in the Ministry of Lands, Housing and Urban Development (Figure 4.30). The environmental unit is responsible for coordinating environmental matters in ISUP and providing technical support to the four ISUP sections: policy development, resource mobilization, infrastructure development and community mobilization. The technical support involves development of environmental frameworks in ISUPs, integration of environmental considerations in policy making process and implementing environmental

management plans. There is however no staff assigned to this unit. This gap is compensated by the linkage between the KENSUP Directorate and the National Environment Management Authority (NEMA); contracted environmental professionals and sectoral infrastructure agencies (Figure 4.30). It is however notable that the coordination role is unfilled.

The linkage between National Environment Management Authority and KENSUP directorate allows for the establishment of a technical support desk by the former in KENSUP's Directorate during the ISUP planning and implementation phase. During this period NEMA provides legal advice and technical assistance in integrating environmental issues into infrastructure development. There is no evidence of technical support to policy and resource mobilization sections. Attention is paid to compliance regulations rather than establishment of structures that facilitate long term sustainability. This could be attributed to the temporary nature of engagement between the two actors. The technical support desk is de-established at the end of project implementation phase. Similarly, the professional agencies offer technical services on environmental matters including environmental impact assessment and environmental monitoring within a limited contract period of a maximum period of one year.

Sectoral agencies including ministries in charge of water, sanitation, environment, public health, road and infrastructure at the national level provide technical support on environmental matters through the Inter Agency Coordination Committee, Project Implementation Unit and Multi Stakeholder Support Group (

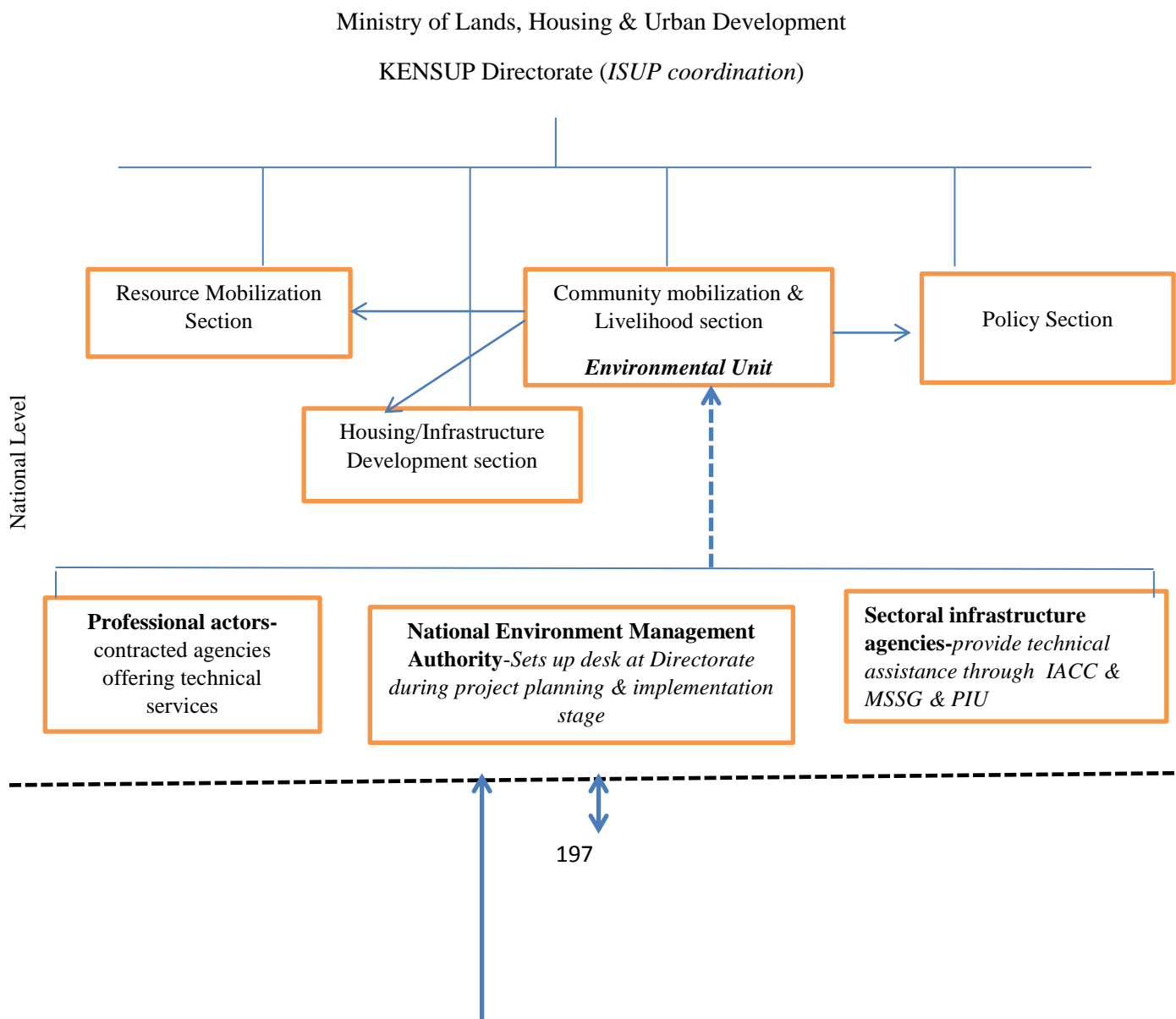
Figure 4.28). The extent to which this support is availed to KENSUP Directorate depends on the active participation of these agencies in the IACC, PIU and MSSG.

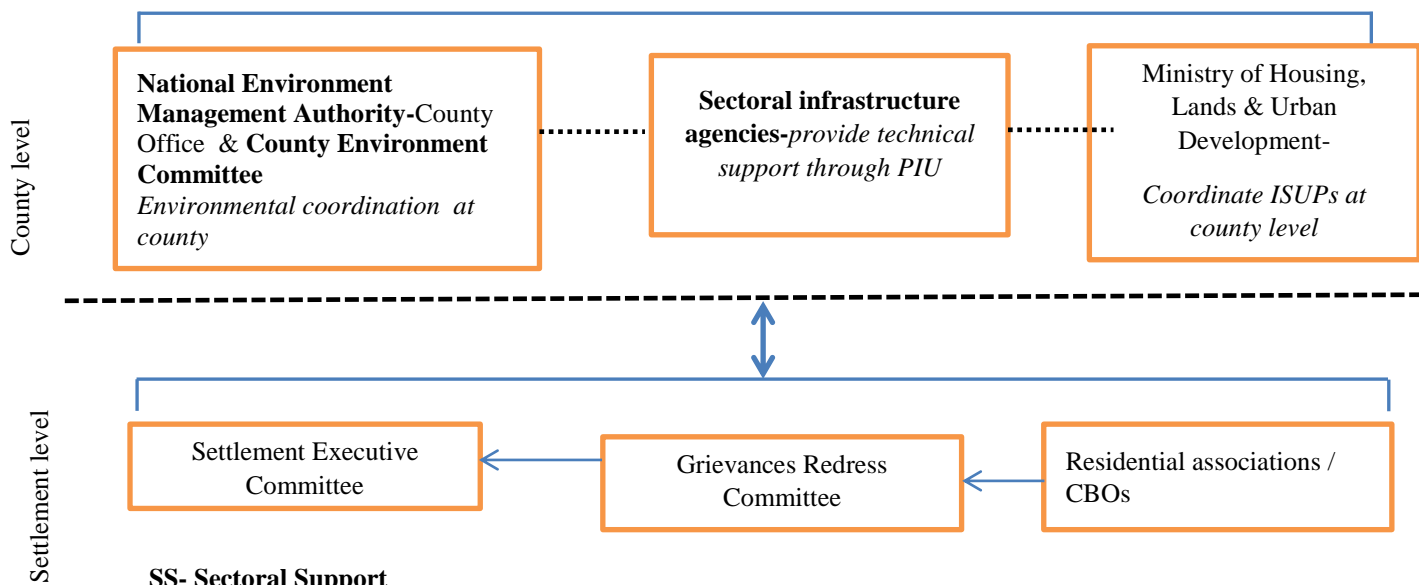
At the county level, all the ISUP sections are hosted within the Ministry of Lands, Housing and Urban Development. This office is responsible for coordinating all matters related to housing in the county. The office is linked to a county Project Implementation Unit (PIU) which provides technical support during the project implementation phase and there after assumes dormancy. The two agencies are also linked to the NEMA office at the county level. In two of the three city counties, it was observed that none of the County Directors of NEMA in the two counties is aware or has participated in ISUP related activities implying a very weak link.

The Settlement Executive Committee (SEC) is the central point through which environmental information and management actions are implemented at the settlement level. The Grievances and Redress Committee, resident associations and community based organizations act as conduits for these activities from the SEC to individual households. The SEC participates in environmental decision making through the NEMA technical support desk at the national level.

The current institutional arrangement is configured by multi levelled institutional linkages. Horizontal linkages at the national and county allow ISUPs to leverage on existing technical capacities from environmental lead agencies and sectoral

institutions. The linkages are however temporary in nature and often assume dormancy once the project is implemented. This poses a threat to long term environmental sustainability in ISUPs.





**Figure 4.30: Horizontal and vertical institutional coordination of environmental matters in ISUP**

The institutional arrangement is characterized by weak coordination demonstrated by lack of a staff assigned to the environmental unit and lack of an environmental strategy to guide inter section and cross sectoral linkages and environmental management in ISUPs. Existing environmental strategies are largely piecemeal data sheets provided by donors for project monitoring. At the county level, the NEMA which is responsible for coordinating all environmental matters remains isolated from the ISUP activities. This delinks upgraded settlements from the county long term environmental sustainability plan. Institutions at the settlement level exhibit a greater level of coordination compared to those at the county. The SEC acts as the coordinating unit for all the environmental issues related to ISUP. However, its level of activity is dependent on the involvement of agencies at the national and county level in ISUP.

Based on this analysis, it is notable that coordinating mechanisms are central to environmental integration in a cross sectoral institutional arrangement. A functional environmental unit in this case could potentially provide a framework through which the technical input from multiple agencies is absorbed by relevant sections in KENSUP Directorate (Berger & Steurer, 2009; Sharma & Singh, 2016). This framework will also allow for implementation of long term environmental strategies in ISUP.

#### **4.6.4 Vertical Institutional coordination**

The KENSUP Directorate coordinates all the ISUP activities among actors at the national, county and settlement level

Decisions on environmental matters are informed by professional actors, NEMA and sectoral agencies at the national and county level and households through SEC, GRC and CBOs (Figure 4.30). Environmental Impact Assessment is used as the main decision making tool.

The EIA process is coordinated by professional actors at the national level. They facilitate direct actor participation in environmental management within the ISUPs. Sectoral agencies at the national and county level participate in the assessment through the Inter Agency Coordinating Committee, Project Implementation Unit and the Multi Stakeholder Support Group. The SEC, GRC and CBOs allow for household participation at the settlement level. The extent to which professional actors coordinate the EIA process is limited to the contract duration. Upon completion of the process, KENSUP directorate obtains an Environmental Management Plan to guide the project planning process. NEMA as the EIA approving agency ensures that the

process is carried out in accordance to the Environmental (Impact Assessment & Audit) Regulations, 2003 (Republic of Kenya, 2003). This is particularly in regard to participation of all stakeholders at the three levels of governance.

During infrastructure implementation, the households' concerns are fed back to the system through the grievances and redress committee to the SEC. The SEC communicates to the county agencies who then raise the matter with the KENSUP Directorate. The Directorate liaises with NEMA to charge.

Since the decision making process on environment matters during planning and implementation is largely coordinated by professional actors and NEMA, a gap is created when the professional contract expires and the KENSUP-NEMA linkage loosens. As a result there is limited engagement with the actors to monitor environmental implications of the upgrading project and effectiveness of the environmental management plan. Though the KENSUP Directorate argues that its role ends at infrastructure development and handover to relevant sectoral agencies, the sustainability performance of the upgraded space should be a primary concern. The inactive environment unit within the KENSUP Directorate poses a major challenge in coordination of environmental issues after infrastructure upgrading.

#### **4.6.5 Community Participation**

The ISUP institutional arrangement provides community participation through the Settlement Executive Committee (SEC) and Grievances Redress Committee. The SEC allows for 21 committee members representing tenants, structure owners, active community based organizations, youth, widows and orphans, people living with

disability, faith based organizations and dominant NGOs. The members are elected by the residents in a community meeting organized by the local administration. In addition to these elected members, the area chief, county commission officer and Member of County Assembly are co-opted to facilitate active community engagement and conflict resolution. The co-opted members however, rarely attend the SEC meetings. SEC disseminates and receives feedback information through meetings organized by the area chief, CBOs and residential associations. Despite this institutional provision and information channels, 54.3% of the residents mentioned that they had never been aware of any opportunity to participate in upgrading activities within their settlement. This points to weaknesses in the process of resident engagement by SEC on aspects relating to targeting and mode of information dissemination. This poses a major limitation for environmental sustainability information flow from institutions at the national and county level to the settlement level and vice versa.

The Grievances and Redress Committee which is responsible for documenting and relaying community grievances that are related to upgrading projects transmit information through the SEC to the project implementation unit. The capacity to transmit this information is however limited by the challenges that characterize the SEC information flow system. Resident participation in environmental management within ISUPs therefore calls for either a review of involvement strategies adopted by SEC or establishment of alternative networks through which residents can participate in decision making. Such networks could include estate management committees in redevelopment projects and residential associations.

#### **4.6.6 Project Management by Contract**

Project planning and implementation in ISUPs is a primary mandate of the Ministry of Lands, Housing and Urban Development through the KENSUP department. This responsibility is delivered through contracted professional entities with the ministry assuming an oversight role. The ministry provides guidelines for undertaking an assignment against which systematic review is done. The assignments include: preparation of infrastructure plans, resettlement action plans, environmental and social management plans; construction of infrastructure and monitoring of project performance. Once the tasks are complete, the adequacy of the output is assessed by lead agencies in the area of physical planning, sectoral infrastructure and environment. In addition, the planning and construction process regularly assessed other actors in the ISUP network such as the IACC, PIU, MSSG and SEC. This allows for broad stakeholder inclusion in the project planning and implementation process.

The contract based arrangement makes two assumptions: that the contracted agencies will work harmoniously during plan preparation and that the planning output will be adequately absorbed within the infrastructure construction process. This is however far from the case because the ISUP infrastructure plans do not demonstrate inclusion of EMP design proposals such as provision of green spaces, waste receptacle points, waste recycling and rainwater harvesting facilities. It also assumes that the contracted agencies will involve actors within the ISUP network in decision making. This is however not the case since the SEC, county level PIU and sectoral agencies mentioned that they were not adequately consulted during the planning process. This was also evident at the settlement level where the level of participation in environmental assessment was 11.1%; 6.4% in baseline survey and 5.1% in

resettlement action planning. The oversight role of KENSUP department should ensure that actors in the network such as IACC, MSSG and SEC can permeate the contracted agencies to allow for inclusive decision making and corrective actions during construction. The SEC members for instance observed that their efforts to raise concerns over poorly constructed storm water drains were not effected by the PIU and KENSUP department. This is indicative of weak supervisory authority on the part of KENSUP department. The principal agent theory explains that the later occurs as a result of the agent's perceived and actual expertise which exceeds that of the principal (Rydin, 2012; Scott, 2015). Humphreys (2016), notes that experts often exercise agency in spaces which they are not familiar with leaving actors at the local level with limited influence over the management of their own space.

## **5. CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS**

### **5.1 Summary**

The overall environmental sustainability scores show that Decanting settlement in Nairobi has the highest rating with a score of 62.5% of the maximum possible score. Manyatta in Kisumu has lowest performance with a score of 37% of the maximum possible score. Settlements in Nairobi have a higher average score of 104 points compared to those in Mombasa and Kisumu which have 88.25 and 72.75 points respectively. The performance of settlements in Nairobi and Mombasa is however not significantly different. The scores in Kisumu settlements are significantly different from settlements in Mombasa and Nairobi. Settlements upgraded through redevelopment, Canaan and Decanting, have the highest rank among the eleven settlements.

Decanting settlement ranked highest in resource consumption category while Obunga and Nyalenda A in Kisumu ranked lowest. This category is a composite of five indicators namely, water consumption, water conservation, energy consumption, energy conservation and non-motorized transport usage. All the settlements have average per capita water consumption below the minimum WHO recommended amount of 50 l/c/d and the 75 l/c/d standard set by the Practice Manual for water service delivery in Kenya for low income settlements. The most significant factors affecting water consumption in the three cities are water supply intermittence in Nairobi, locational and service operation challenges in Kisumu

and prohibitive water prices in Mombasa. 83.3% of the households have adopted water conservation measures. There is a significant difference in adoption of water conservation measures between the three Kenyan cities. Nairobi has the highest level of adoption (61.6%). Water recycling is the most popular mode of conservation while use of water saving devices is least common. There is a strong correlation between water recycling and water supply intermittence implying that recycling could be motivated by water scarcity rather than environmental values. Redeveloped settlements do not provide for rainwater harvesting or waste water recycling though it is a requirement within the Building Code of 2009.

Regarding energy usage and conservation, 89.6% of the residents in upgraded settlements use electricity as a main source of energy for lighting. There is no significant difference in electricity usage between Nairobi, Kisumu and Mombasa. The most common sources of cooking energy are charcoal and wood fuel, LPG and kerosene at 52.4%, 27.6% and 20% respectively. 88.8% of the households have adopted at least one lighting energy conservation measure while 66.9% have adopted a cooking energy conservation measure. Use of energy saving bulbs and energy saving cookers is the predominant energy conservation measure. Renewable energy sources such as solar and biogas are rarely used. Income has a significant but negative correlation with adoption of energy saving measures among households.

Non-motorized transport is used by 53.8% of the residents in upgraded settlements. There is no significant difference in usage of non-motorized transport

between the three cities. Among the households' characteristics that were tested, only income has a significant correlation to walking and cycling. Increased income has a negative influence on the use of non motorized transport.

27.2% of the households use city county services for waste disposal, 20.1% use community based organizations, 43.2% use open dumping, 3.1% use burning while 6.3% use mixed disposal methods. More households in Nairobi have access to waste collection services compared to Mombasa and Kisumu. Recycling of biodegradable waste is practiced by 2% of the households while 4.8% recycle their non-biodegradable waste. Frequency trends show that households who recycle their waste have characteristically low incomes, basic education, less than 3 household members and below average environmental value rating. There are a total of four recycling facilities in the eleven upgraded settlements. Three of these facilities are used for recycling plastic and metal waste while the other one is designed to recycle biodegradable and non-biodegradable waste. 70.1% of the households share toilet facilities. There is a significant difference between cities in the percentage of households sharing facilities implying city level influence. 54.5% of the residents use pit latrines despite the provision of sewer in ten out of the eleven settlements.

Residents perceive the environmental quality of their settlement to be either very desirable (8.3%), desirable (39.9%), fair (31.2%), undesirable (15.8%) or very undesirable (4.5%). Perceived environmental quality bears a significantly strong correlation with housing tenure. In settlements with high owner tenant ratio,

residents have devised strategies to improve environmental quality including coproduction of municipal services. 81.8% of the residents in upgraded settlements have been treated for waterborne diseases in the last one year. Settlements with perceived high environmental quality do not necessarily have lower disease incidences and vice versa. Four out of the eleven settlements have areas designated as open space which are used for recreational activities and community meetings. The open spaces in two of the four settlements are inaccessible. They are characterized by overgrown grass and heaps of waste.

A community based environmental management plan is available in one out of the eleven settlements. It has been developed by the SEC implying that there exists capacity at settlement level for preparation of community based EMPs. A total of 45.7% of the households have participated in the informal settlement upgrading processes with the lowest level of involvement being passive attendance of meetings. The participation rate in the eleven settlements ranges between 80% and 12.9%. There is a significant negative correlation between residents' participation in informal settlement upgrading activities and family size, age of household head, income level and number of years lived in a settlement. There is no significant difference between level of household participation in upgrading activities between cities. 28.4% of the residents are members of a community based organization. Out of these, 63% are in settlements within Kisumu, 20% in Mombasa while 17% are in Nairobi. There is a strong correlation between the period lived in a settlement and participation in upgrading activities. All the eleven settlements apart from Canaan and Decanting, have active partnerships

between community and business entities such as microfinance, communication firms and industrial firms. Settlements with high number of partnerships also exhibit a high level of CBO membership. These partnerships are aimed at increasing access to business and personal credit facilities, facilitating purchase of household assets such as LPG gas cylinders and solar home systems, improving environmental quality through tree planting and conducting regular clean ups.

Based on the overall sustainability performance scores, Decanting has the highest score of 62.5% while Manyatta has the lowest score of 37%. The three settlements in Nairobi ranked first (Decanting), second (Canaan) and fourth (Kayole KCC) with 62.5%, 61.4% and 53.4% of the total score respectively. In Mombasa, the total score percentage ranges from 56.3% in Ziwa la Ngombe, 48.9% in Jomvu Kuu, 48.3% in Ziwa la Ngombe to 47.2% in Jomvu Mikanjuni. The percentage of total scores in Kisumu is 46.6% in Nyalenda B, 42% in Nyalenda A, 39.8% in Obunga and 37% in Manyatta. Overall, settlements in Nairobi have the highest mean score while Kisumu has the lowest. The results revealed significant difference in mean scores between Nairobi, Kisumu and Mombasa. Therefore, the study concludes that there is no difference in environmental performance between upgraded settlements in Nairobi, Mombasa and Kisumu.

The analysis shows that 62.6% of the variation in overall environmental sustainability scores in the upgraded settlements can be attributed to resource consumption scores; 65.6% variation is attributed to waste management scores, 79.3% to environmental quality and 45.7% to community organization. The latter

is however not significant. Based on these results, environmental quality scores have the highest predictive ratio of 79.3% for environmental sustainability scores in a settlement. Therefore, environmental quality indicator can be used to rate environmental sustainability of multiple settlements in a rapid assessment.

The Kenya Slum Upgrading Program has utilized seven environmental sustainability pathways to varying extent. Environmental infrastructure is inherently the most predominant pathway. The upgraded infrastructure includes: water supply, sanitation, waste management, storm water drainage and open spaces. Water supply interventions involve connections to dwelling unit, provision of service mains, community water kiosks, water storage tanks in communal facilities and borehole water supply. On one hand, the characteristic high plot connections of 93% in Nairobi, 81% in Mombasa and 70% in Kisumu and flexible community based management systems in water kiosks enhance water access in upgraded settlements. On the other hand, intermittent water supply and unregulated prices at water kiosks limit water access. Standard billing in some settlements acts as a disincentive for water conservation. With regard to sanitation, the intervention includes connection of sewer system to the dwelling unit in two out of the eleven settlements, provision of sewer mains in four settlements and ablution blocks in five settlements. Sewer systems are characterized by frequent overflows due to inappropriate usage. The cost and operation hours of the ablution blocks are irregular due to water supply intermittence.

Waste receptacles are provided in two settlements and a recycling facility in one settlement, all which are in Nairobi. One receptacle is provided for all types of waste hence inhibiting segregation. The receptacles in one of the settlements are placed at the periphery of the settlement which inconveniences the residents who are on the far end. The waste recycling facility provides a component for recycling biodegradable and non-biodegradable waste. It is attached to a community hall to enhance the economic benefits of the facility. Storm water drains are mostly open and clogged resulting to flooding during the rainy season. Open spaces are provided in two redeveloped settlements. 50% of the open spaces in Canaan and 75% in Decanting is vegetated. The open space is used for recreational activities and community meetings. 43.2% of the residents are dissatisfied with the infrastructure upgrade. Some of the reasons for dissatisfaction are inadequate infrastructure provision (27.9%), poor workmanship (22.1%), frequent service breakdown (19.5%), lack of community participation (13%), infrastructure service mismanagement (7%), high operational costs (6%), inappropriate siting (2%) and lack of complementary facilities (2%).

Clean technologies adopted by households in upgraded settlements are those that enhance energy consumption efficiency such as energy saving bulbs, energy saving cook stoves and use of briquettes plus those that promote water use efficiency including water saving taps and showers. 15% of the households have adopted one or more clean technologies. There is a significant difference in clean technology adoption among households in the three cities. Since Nairobi has the highest, it would imply that populous cities provide a potent space for permeation

of clean technologies. Technical, environmental and financial challenges were mentioned as the major challenges encountered in the use of clean technologies by 37.1%, 14.5% and 6.5% of the respondents respectively. Programs to promote the use of these technologies in informal settlements are mainly geared towards providing information and innovative financial solutions to the residents.

Housing tenure regularization processes in the eleven upgraded settlements include: planning, survey and securing titles in nine settlements; house purchase arrangement in Canaan; and legal tenant occupancy in Decanting settlement. Land titles are issued to structure owners hence the variation in owner tenant ratio in the settlements. As a result of titling, the nine settlements have become vulnerable to gentrification. The house purchase arrangement provides an opportunity for residents to become house owners through a mortgage scheme. A household can either occupy the house or rent out. Though sale of housing units is discouraged, some of the residents have already sold the allocated houses. The public housing estate provides legal tenant occupancy to informal settlement residents. This public housing arrangement is characterized by low involvement of residents in estate management meetings, high number of rent defaulters and poor waste management despite the existence of waste disposal facilities. Housing tenure is significantly correlated to two out of the fifteen measured indicators, water consumption and environmental quality, implying that it is not a major determinant of environmental sustainability in upgraded settlements.

The use of environmental education as an environmental integration tool in ISUPs is multi levelled. At the institutional level, workshops and meetings are used to build staff capacity on management of environmental issues related to informal settlement upgrading. The training workshops target project officers at the national and county level. The training is tailored towards safeguarding the ecosystem and human health during the project construction phase. This approach limits the scope of environmental integration to one phase rather than the entire project life cycle. At the settlement level, members of SEC are trained by the project staff on environmental safeguards during project implementation phase. The limitation of training scope to environmental safeguards in one project phase influences the nature of environmental management strategies that are devised at the settlement level. At the household level, residents in upgraded settlements receive information and training on environmental management from the SEC, NGOs and CBOs working in these settlements. These multiple sources expose residents to a wider scope of environmental information including environmental safeguards in project construction, clean energy sources, waste management, sanitation practices and community organization. The response to this information is however limited by lack of physical and social structures through which certain actions have to be carried out.

The informal settlement upgrading processes allows for establishment of local institutions to link residents and community based groups to the project coordinating unit and implementing agencies. These local institutions have been actively involved in environmental management evidenced by past and on-going

community based activities. These initiatives however are often uncoordinated and adhoc. Their efforts have positively affected environmental sustainability indicators such as water consumption in Canaan, environmental management planning in Ziwa la Ngombe and participation in upgrading activities in the eleven settlements.

Environmental Impact Assessment is a legal requirement and is undertaken during the project planning phase. Four EIA project reports were developed including: KCC Kayole, Kisumu settlements, Mombasa settlements and Canaan. KCC Kayole report shows the highest level of environmental sustainability considerations while the Canaan report demonstrates the least consideration. Canaan and Kisumu reports do not mention any implication of the proposed upgrading on resource consumption. KCC Kayole report takes cognisance of the impact of the project on water and electricity demand. It mentions rainwater harvesting at household level, adoption of solar systems and sensitization on resource use efficiency as appropriate mitigation measures. Waste management particularly recycling of waste at the household level is mentioned in all the four reports. The four reports highlight the need for good environmental quality. None of the reports mentions the need for creation or improved maintenance of open spaces. One report provides measures to mitigate exacerbation of waterborne diseases as a result of clogged storm water drains and inadequate water to sustain the sewer system. All the reports state the need for resident participation in environmental management and development of environmental management plans. CBOs are mentioned in all reports apart from Canaan as vehicles through

which community environmental management plans can be implemented. None of the reports identifies partnerships which the project could leverage on in the implementation of the Environmental Management Plan (EMP). The EIA reports place more emphasis on mitigating nuisance such as dust, noise and hazards compared to improving existing environmental quality. This is aggravated by sectoral laws which focus on environmental mitigation measures during the construction phase. As a result, the EIA does not offer a solid pathway through which environmental sustainability can be integrated into ISUPs.

Common green enterprises in upgraded settlements include waste collection, recovery of waste materials, management of communal toilet facilities, production and sale of briquettes and energy saving jikos and bead making using recovered waste materials. Waste management and sanitation present the most common avenues for establishment of these enterprises. 5.8% of the residents have at least one household member who is engaged in green entrepreneurship. The enterprises leverage on the absence of municipal services, the characteristic high population density and community cohesion. They mostly operate as CBOs with one of the mandates being environmental management. The highest monthly income from green enterprises is Ksh 30,000 per household. 0.7% indicated that they do not earn anything from the enterprise since the proceeds are used in communal projects.

Government led informal settlement upgrading projects in Kenya are implemented through a multi-agency program based approach. The Inter Agency Steering

Committee (IASC) was the supreme decision making body. It draws membership from relevant ministries, county governments and development partners. It assumed dormancy in 2011 when the Kenya Slum Upgrading Program (KENSUP) was restructured into a department within the Ministry of Lands, Housing and Urban Development (MoLHUD). Its role was assumed by the ministry's Cabinet Secretary (CS). The Inter Agency Coordinating Committee (IACC) is structured below the IASC and is responsible for diffusing policy recommendations from IASC and providing technical expertise in the program. The IACC has a membership composition similar to IASC. Though the IACC position has not changed, its mode of engagement has changed from regular to adhoc. The KENSUP secretariat is responsible for the general coordination of all ISUP activities. It receives strategic and technical support from IASC and IACC respectively. It bears direct link with all the actors apart from IASC. It was initially domiciled in the MoLHUD as a program support unit but in 2011 it was restructured into a ministerial department. As a department, the secretariat has less operational flexibility as it is subject to bureaucratic systems of a public organization. The extent to which it can propel environmental policy integration in ISUPs is determined by existing organizational constructs and channels.

The Project Implementation Units (PIUs) are established within the county government and are responsible for the design and construction of infrastructure. Membership is drawn from relevant departments within the county government. The Multi Stakeholder Support Group (MSSG) is positioned below the secretariat and the PIUs to play a project monitoring role and provide feedback. It has a

broad stakeholder representation of government agencies, development partners and civil society and community representatives. The Settlement Executive Committee (SEC) links the community to the KENSUP Secretariat and Project Implementation Unit. Its primary role is to mobilize the community to participate in upgrading activities within their settlements.

New networks have emerged since the program was inception. The link between National Environment Management Authority (NEMA) and KENSUP secretariat provides regulatory and technical support in environmental matters. It complements the IACC as the repository of technical expertise. KENSUP secretariat has a direct link with professional organizations who provide technical expertise in development of environmental plans. Resident Associations, Community Based Organizations and Community Based Service Providers augment the SEC in community mobilization and project monitoring.

Reconstruction of IS upgrading institutional structure and function presents significant implications for environmental sustainability integration in ISUPs. The shift in strategic support role from IASC to the CS in the ministry in charge of housing implies that the environmental sustainability agenda has to compete with other multiple housing development agendas in the boardroom. As a result, there are limited strategic recommendations to address environmental sustainability in upgrading processes. The change in IACC mode of engagement from regular to adhoc provides urgent response mechanism for specific project matters on one hand while on the other hand irregular involvement limits sustained active

participation of stakeholders. The latter is not suitable for supporting a long term mainstreaming agenda such as environmental sustainability. The PIU which is primarily the implementing organ has acquired a new role of coordinating and devising mechanisms for uptake of technical input from new actors including professional consultants, NEMA and community based organizations. Initially this information was transmitted through a single channel from IACC to the PIUs. This could imply an overload on the PIUs which negatively affects its performance.

The Multi Stakeholder Support Group has retained its project monitoring role without any additional functions. Its composition has varied over the years but it has not attracted vibrant environmental players. The Settlement Executive Committee has adopted new roles in addition to the previous functions including: development of community based plans to guide infrastructure maintenance; negotiation for service provision and estate management oversight. The roles are instrumental in propagating environmental management. The additional roles have however been taken up without commensurate capacity. New actors that have emerged at the community level including residential associations, grievances redress committee, CBOs and community based service providers have taken up some of the functions of SEC such as community mobilization and project monitoring. The active participation of new actors at this level helps to address the capacity gap within SEC.

Institutional structural dynamism in ISUPs is driven by emerging needs and perceived or actual inefficiency of existing institutions. Its implication on

environmental management in upgraded settlements is twofold. On one hand, the emergence of new actors increases the conduits through which environmental sustainability information can flow. It also minimizes the risk of patronage by some actors who have control over resources. On the other hand, the numerous actors that result from the organic networks pose coordination challenges. The latter impairs efforts to diffuse environmental sustainability goals in the ISUP cycle. Institutional structures and functional reconstruction affect environmental policy integration processes, stakeholder participation, institutional coordination, community participation and project management all which consequently influence environmental sustainability outcomes.

## **5.2 Conclusion**

There is no uni-dimensional approach to improved environmental sustainability performance in upgrading processes. The performance of environmental sustainability domains in upgraded settlements is unequally mediated by household characteristics, settlement upgrading interventions and city level factors. Cities have a greater impact on the overall environmental sustainability performance of these settlements. Upgraded settlements in bigger cities perform better in overall environmental sustainability than those in smaller cities. The growth and emergence of big cities should therefore not be perceived as a sustainability risk since it bears potential for influencing environmental sustainability in the informal settlement space. However, some specific indicators perform well in Mombasa and Kisumu compared to Nairobi. Smaller cities can leverage on the well performing indicators to spur the other indicators towards improved performance.

Settlements upgraded through redevelopment exhibit higher performance in environmental sustainability compared to those upgraded through infrastructure provision. This is because redevelopment of informal settlements provides a wider space for integration of environmental management aspects during planning. Community organization, which exhibits high performance in settlements upgraded through infrastructure provision, provides a competitive edge through which the performance of other domains can be improved.

A parallel pursuit of both adequate housing and environmental management goals is one of the greatest barriers to towards progressive environmental sustainability in ISUPs. Integration of the two goals during the planning stage could enhance most of the expected outcomes without any significant increase in project costs.

Existing pathways to environmental sustainability in ISUPs is not adequately optimized. This is due to poor institutional coordination, conventional decision making processes that fail to take into consideration sustainability dynamics in an upgraded space and lack of regulatory frameworks to support their utilization. Housing tenure regularization is not a significant environmental sustainability pathway in upgraded settlements.

The multi-agency ISUP institutional structure provides multiple channels through which environmental sustainability goals can be infused into the upgraded settlement space. The environmental sustainability performance of upgraded

settlements is negatively influenced by reconstruction of this structure as a result of actor redundancy, additional actor roles without commensurate capacity increase and multiplicity of actor networks in the context of weak coordination mechanisms. Similarly, the reconstruction bears positive environmental sustainability impact due to emergence of organic networks to address institutional gaps and new actors that play complementary roles.

### **5.3 Recommendations**

Based on the findings of the research, discussed in Chapter four, and the conclusions listed above, the following recommendations on improving the environmental sustainability in ISUPs are made:

- i. Multi stakeholder approach towards informal settlement upgrading should be adopted to allow for an integrative approach to infrastructure upgrading in informal settlements. This will also ensure sustainable infrastructure service delivery in the upgraded settlements.
- ii. A guideline for undertaking environmental impact assessment in ISUPs should be developed to improve environmental sustainability consideration. The environmental impact assessment process should systematically allow for strategic environmental assessment at the program level, environmental impact assessment at the project level and community environmental management plans at the settlement level.
- iii. KENSUP should establish a functional environmental unit to coordinate the environmental activities within ISUP
- iv. The link between the Inter Agency Steering Committee and the Ministry of Lands Housing and Urban Development should be strengthened to

enhance environment policy integration at the program planning level. The role of the Inter Agency Coordination committee as technical repository of the program should be reinstated. It should acquire a new function of coordinating all the professional actors within so as to ensure effective utilization of information generated within this institutional framework (Appendix V)

- v. Active stakeholder participation should be sustained through regular rather than adhoc actor engagement.
- vi. There is need to increase the capacity of Settlement Executive Committee to mobilize resident involvement in informal settlement upgrading projects and develop community environment management plans.

#### **5.4 Areas of further studies**

This study provides a basis upon which further studies can be undertaken to expand empirical research in this field.

##### **Social sustainability performance of upgraded settlements**

- i. This study assessed environmental sustainability performance of upgraded settlements in Kenyan cities. Further studies should assess the social sustainability performance of upgraded settlements with a view of establishing areas of convergence in the construction of social and environmental sustainability in this space.
- ii. The study mainly focused on environmental sustainability performance of the residential space in upgraded informal settlements in Kenyan cities. Further studies should assess the environmental sustainability of other

spaces that define the metabolic process of the upgraded settlements so as contribute towards a comprehensive list of indicators

#### Environmental sustainability pathways

- iii. This study focused on assessing the efficacy of selected environmental sustainability pathways in ISUPs. Further studies should undertake an in depth analysis of these pathways to determine how they are conceptualized, their construction dynamics and path dependency.

#### ISUP institutional arrangement and environmental sustainability implications

- iv. Further studies should focus on analysing contemporary issues in ISUP institutional arrangement and their implications on environmental sustainability.

### **5.5 Contribution to Knowledge**

This study applies the environmental sustainability assessment framework to the informal settlement upgrading space adding to the existing knowledge on sustainability in the wider urban space. While there are numerous urban sustainability indicator lists, there is no specific list of indicators for assessing upgraded settlements in urban areas. This research derives distinct sustainability domains, indicators and indices that shape upgraded settlements from the generic urban sustainability indicators leading to development of a list of environmental sustainability indicators for upgraded settlements.

The methodology that is used in this study to rate environmental sustainability performance of upgraded settlements indicates three sustainability indicators that have the highest predictive ratio. If replicated in a similar study, these three indicators can be used to perform preliminary and rapid settlement ranking.

The study results demonstrate the applicability of extended metabolism concept in sustainability assessment of a defined socio spatial space. Though the concept has been widely applied in towns and cities, there is limited application on smaller metabolic units such as a settlement. This research provides information on the applicability and limitations of using this concept at a micro scale. The development of environmental sustainability indicators based on this concept builds on existing knowledge on processes of constructing assessment frameworks on the basis of theories and models.

The identified environmental sustainability pathways in informal settlement upgrading processes widen the constrictive boundaries that have characterized urban sustainability assessment over the years. It illuminates new variables of consideration in the assessment of environmental sustainability of a program. This will increase the rigor of future research in this field and enhance the resultant environmental sustainability plans in varied urban improvement processes.

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## APPENDICES

### Appendix I: Spearman's correlation of adoption of energy conservation measures and household characteristics

<b>Correlation factor</b>	<b>Housing tenure</b>	<b>Income</b>	<b>Education</b>	<b>Household size</b>
<i>Level of adoption of cooking energy conservation measures</i>				
Co efficient	0.034	-0.189	-0.157	-0.09
Signifance level	0.406	0.000	0.000	0.051
<i>Level of adoption of lighting energy conservation measures</i>				
Co efficient	-0.002	-0.192	0.069	0.009
Signifance level	0.96	0.000	0.088	0.816

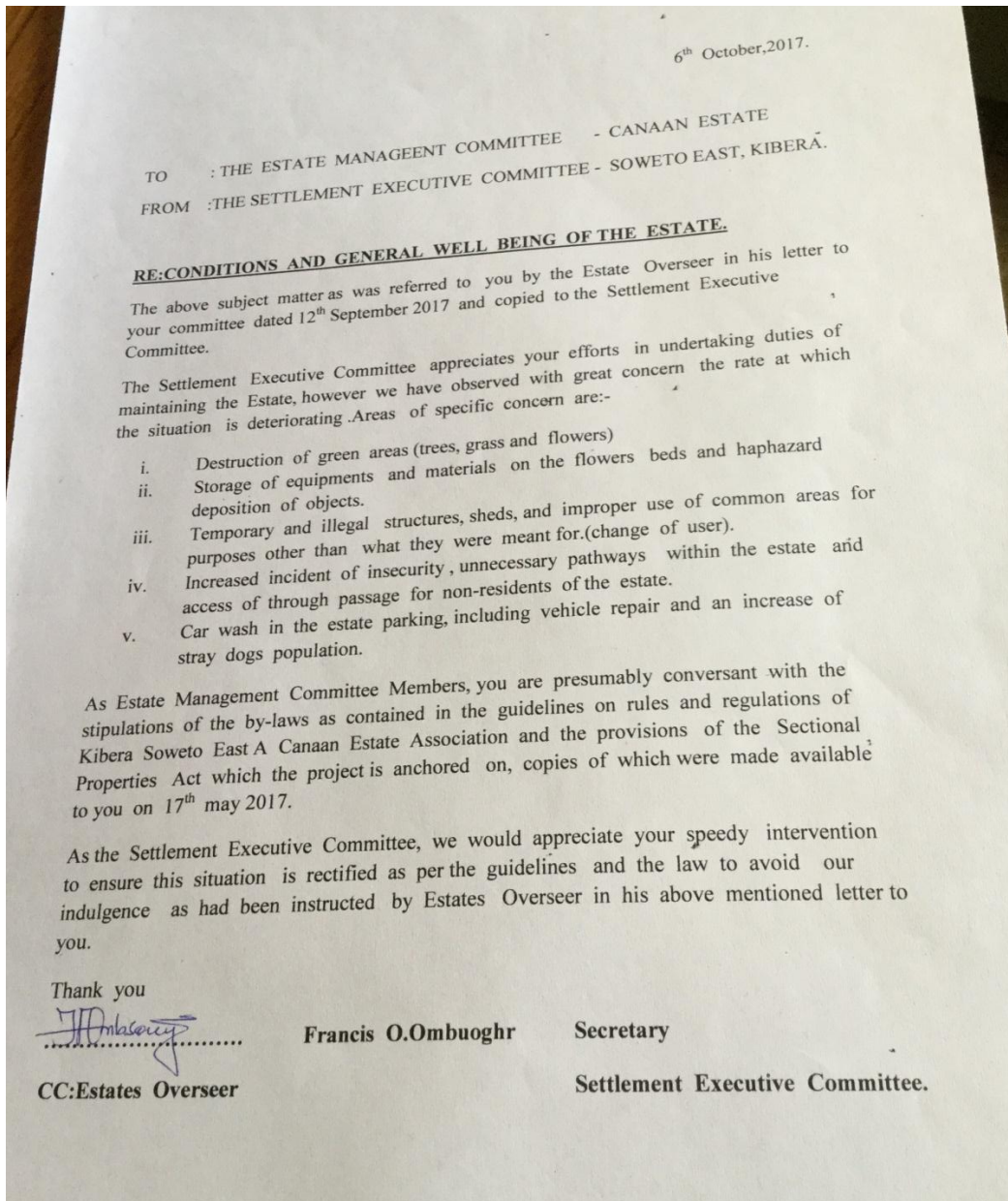
### AppendixII: Multi Correlation between category scores and overall sustainability scores

	<i>Resource Consumption</i>	<i>Waste Management</i>	<i>Environmental Quality</i>	<i>Community Organization</i>	<i>Environmental Sustainability</i>
<i>Resource Consumption</i>	1				
<i>Waste Management</i>	0.148909	1			
<i>Environmental Quality</i>	0.524235	0.185277	1		
<i>Community Organization</i>	-0.77641	-0.32056	-0.41991	1	
<i>Environmental Sustainability</i>	0.625802	0.65631	0.792628	-0.45688	1

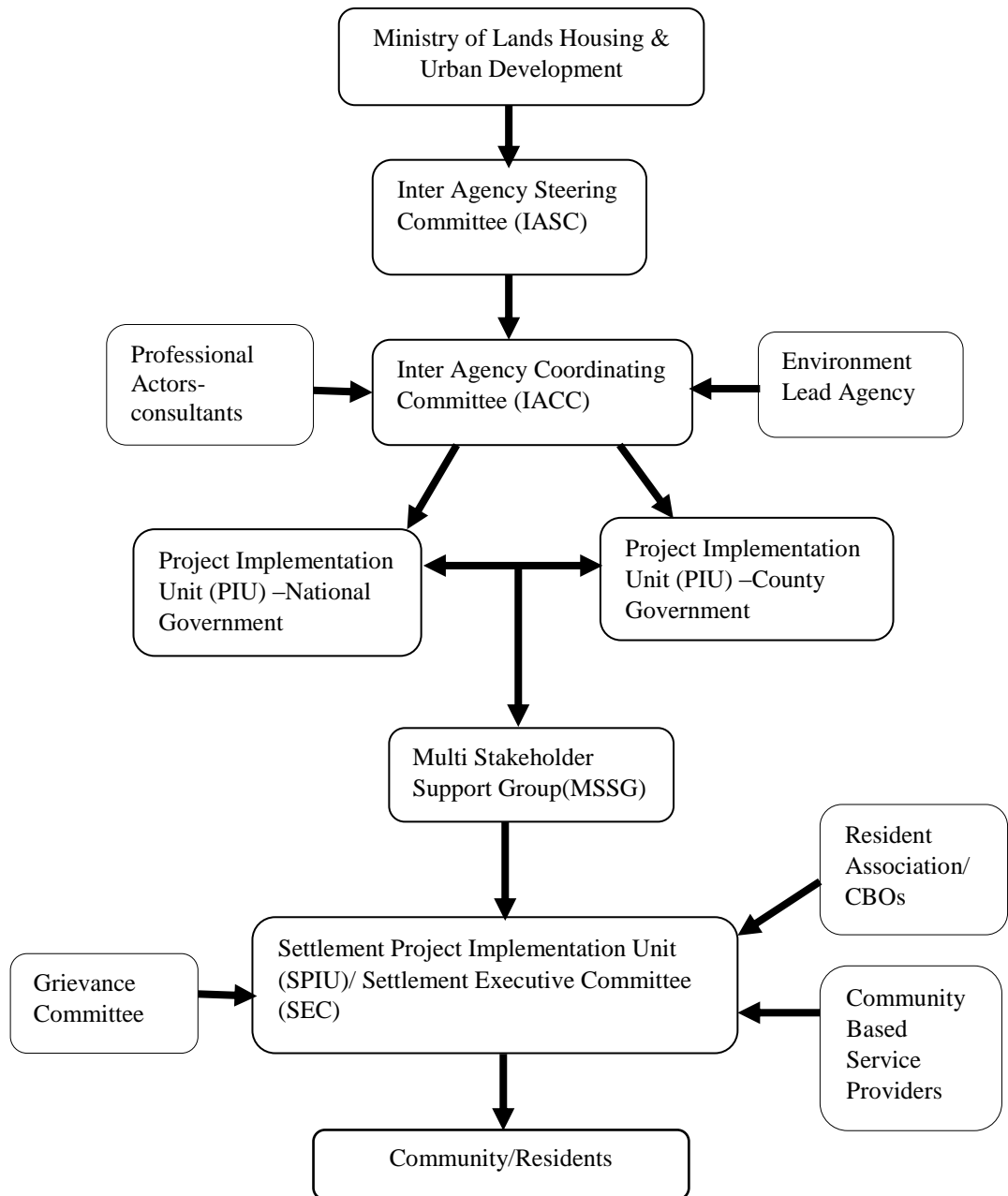
**Appendix III: KENSUP project areas in Nairobi, Mombasa & Kisumu**

<b>City</b>	<b>Upgraded Settlement</b>	<b>Upgrading on going</b>	
Nairobi	Embakasi KCC Kayole Soweto Kibera	Embakasi Village	Kosovo Mathare
		Ghetto	Mathare 4B
		Gitathuru	Mathare Mashimoni
		Kahawa Soweto	Njiku Waithaka
		Kambi Moto	Redeemed
		Kanuku Kinyago	Mji wa Huruma
		Kitui	
Mombasa	Ziwa la Ng'ombe Mkomani Jomvu Kuu Jomvu Mikanjuni	Kwa Hakatsa	Gana Hola
		Kindunguni	Chaani Kwarasi
		Kisumu Ndogo	Chaani Mathare
		Misufini	Chaani Kalahari
		Mwatate	
Kisumu	Manyatta Arab Obunga Nyalenda	Kaloleni	Obunga
		Kopere	Swahili Village
		Manyatta Arab	ShauriYako
		Nyawita	

**Appendix IV: Communication from Canaan Settlement Executive Committee on open space management**



**Appendix V: Recommended Institutional Framework for Implementation of Informal Settlement Upgrading Projects**



### Appendix VI: Work Plan

Project Activities/ Time Frame	2016/2017		2016/2017		2016/2017		2017/2018		2017/2018		2017/2018		2018/2019		2018/2019	
	Sept-Dec	Jan-April	May-Aug	Sept-Dec	Jan-April	May-Aug	Sept-Dec	Jan-April	May-Aug	Sept-Dec	Jan-April	May-Aug	Sept-Dec	Jan-April	May-Aug	Sept-Dec
Proposal Development																
Field Reconnaissance																
Data Collection																
Data entry & analysis																
Development of a draft thesis																
Submission of thesis																

### Appendix VII: Budget

Item	Cost (Ksh)	Total Cost(Ksh)
YEAR 1		
Books	20,000	20,000
Journal subscription fee	10,000	10,000
Printer	12,000	12,000
Stationery	24,000	24,000
<i>Sub total</i>		62,000
YEAR 2		
Books	20,000	20,000
Journal subscription fee	10,000	10,000
Printer	40,000	40,000
Stationery	20,000	20,000
Transport	40,000	40,000
Accommodation	30,000 per city@ 2 cities	60,000
Research Assistants	50,000 per city@3 cities	150,000
SPSS software	5,000	5,000
<i>Sub total</i>		345,000
<i>DAAD</i>		(190,000)
		155,000
YEAR 3		
Stationery	50,000	50,000
<i>Sub total</i>		50,000
<b>Total</b>		<b>457,000</b>

## Appendix VIII: Questionnaire

### KEY INFORMANT INTERVIEW SCHEDULE (Program Secretariat)

Name of the organization.....

Department within the organization .....

Position in the Organization .....

*My name is ..... from Kenyatta University. I am conducting a PhD study on the topic titled **Environmental Sustainability in Informal Settlement Upgrading Programs in Kenyan Cities**. I am therefore seeking your views on the contribution of KENSUP/KISIP to the environmental quality in informal settlements. Your participation is voluntary and your responses will only be used for purposes of this study.*

[1] Program:

KISIP

KENSUP Kenya Slum Upgrading Project  Mombasa Slum Upgrading Project  Kisumu Slum Upgrading Project

#### **General program information**

[2] Institutional mandate with regard to informal settlement upgrading

[3] Organizational structure (linkage with key agencies)

[4] Informal settlement upgrading strategy: rationale, objective, intervention strategies, program partners. (program reports)

#### **Program conceptualization**

[5] Does the philosophy, rationale or theory of change mention causal links between environment and poverty? (*Concept document*).

[6] How many program objectives explicitly relate to environmental sustainability?

[7] Which other environmental considerations were made in the program conceptualization? (are there specific targets/actions e.g. in *annual work plans*)

[8] Were the environmental considerations at the conceptualization stage informed by national/county policies e.g. Environment Policy, CEP, NEAPs, CIDPs others?

[9] Which environmental players were involved in the concept development?

[10] What factors may have influenced the environmental actors level of involvement (concept development timeframe, budget, conflicting interests)

**Program funding**

[11] What were the various sources of funding for the program?

Donor	Amount/percent of total program cost	Components funded	Requirements (environmental)	Recommended envtal integration approach Tools,methods, personnel, database, assessment & reporting, feedback	Budgetary allocation for EI
	Financial report	Funding document		Envtal policy, guidelines	
1.					
2.					
3.					

**Program implementation**

[12] Does the program have an environmental coordinating unit/department-no of staff, capacity vs training, and equipment?

[13] What are the functions?

[14] How does the unit relate with other partners involved in the program implementation? Is there an inter-institutional unit? Are there other leverage platforms which facilitate this coordination?

[15] What is the frequency of meeting –inter-institutional forum/unit? Does this play a coordinating role or a technical role or both?

[16] Does the program have an environmental policy/guideline/manual for all its stakeholders –consultants, community, partner agencies

[17] What specific program interventions have been implemented that directly affect environmental quality in targeted settlements?

Intervention category	Quantity	Effect/	Document
-----------------------	----------	---------	----------

	<b>*settlement coverage</b>	<b>Recommendation</b>	<b>Reference</b>
Infrastructure e.g. Sanitation facilities, green spaces			
Technological intervention e.g. decision making, energy, water, recycling, green roofs			
Alternative process intervention e.g. Walking/cycling			
Education e.g. Awareness			
Market Based e.g. green enterprises			
Social e.g. land/housing tenure			
Institutional e.g. local plans			

- [18] What have been the major environmental outcomes in the program- including discrepancies between intended and achieved (*log frame*)
- [19] Method and tools adopted in environmental assessment, monitoring, reporting and improvement (system-personnel, actors, frequency of reporting; SEA, EIA, EA,ISO, OHS tools, Information Database)
- [20] Systemic technology adopted to enhance integration? (GIS)
- [21] Partnership and collaboration with local community, private sector, government and expert agencies on environmental management
- [22] Policy and institutional incentives for environmental integration- performance contracting, donor reporting requirements, additional funding from existing and new donors
- [23] Institutional capacity (financial-budgetary allocation Technical-staff-numbers and expertise).
- [24] Role of county government in facilitating integration efforts (Financing, design, implementation, enforcement, monitoring)
- [25] Institutional/ social/financial challenges in the environmental integration process
- [26] What measures have you taken to address these challenges?  
Funding/training etc

[27] Challenges and recommendations for enhancing environmental sustainability in informal settlement upgrading

**KEY INFORMANT INTERVIEW SCHEDULE (Donor agencies-UN-Habitat, World Bank, Government of Kenya)**

Name of the organization.....

Department within the organization .....

Position in the Organization .....

*My name is ..... from Kenyatta University. I am conducting a PhD study on the topic titled **Environmental Sustainability in Informal Settlement Upgrading Programs in Kenyan Cities**. I am therefore seeking your views on the contribution of KENSUP/KISIP to the environmental quality in informal settlements. Your participation is voluntary and your responses will only be used for purposes of this study.*

[1] Program:

KISIP

KENSUP  Cities Without Slums  Kibera Slum Upgrading Program

Mombasa Slum Upgrading Program

**General organizational and program information**

[2] Institutional mandate with regard to informal settlement upgrading

[3] Organizational structure (linkage with key agencies) involved in slum upgrading in Kenya

[4] Informal settlement upgrading strategy: rationale, objective, intervention strategies, program partners. (program reports)

**KENSUP/KISIP Program conceptualization**

[5] Does the philosophy, rationale or theory of change allude to the impact of environmental quality on the broader program goal? (*Concept document*).

[6] Which other environmental considerations were made in the program conceptualization? (are there specific targets/actions e.g. in *annualworkplans*)

[7] Were the environmental considerations at the conceptualization stage informed by national/county policies e.g. Environment Policy, CEP, NEAPs, CIDPs, donor environmental policy?

### Program funding

[8] What was your organizational contribution towards the program?

	Amount/percent of total program cost	Components funded	Requirements and conditions (environmental)	Recommended envtal integration approach Tools,methods, personnel, database, assessment & reporting, feedback	Budgetary allocation for EI Amount& Percentage
	Financial report	Funding document		Envtal policy, guidelines	
1.					
2.					
3.					

[9] What was the mode of funding? General budgetary support/ sectoral financing

[10] In your own opinion, does this mode of funding influence environmental integration –donor control over resources? How has this been addressed?

### Program implementation

[11] Do you have an environmental coordinating unit/department for this program? (no of staff and capacity-training, equipment, budgetary allocation)

[12] What are the functions/responsibilities?

[13] How does the unit relate with other partners involved in the program implementation e.g. program secretariat? Is there an inter-institutional unit? Are there other leverage platforms which facilitate this coordination?

[14] Does the organization have an environmental policy/guideline/manual for all its stakeholders –partner agencies. Are there policy dialogues with partners on policy development?

[15] What specific program interventions have been implemented that directly affect environmental quality in targeted settlements?

<b>Intervention category</b>	<b>Quantity</b>	<b>Effect/ Recommendation</b>	<b>Document Reference</b>
Infrastructure e.g. environmental infrastructure			
Technological intervention e.g. decision making, energy, water, recycling, green roofs			
Alternative process intervention e.g. Walking/cycling			
Education e.g. Awareness			
Market Based e.g. green enterprises			
Social e.g. land/housing tenure			
Institutional e.g. local plans			

- [16] What have been the major environmental outcomes in the program- including discrepancies between intended and achieved (*log frame*)
- [17] Method and tools adopted in environmental assessment, monitoring, reporting and improvement (system-personnel, actors, frequency of reporting technology; SEA, EIA, EA, Information Database). Have they been effective? Are there lessons on successful environmental integration that can be drawn from other programs?
- [18] Partnership and collaboration with local community, private sector, government and expert agencies on environmental management
- [19] Policy and institutional incentives for environmental integration for organizational staff, partners and government -performance contracting, donor reporting requirements, additional funding
- [20] Role of county government in facilitating integration efforts (Financing, design, implementation, enforcement, monitoring)
- [21] Institutional/ social/financial challenges in the environmental integration process
- [22] What measures have you taken to address these challenges?  
Funding/training etc

[23] Challenges and recommendations for enhancing environmental sustainability in informal settlement upgrading

**KEY INFORMANT INTERVIEW SCHEDULE (Ministry of Lands, Housing and Urban Development; relevant county departments)**

Name of the organization.....

Department within the organization .....

Position in the Organization .....

*My name is ..... from Kenyatta University. I am conducting a PhD study on the topic titled **Environmental Sustainability in Informal Settlement Upgrading Programs in Kenyan Cities**. I am therefore seeking your views on the contribution of KENSUP/KISIP to the environmental quality in informal settlements. Your participation is voluntary and your responses will only be used for purposes of this study.*

[1] Program:

KISIP

KENSUP  Cities Without Slums  Kibera Slum Upgrading Program

Mombasa Slum Upgrading Program

**General organizational and program information**

[2] Institutional mandate with regard to informal settlement upgrading

[3] Organizational structure (linkage with key agencies) involved in slum upgrading in Kenya

[4] Role /responsibility within the program: (program reports)

**KENSUP/KISIP Program conceptualization**

[5] What was your level of involvement in this program conceptualization process

[6] Does the philosophy, rationale or theory of change allude to the impact of environmental quality on the broader program goal?

[7] Which environmental considerations were made in the program conceptualization?

[8] Were the environmental considerations at the conceptualization stage informed by national/county policies e.g. Environment Policy, CEP, NEAPs, CIDPs, donor environmental policy?

[9] Did your organizational targets influence environmental consideration in this process?(are there specific targets/actions e.g. in *annual work plans*)

**Program funding/Resources**

[10] What was your organizational contribution towards the program?

	Resource	Components supported	Requirements and conditions for support (environmental)	Recommended envtal integration approach Tools, methods, personnel, database, assessment & reporting, feedback	Adequacy
	Report	Funding document		Envtal policy, guidelines	
1.					
2.					
3.					

**Program implementation**

[11] Do you have an environmental coordinating personnel/unit/department for this program? (no of staff and capacity-training, equipment, budgetary allocation)

[12] What are the functions/responsibilities?

[13] How does the unit relate with other partners involved in the program implementation e.g. program secretariat, donor? Is there an inter-institutional unit? Are there other leverage platforms which facilitate this coordination?

[14] Does the organization have an environmental policy/guideline/manual for all its stakeholders –partner agencies? Are there policy dialogues with partners on policy development?

[15] What specific program interventions have been implemented that directly affect environmental quality in targeted settlements?

Intervention category	Quantity	Effect/	Document
-----------------------	----------	---------	----------

		<b>Recommendation</b>	<b>Reference</b>
Infrastructure e.g. environmental infrastructure			
Technological intervention e.g. decision making, energy, water, recycling, green roofs			
Alternative process intervention e.g. walking/cycling			
Education e.g. awareness			
Market Based e.g. green enterprises			
Social e.g. land/housing tenure			
Institutional e.g. local plans			

- [16] What have been the major environmental outcomes in the program- including discrepancies between intended and achieved (*log frame*)
- [17] Method and tools adopted in environmental assessment, monitoring, reporting and improvement (system-personnel, actors, frequency of reporting technology; SEA, EIA, EA, Information Database). Have they been effective? Are there lessons on successful environmental integration that can be drawn from other programs?
- [18] Partnership and collaboration with local community, private sector, government and expert agencies on environmental management
- [19] Policy and institutional incentives for environmental integration for organizational staff, partners and government -performance contracting, donor reporting requirements, additional funding
- [20] Institutional/ social/financial challenges in the environmental integration process within the program
- [21] What measures have you taken to address these challenges?  
Funding/training etc
- [22] Challenges and recommendations for enhancing environmental sustainability in informal settlement upgrading

**KEY INFORMANT INTERVIEW SCHEDULE (NEMA, SGS)**

Name of the organization.....  
 Department within the organization .....  
 Position in the Organization .....

*My name is ..... from Kenyatta University. I am conducting a PhD study on the topic titled **Environmental Sustainability in Informal Settlement Upgrading Programs in Kenyan Cities**. I am therefore seeking your views on the contribution of KENSUP/KISIP to the environmental quality in informal settlements. Your participation is voluntary and your responses will only be used for purposes of this study.*

**General organizational and program information**

- [1] Institutional mandate with regard to informal settlement upgrading
- [2] Organizational linkage with key agencies involved in slum upgrading in Kenya
- [3] Role /responsibility within the program: (program reports)

**KENSUP/KISIP Program conceptualization**

- [4] What was your level of involvement in this program conceptualization process
- [5] Does the philosophy, rationale or theory of change allude to the impact of environmental quality on the broader program goal?
- [6] Which environmental considerations were made in the program conceptualization?
- [7] Were the environmental considerations at the conceptualization stage informed by national/county policies e.g. Environment Policy, CEP, NEAPs, CIDPs?

**Program funding/Resources**

- [8] What was your organizational contribution towards the program?

	Resource	Components supported	Requirements and conditions for support (environmental)	Recommended envtal integration approach Tools, methods, personnel, database, assessment &	Adequacy

				reporting, feedback	
	Report	Funding document		Envtal policy, guidelines	
1.					
2.					
3.					

### **Program implementation**

- [9] Do you have an environmental coordinating personnel/ unit/department for this program? (no of staff and capacity-training, equipment, budgetary allocation)
- [10] What are the functions/responsibilities?
- [11] How does the unit relate with other partners involved in the program implementation e.g. program secretariat, donor? Is there an inter-institutional unit? Are there other leverage platforms which facilitate this coordination?
- [12] Does the organization have an environmental policy/guideline/manual for all its stakeholders –partner agencies? Are there policy dialogues with partners on policy development? To what extent have they influenced environmental sustainability outcomes in ISUPs?
- [13] Have you developed any indicators to assess sustainability in redevelopment programs/ neighbourhood sustainability?
- [14] What specific program interventions have been implemented that directly affect environmental quality in targeted settlements?

<b>Intervention category</b>	<b>Quantity</b>	<b>Effect/ Recommendation</b>	<b>Document Reference</b>
Infrastructure e.g. environmental infrastructure			
Technological intervention e.g. decision making, energy, water, recycling, green roofs			
Alternative process intervention e.g. walking/cycling			
Education e.g. Awareness			

Market Based e.g. green enterprises			
Social e.g. land/housing tenure			
Institutional e.g. local plans	Community Environment Management Committee		

- [15] What have been the major environmental outcomes in the program- including discrepancies between intended and achieved (*log frame*)
- [16] Method and tools adopted in environmental assessment, monitoring (*baseline, mid-term progress reports*), reporting and improvement (system-personnel, actors, frequency of reporting technology; SEA, EIA, EA, CMEP Information Database). Have they been effective? In case of consultant engagement, how does the output feed into the program? Are there lessons on successful environmental integration that can be drawn from other programs?
- [17] Partnership and collaboration with local community, private sector, government and expert agencies on environmental management in informal settlements?
- [18] Policy and institutional incentives for environmental integration for partners and government –rating, recognition awards
- [19] Institutional/ social/financial challenges in the environmental integration process within the program
- [20] What measures have you taken to address these challenges?  
Funding/training etc
- [21] Challenges and recommendations for enhancing environmental sustainability in informal settlement upgrading

**HOUSEHOLD QUESTIONNAIRE (Household head)**

---

Program .....

City.....

Settlement..... Village

.....

Respondent Name..... Respondent Code

.....

*My name is ..... from Kenyatta University. I am conducting a PhD study on the topic titled **Environmental Sustainability in Informal Settlement Upgrading Programs in Kenyan Cities**. I am therefore seeking your views on the contribution of KENSUP/KISIP to the environmental quality in informal settlements. Your participation is voluntary and your responses will only be used for purposes of this study.*

**Section A**

1. Background information

Name	Relationship to the HH	Age (years)	Sex (M/F)	Marital Status	Religion	Highest Education Level	Main occupation (For 16 years and over)	Other occupation(For 16 years and over)	Total Monthly Income

2. How long have you lived in this settlement?  
[1] Less than 5 years [2] 5-10 years [3] 11-15 years [4] 16-20 [5] More than 20 years
3. What is your housing tenure arrangement?  
[1] Owner [2] Tenant [3] Sub-letting [4] Others (specify)
4. How many rooms does your household occupy?  
[1] 1 room [2] 2 rooms [3] 3 rooms [4] 4 rooms [5] 5 rooms [6] More than 5 rooms
5. What is the approximate size of all the rooms?  
[1] Less than 3sqft [2] 3-6sqft [3] 7-10sqft [4] 11-12sqft [5] 13-15sqft [6] More than 15sqft
6. Have you been involved in slum upgrading activities?  
[1] Yes [2] No
7. If yes, which program/project were you involved in?  
[1] Government program-KENSUP/KISIP [2] NGO based programs [3] Community based project [4] Others (specify)
8. What level of slum upgrading were you involved?(mention specific activities)  
[1] Planning  
[2] Implementation  
[3] Monitoring  
[4] Others (specify)
9. If No, give reasons.

- [1] Never informed
- [2] Lack of interest in upgrading activities
- [3] Expressed interest but didn't get an opportunity to be involved
- [4] Recently moved into the area
- [5] Interested but was too busy
- [6] Am sceptical of government activities in this area
- [7] Am sceptical of NGOs activities in the area
- [8] Others (Specify)

**Section B: Impact of KENSUP/KISIP on environmental Sustainability**

- 10. How would you rate your level of environment awareness?  
[1] Very High [2] High [3] Average [4] Low [5] Very Low
- 11. How would you rate your level of environmental consideration in your daily activities within the settlement?  
[1] Extreme Consideration [2] Moderate Consideration [3] Somewhat Consideration [4] Slight Consideration [5] No Consideration
- 12. How would you rate the extent to which you appreciate nature i.e. plants, rivers, air, aesthetics  
[1] Very high level of appreciation [2] High level of appreciation [3] Moderate level of appreciation [4] Low level of appreciation [5] Very low level of appreciation

**Metabolic processes in the settlement**

- 13. Do you have any form of vegetation around the house e.g. in the balcony
- 14. [1] Yes [2] No
- 15. If yes, which type of vegetation e.g. plants, trees, flowers?  
.....  
.....
- 16. What challenges do you experience in maintenance the vegetation?  
.....  
.....
- 17. How can this be challenges be addressed?  
.....  
.....  
.....
- 18. What is your main source of cooking fuel?  
[1] Kerosene [2] Charcoal [3] Woodfuel [4] LPG [5] Others(specify)
- 19. What is your main source of energy for lighting?  
[1] Kerosene [2] Electricity [3] Candle [4] Solar [5] Others(specify)
- 20. Do you use any form of renewable energy in lighting or cooking in your house?  
[1] Yes [2] No  
If yes,

Type e.g. solar	Usage-[1]lighting [2] cooking [3] Business [4] others (specify)	Challenges-technical, financial, environmental

21. What mechanism have you adopted to reduce the amount of energy you use in lighting?  
 [1] Use of energy saving bulbs  
 [2] Switching off lighting when not in use  
 [3] Use of natural lighting during the day  
 [5] None  
 [6] Others (specify)
22. What mechanism have you adopted to reduce the amount of energy you use in cooking?  
 [1] Use of energy saving stoves  
 [2] Use of alternative fuel sources  
 [3] Pooled cooking  
 [4] Others (specify)
23. What is your most common mode of transport to work?  
 [1] Public taxi [2] Train [3] Private car (own) [4] Private car (pooled) [5] Walking [5] Cycling [6] Others (specify)
24. What challenges are associated with this mode of transport?  
 .....  
 .....  
 .....  
 .....
25. What is most common mode of transport to the market?  
 [1] Public taxi [2] Train [3] Private car (own) [4] Private car (pooled) [5] Walking [5] Cycling [6] Others (specify)
26. What is your main source of water for domestic consumption  
 [1] Piped water-city county [2] Borehole [3] River [4] Vendors [5] Community standpipe [6] Others
27. How many liters of water do you use per day for your domestic activities (drinking, cooking, cleaning)?  
 [1] Less than 250Litres [2] 200-250Litres [3] 150-200Litres [4] 100-150Litres [5] More than 100Litres
28. How much do you pay for water in a month (Kshs)  
 [1] No cost [2] Less than 500 [3] 500-1000 [4] 1001-1500 [5] 1501-2000 [6] 2001-2500 [7] 2501-3000 [8] More than 3000
29. What mechanism have you adopted to reduce the amount of water you use in domestic activities?  
 [1] Installation of water saving taps  
 [2] Water recycling  
 [3] Reduced washing frequency  
 [4] Pooled cleaning for all household members  
 [5] Regular replacement of leaking taps  
 [6] Rainwater harvesting

- [7] None
  - [8] Others (specify)
30. How do you dispose your biodegradable waste?  
 [1] Recycling [2] use city county services [3] open dumpsite in the settlement [4] Community based collection services [5] Others
31. How do you dispose your non-biodegradable waste e.g. plastics?  
 [1] Recycling [2] use city county services [3] open dumpsite in the settlement [4] Community based collection services [5] Others
32. What challenges do you experience with this form of disposal?  
 .....  
 .....  
 .....
33. How do you dispose your waste water (from domestic activities e.g. housecleaning)?  
 [1] Open drain [2] Outside the house into the compound [3] Latrine [4] Sewer [5] Others (specify)
34. Which sanitary facility do you COMMONLY use?  
 [1] Common Latrine [2] VIP Latrine [3] Water Closet [4] Others (specify)
35. What is the number of people sharing this facility?  
 [1] Less than 5 people [2] 5-10 people [3] 11-15 [4] 16-20 [5] More than 20
36. Which facility maintenance mechanisms have been put in place?  
 [1] Regular maintenance by the estate management  
 [2] Regular maintenance by the landlord  
 [3] Pit latrine emptying  
 [4] Writing sensitization messages on the facility  
 [5] Engaging a caretaker  
 [6] Others (specify)
37. Are there any green spaces in this settlement [1] Yes [2] No
38. If Yes, how would you rate the quality of green spaces in this settlement?  
 [1] Excellent [2] Very Good [3] Good [4] Fair [5] Poor [6] Very poor
39. How does your household and other community members use the green spaces  
 [1] Recreation  
 [2] Hosting visitors  
 [3] Religious activities  
 [4] Neighbourhood associations' meetings  
 [5] Others
40. What would you recommend to enhance the quality of green spaces in the settlements  
 .....  
 .....  
 .....

- .....  
 .....  
 41. Is any of the household members involved in green enterprenuership e.g. beadmaking from waste, resale of recovered waste, management of toilets? [1] Yes [2] No

42. If Yes, describe the type of enterprenuership

Enterprenuership Activity	Monthly income generated (Kshs)

43. How would you describe the overall physical outlook of the settlement.  
 [1] Very Desirable [2] Desirable [3] Neutral [4] Undesirable [5] Very Undesirable

44. What is your frequency of participation in environmental programs/activities at the settlement level?

- [1] Everytime there is such an activity  
 [2] Usually, in about 90% of the chances I could have  
 [3] Frequently, in about 70% of the chances I could have  
 [4] Sometimes, in about 50% of the chances I could have  
 [5] Occasionally, in about 30% of the chances I could have  
 [6] Rarely, in about 10% of the chances I could have  
 [7] Never

45. What would you recommend in order to enhance or sustain your participation?

.....  
 .....  
 .....

46. Are you a member of any group or association in this settlement? [1] Yes [2] No  
 If Yes, describe the association

Name	Key Functions	Position e.g. chair

47. Which of these environmental management plans have you participated in their development?

- [1] Infrastructure/Housing upgrading environment impact assessment  
 [2] Settlement upgrading environment assessment  
 [3] Local environment action plan  
 [4] County environment action plan  
 [5] County integrated development plan  
 [6] National environment action plan  
 [7] Others (specify)  
 [8] None

48. Are you aware of any partnerships between local community and business entities?  
 [1] Yes [2] No

49. If Yes, provide a description

Type of partnership	Objective/Purpose	Outcomes

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**Section C: Contribution of KENSUP/KISIP to environmental sustainability**

50. Has the program increased your level of awareness on environmental management?

[1] Yes [2] No

51. If yes, in which specific areas?

- [1] Solid waste management
- [2] Waste water management
- [3] Water conservation
- [4] Energy conservation
- [5] Tree planting
- [6] Gardening
- [7] Environmental regulations and institutions
- [8] Others (specify)

52. Are you aware of any new /innovative technologies that have been introduced in the settlement through the program? [1] Yes [2] No

53. If yes, describe the technology

Technology e.g. solar nano, ABT	Benefit	Adoption by household [1]Yes [2]No

54. Has the program influenced your household consumption patterns? [1] Yes [2] No

55. If Yes, which ones?

Consumption patterns	Nature of change	Effect e.g. cost savings
Amount of water consumed per day in domestic activities		
Waste water disposal		
Type /amount of energy used in cooking		
Amount/type of energy used in lighting		
Mode of transport commonly used to the workplace		
Waste generation and disposal		
Use of green spaces		
Involvement in development activities		
Involvement in environmental activities e.g. tree planting, cleaning communal facilities		

56. Has the program provided any economic incentive to households who adopt environmentally sustainable practices? [1] Yes [2] No

If yes, describe the incentive

Incentive e.g. recognition award	Effect

57. What would you recommend to improve the effectiveness of these incentives?

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 .....  
 .....

58. If no incentive has been provided, which ones would you recommend?

.....  
 .....

59. How has your household benefited from infrastructure development through the program?

Infrastructure type (specify)	Benefit
Water supply	
Road	
Sanitation	
Bridge	
School	
Street Lighting	
Market stall	
Green open space	

60. How has this infrastructure affected environmental quality at the household and settlement level?

Household.....  
 .....  
 .....  
 .....  
 Settlement.....  
 .....  
 .....

61. Are you aware of any local community groups that are working with the program? [1] Yes [2] No

62. If Yes, is any member of your household a member of these groups? [1] Yes[2] No

Name of the group	Position in the group	Key activities of the group

**Section D: Overall Perception and Recommendations**

63. Overall, how would you rate the impact of KENSUP/KISIP on the quality of environment in this settlement?

- [1] Negative significant effect
- [2] Negative moderate effect
- [3] No effect
- [4] Positive significant effect
- [5] Positive moderately effect

64. In your own opinion, what you recommend to enhance the performance of KENSUP/KISIP in improving environmental quality in informal settlements?

[1]Program design e.g. actor involvement, management models

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[2]Specific interventions at the settlement level

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THANK YOU