GREENING THE REAL ESTATE THROUGH SUSTAINABLE HOUSING DEVELOPMENT PRACTICES IN KIGALI CITY, RWANDA

BY

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Declaration

Declaration by candidate

This research project is my own original work and it has never been presented for degree in any other institution.

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This research project has been submitted for examination with our approval as University Supervisors

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Dedication

This thesis is dedicated to my beloved wife Olivienne AKAYEZU and my sweet daughter Claudia Darleen ASHIMWE and to my beloved mother, father, brothers and sisters.

Acknowledgment

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Acronyms and Abbreviations

BK: Bank of Kigali
BPR: Banque Populaire du Rwanda (Popular Bank of Rwanda)
BRD: Banque Rwandaise de Development (Rwandan Development Bank)
BREEAM: Building Research Establishment Environmental Assessment Method
CBD: Central Business District
CC: Climate Change
CFCs: Chlorofluorocarbons
CH$_4$:   Methane
CO: Carbon monoxide
CO$_2$:   Carbon dioxide
CST: College of Science and Technology
Cu.m: Cubic meter
DGNB: Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council)
DPSIR: Drivers-Pressures-States-Impact-Responses
DU: Dwelling Unit
EDPRS: Economic Development and Poverty Reduction Strategy
EEA: European Environment Agency
EWSA: Energy, Water and Sanitation Authority
F: Frequency
GDP: Gross Domestic Product
GHG: Greenhouse gas
GIZ: Gesellschaft für Internationale Zusammenarbeit (German Federal Enterprise For   International Corporation)
HFCs: Hydro fluorocarbons
IMF: International Monetary Fund
KCBR: Kenya Commercial Bank /Rwanda
Kg: Kilogram
L/cap.d: Litres per capita per day
LEED: Leadership in Energy and Environmental Design
LTD: Limited
MDGs: Millennium Development Goals
MINALOC: Ministère de l'Administration Locale (Ministry of Local Government)
MINECOFIN: Ministère de l'Economie et de Finance (Ministry of Finance and Economic Planning)
MININFRA: Ministère des Infrastructures (Ministry of Infrastructure)
MINIRENA: Ministère de Resources Naturelles (Ministry of Land and Natural Resources)
N$_2$O: Nitrous oxide
NBR: National Bank of Rwanda
NGO: Non Governmental Organization
NISR: National Institute of Statistics of Rwanda
NOX: Oxides of Nitrogen
OECD: Organisation for Economic Cooperation and Development
OSC: One Stop Centre
RAMA: Rwandaise Assurance Maladie
RBS: Rwanda Bureau of Standards
REMA: Rwanda Environment and Management Authority
RHA: Rwanda Housing Authority
ROR: Republic of Rwanda

RSHDA: Rwanda Sustainable Housing Development Authority
SPSS: Statistical Package for the Social Sciences
T: Tons
UN: United Nations
UNCED: United Nations Conference on Environment and Development,
UNCSD: United Nations Commission on Sustainable Development
UNCHS: United Nations Conference on Human Settlements
UNDP: United Nations Development Programme
UNEP: United Nations for Environment Programme
UR: University of Rwanda
U.S: United States
USA: United State of America
VAT: Value Added Tax
VOC: Volatile Organic Compound

Abstract

Rwanda has one of the highest densities of population in the world making sustainable housing an important aspect of national development. In its capital Kigali, challenges of scarce land resources and a growing population make sustainable housing one of the most important considerations for the 21st Century. The main objective of this study was to investigate existing practices promoting sustainable housing development in Kigali City. The specific objectives were to map the roles of key stakeholders involved in housing development sector in Kigali City, to determine activities being pursued by stakeholders to green the housing sector and to assess the gaps that need interventions to increase uptake of sustainable housing development. The study applied a survey (cross-sectional) research design to collect primary data from a systematic random sample of 92 households drawn from the three Districts of Kigali City. Actual data collection used a semi-structured questionnaire to capture data from household heads. Key informant interviews, focus group discussions and observation were applied to obtain first-hand data from selected respondents and to complement questionnaire data. Secondary data were collected from official government documents, international reports and scientific publications. Questionnaire data were analyzed with the aid of the Statistical Package for the Social Sciences (SPSS) software while data from interviews were analysed using stakeholder analysis and content analysis methods. The results show that key stakeholders in housing sector development in Kigali City were public sector agencies, private sector, civil society, academia and end users. Activities for promoting sustainable housing in Kigali City included green design of houses to maximise the use of natural lighting and ventilation, efficient use of energy, adoption of solar energy as an alternative, harvesting of rainwater to reduce usage of piped water and location of houses to lower the risk from natural hazards and promote safety of occupants. A Chi-square test revealed significant relationships between income and existing practices promoting sustainable housing development. A lack of mainstreaming of the concept of sustainability in the housing sector, limited financial resources, widespread inexperience in sustainable housing design and a weak regulatory framework on sustainable housing are the main barriers hindering sustainable housing development in Kigali City. The study concludes that stakeholders have adopted several activities for greening the housing development sector but recommends a removal of existing barriers in order to accelerate sustainable development in Kigali's housing sector.

1.0 INTRODUCTION

1.1 Background to the Study

In June of the year 1996, the United Nations Conference on Human Settlements (UNCHS) referred to as Habitat II took place in Istanbul addressing the issues of adequate shelter for all and Sustainable human settlements development in an urbanizing world[1]. Commitments of the conference were to improve living conditions on equitable and sustainable basis so that everyone has adequate shelter that is healthy, safe, secure, accessible, and affordable and that includes basic services, facilities and amenities with efficient use of resources and promotion of socially integrated and accessible human settlements (UNCHS, 1996).

One of the pillars of sustainable development is access to adequate housing and land. However, some 1.6 billion people are living in sub-standard housing, 100 million are homeless and around a quarter of the world's population is estimated to be landless (Miloon & Chaudhry, 2012). In developing countries the number of people living in slums is 828 million; all of them lack access to improved water sources and adequate sanitation and live in distressing housing conditions without sufficient space or secure tenure (ibid.).

Developing countries are experiencing rapid and continuing urbanization, driven by population growth and migrations from rural to urban areas. This increases the demand for housing and urban infrastructure and services, which cities struggle to cope with.

Like most developing countries, Rwanda faces enormous challenges in reaching the Millennium Development Goals (MDGs) due to its recent past and the accelerated and uncontrolled growth of its capital city Kigali (Umuhoza, 2007). Rwanda has a total number of 2.41 million private households, which account for about 99% of the total resident population (ibid.). About 49% of private households are found in clustered rural settlements (umudugudu), 34% in dispersed settlements, about 14% in squatter housing and 2% in planned urban housing (NISR, 2012).

Housing is one of the basic social conditions that determine the quality of life and welfare of people and places. The design, use and the way houses are weaved into the environmental, social, cultural and economic fabric of communities are factors that influence the daily lives

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[1] www.un.org/en/development/devagenda/habitat.shtml accessed on 28/02/2015

of people, their health, security and wellbeing, and which affect both the present and future generations. Hence Housing is central to sustainable development (UN Habitat, 2012). Sustainable housing offers opportunities to promote economic development, environmental stewardship, quality of life and social equality, while mitigating the precarious convergences of the problems related to population growth, urbanisation, slums, poverty, climate change, lack of access to sustainable energy, and economic uncertainty (Ibid). Despite policies and the related implementation processes, it appears that there has been increased evidence that uncontrolled urban growth and housing remain the pressing issues in terms of making Kigali a modern and sustainable city. The rural-urban migrations continue to increase the population size of Kigali leading to a problem of land and housing availability (Manirakiza, 2012).

This research project therefore focuses on investigating existing practices promoting sustainable housing development in Kigali City and recommends a strategy for sustainable housing development in Kigali City.

1.2 Problem statement

All over the world, the housing sector is one of the biggest direct consumers of natural resources like water, energy, sand, and forest timber products. Also, the sector has a high demand for land. Further, houses are important points of production of waste materials that pollute the environment. Sustainable housing should therefore address issues of material consumption on one hand and waste management on the other.

Real estates, through their development phases of construction, use and demolition, are responsible for about 30–40% of global carbon dioxide emissions (Hossain, 2000). Buildings are responsible for at least 40% of all energy end use and all greenhouse gas (GHG) emissions produced globally (UN Habitat, 2012; Bruelisauer, 2007). Furthermore, the operational phase of buildings is responsible for 40% of the total waste going to landfill sites (Ibid). Globally, buildings consume 16% of fresh water, 40% of raw materials (used in the real estate sector), and 25% of all timber harvests (Sara, 2008) and 40% of the raw stone, gravel and sand used in the world each year *(Baris & Johanson, 2000). Also, this sector accounts for around one-tenth of the world's Gross Domestic Product (GDP) and at least 7% of its jobs *(Bruelisauer, 2007).

Fifty percent of Global ozone depletion can be attributed to buildings *(Willmott, 2010)* while many house construction products such as particleboard, glues, paints, varnishes, strippers, degreasers and cleaners contain Volatile Organic Compound (VOCs), which degrade air quality (Parrott, 1997). The material consumption trends and environmental footprint of the sector are clearly unsustainable in a world that increasingly grapples with scarcity of material

resources. The building and construction sector therefore has a huge responsibility and potential when it comes to achieving sustainable development aspirations.

According to a housing market study of 2012, Kigali City will experience a supply gap of 344,068 housing units by the year 2022 in different housing typologies (Kigali City Council, 2013). This translates to an average of over 30,000 units which must be constructed every year to meet this demand (Ibid.) This demand is a demonstration that housing development in Kigali City promises to be one of the biggest challenges and largest material consumers in the near future if the city developers will adequately supply projected housing needs. Scarce land resources and a fast-growing population compound the challenges of sustainable housing supply in the city. For Rwanda's fast-growing Kigali City with an ever increasing demand for housing, sustainable housing is one of the most important considerations due to its limited land availability, a burgeoning population, and the overriding need for the country to implement a sustainable development agenda based on its scarce natural resources.

This study investigates existing practices promoting sustainable housing development in Kigali City, and benchmarks the approaches to best practices in the world with a view of building a reference knowledge repository for sustainable housing supply vis-a-vis green real estate development in Kigali City. The findings will contribute to informing policy options for sustainable housing development in Kigali City and other urban centres in Rwanda. The study findings will also form an important knowledge repository for actors to make informed decisions on sustainable housing development and real estate management in Rwanda's cities.

By benchmarking with best practices, the study established sustainability gaps in the housing development subsector and recommended improvements. The study also contributes to solutions to global environmental issues such as climate change, ozone depletion, and general ecosystem decline.

1.3 Study objectives

1.3.1   Main objective

The main objective was to investigate existing practices promoting sustainable housing development in Kigali City.

1.3.2   Specific objectives

The specific objectives of this research, with respect to Kigali City, were to:

i.   Map the role of key stakeholders involved in housing development sector ;
ii.   Determine activities being pursued by stakeholders to green the housing sector;
iii. Assess the gaps (from the expectations of the stakeholders and existing literature) that need interventions to increase uptake of   sustainable housing sector development, and;

1.4 Study questions

i.   Who are key stakeholders in Housing Development in Kigali City? What are their roles in the Housing Development in Kigali City?
ii.   What activities do stakeholders undertake to green the housing sector?
iii. What gaps need interventions to increase uptake of sustainable housing development in Kigali City?

1.5 Hypothesis of the study

The study tested the hypothesis that there is no relationship between the income category and the existing practices promoting sustainable housing development in Kigali City. The study wanted to test whether the practices promoting sustainable housing development in Kigali City were different across the categories of incomes. These are high income, middle income and low income categories. This helped the study to test whether the income affects the use of existing practices promoting sustainable housing development in Kigali City. The Chi-Square test was used to test this hypothesis.

The following are the hypotheses which have been tested in this research.

Hypothesis 1:

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the use of energy efficient light bulbs across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the use of energy efficient light bulbs across the estates in Kigali City

Hypothesis 2:

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the use of rainwater harvesting tanks across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the use of rainwater harvesting tanks across the estates in Kigali City

Hypothesis 3:

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the rates of crime across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the rates of crime across the estates in Kigali City

1.6 Justification of the study

Kigali has been the economic, cultural, and transport hub of Rwanda ever since it became the capital upon independence in 1962. The rapidly growing City is the country's most important commercial centre and main port of entry. It is serviced by an efficient International Airport and connected to neighbouring Uganda, Tanzania and Burundi by tarmac roads[2].

The population of Kigali City by 2012 was approximately 1,168,570 (World Gazetteer, 2012) which comprised 11% of the total population of Rwanda (IMF, World Economic Outlook Database, 2012) living in an area of 730 km^2 or 2.79% of the country (ibid.) Kigali City has a

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[2]See www.kigalicity.gov.rw (retrieved on 07/05/2014)

high population density and faces problems that are caused by rapid urbanisation such as scarcity of land, proliferation of unplanned settlements, and environmental degradation. Housing, besides being a very basic requirement for the urban population, also holds the key to accelerate the pace of development (National Urban Housing Policy for Rwanda, 2008).

Rapid urbanization and growth in the building and construction sector coupled with the country's scarce resources call for development approaches that promote sustainable housing in Kigali City as a model for other cities in Rwanda. The proposed study addressed the wider question of sustainable cities and the specific issue of sustainable housing in urban centres. The study was motivated by the fact that few studies if any have addressed the issue of sustainable housing in Kigali City. As challenges related to this issue burgeon, such a study has become increasingly necessary to stimulate debate on the future sustainable development of Kigali City. The study will form a timely reference for policy-makers, development practitioners and managers of Kigali City while strengthening the reality of Kigali's slogan: "Keep Kigali Clean and Green".

1.7 Scope of the study

The geographic scope of the study was Kigali City. This study was conducted in the three Districts of Kigali City which are Gasabo, Nyarugenge and Kicukiro District. In terms of data collection, the study was limited to investigation of existing practices promoting sustainable housing development in Kigali City based on selected criteria from the literature review. The authors have proposed various criteria and characteristics of sustainable houses. This study used common criteria selected by the researcher and these included the following: Energy efficiency, Water conservation, Security and safety of the house, connection to water and sanitation and connection to social amenities in residential real estates in Kigali City. These have been selected also to be used because they helped the researcher to cover social, economic and environmental aspects of sustainable housing. This study was limited to the investigation of practices promoting sustainable housing development in the residential housing sector.

Kigali has been chosen for this study because it is the capital City and has high population density and a rapid urbanization causing scarcity of land and other natural resources as well as environmental degradation. The growth in building and construction sector in Kigali City coupled with country's scarce resources call for approaches promoting sustainable housing development in Kigali City and findings from this study will contribute to informing policy options for sustainable housing development in other urban centres in Rwanda.

1.8 Definition of terms

This study applies the following terms in the context stated:

- Housing: Buildings in which people live in.It refers only to residential houses and built environment.
- Housing Development is a group of individual dwellings or apartment houses typically of similar design that are usually built and sold or leased by one management
- Sustainable housing means housing that takes into account the long-term environmental, social, cultural and economic balance of the housing stock and its occupants.
- Greening is a process of making or becoming more aware of environmental considerations
- Green building is a practice of creating structures and using process that is environmentally responsible and resource-efficient from planning to design, construction, operation, maintenance, renovation and deconstruction.
- Real Estate: Property consisting of buildings and land
- Grey water: Any domestic wastewater produced, excluding sewage. The main difference between grey water and sewage (or black water) is the organic loading. Sewage has a much larger organic loading compared to grey water.

2.0 STUDY AREA

2.1 Rwanda in general

Rwanda, known as the "land of a thousand hills", is a small, fertile country covering some 26,338 km^2 of equatorial East Africa. Rwanda is bordered by the Democratic Republic of Congo to the West, Uganda to the North, Tanzania to the East, and Burundi to the South[3].

With an altitude ranging from 900 m to 4,500 m above mean sea level, Rwanda has a temperate climate and average annual rainfall of 1,200 mm. The Upper Nile Basin occupies 67% of Rwanda and drains 90% of its surface waters, with the remaining 10% draining into the Congo Basin. With 8% natural forest cover, 10% marshlands cover (including cultivated land and peat bogs) and lakes, Rwanda is a biodiversity hotspot, home to more endemic mammals, birds, reptiles and amphibians than any other African country (Republic of Rwanda, 2011).

The population of Rwanda in 2012 was 10,515,973 residents, which was still largely rural, with 83% living in rural areas. The population density was 415 inhabitants per square kilometre. Compared to neighbouring countries: Burundi (333), Uganda (173), Tanzania (50) or Kenya (73), Rwanda is the most densely populated country in the region. It was only 183 persons per sq. km in 1978, and 321 in 2002 *(*NISR, 2012).

2.2 Location and setting of Kigali City

Kigali is the Capital City and commercial hub of the land-locked Republic of Rwanda, and lies at an altitude of 1,850 m above sea level[4]. It is geographically located at the heart of Rwanda (see Figure 1) at latitude of 1º 58' S and a longitude of 30º 07' E (Manirakiza, 2012).The City covers a total area of 730 km^2 (ibid.)

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[3]See www.wikipedia.org (retrieved on 17/06/2014)
[4] See www.wikipedia.org (retrieved on 17/05/2014)

Figure 1: Location of Kigali City (Source: www.maps.com retrieved on 28/02/2015)

Population density in Kigali is estimated at 1,560 inhabitants/ km². Kigali City is administratively divided into three districts (See Figure 2) namely Nyarugenge (2,124 inhabitants/ km²), Kicukiro (1,911 inhabitants/ km²), and Gasabo (1,234 inhabitants/km²) (NISR, 2012).

Kigali is built in hilly landscapes sprawling numerous ridges and wet valleys. Big structures like universities, banks, hotels, international organizations, embassies, government offices, commercial buildings and residential areas of affluent people tend to be built on top of the ridges while the poorer people tend to settle in the valleys. Most of the City is surrounded by high hills, with Mt. Kigali being the highest peak at 1,850m above sea level[5].

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[5]www.wikipedia.org accessed on 07/05/2014 at 10h45
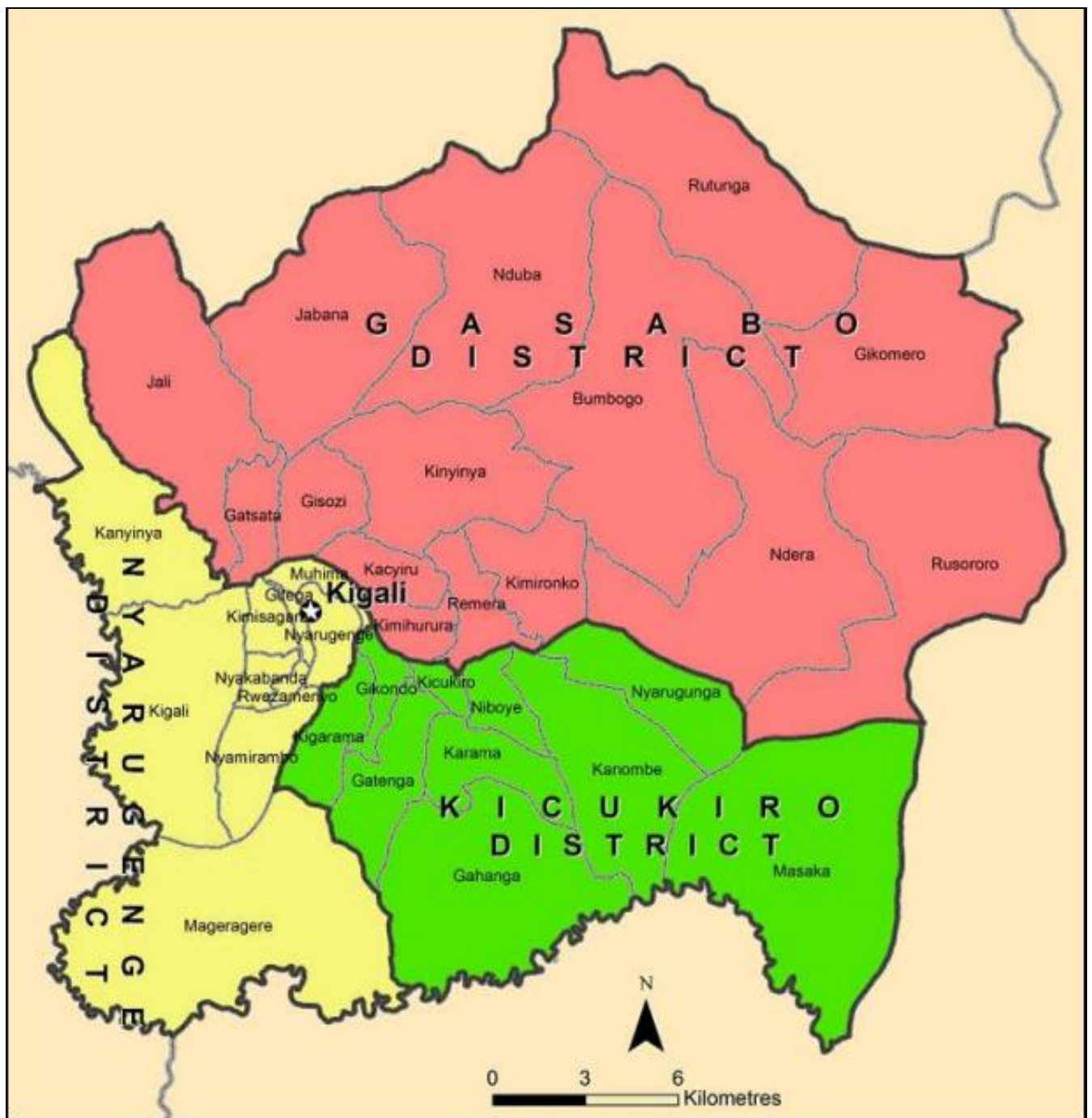
Figure 2: Map of Kigali City with its Districts (Source: REMA, 2013)
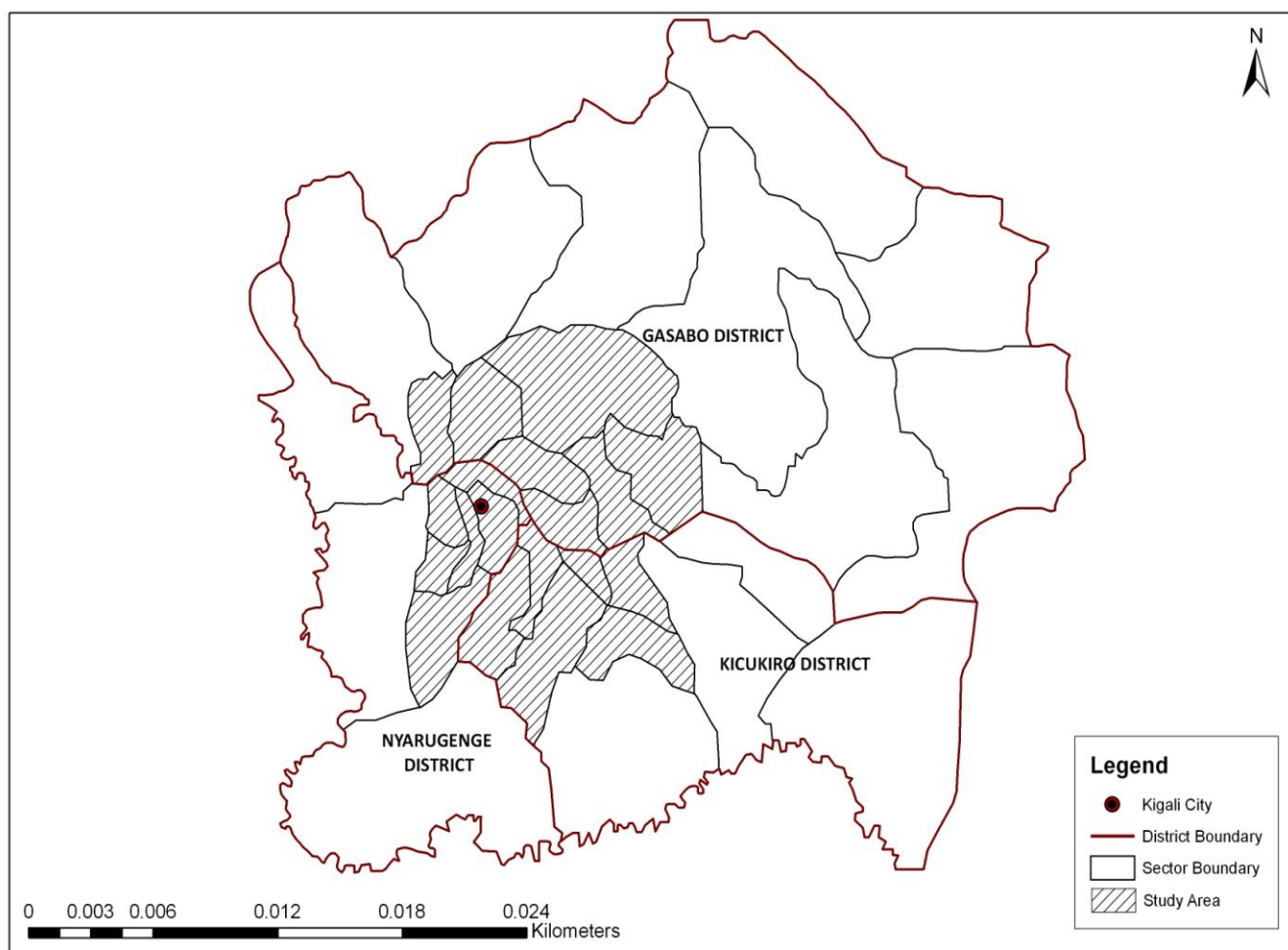
Figure 3: Map of the study area showing Kigali City and its Districts (Source: REMA, 2013)

2.3 Climate of Kigali City.

Among the safest and friendliest of African capitals (Manirakiza, 2012), the City of Kigali is blessed with a temperate climate.

Table 1 indicates the characteristics of the climate of Kigali City typically with a pronounced dry season[6]

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[6]Climate Data for Rwanda (Source: www.wikipedia.org)

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Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high (°C)	26.9	27.4	26.9	26.2	25.9	26.4	27.1	28.0	28.2	27.2	26.1	26.4	26.89
Average low (°C)	15.6	15.8	15.7	16.1	16.2	15.3	15.0	16.0	16.0	15.9	15.5	15.6	15.73
Precipitation (mm)	76.9	91.0	114.2	154.2	88.1	18.6	11.4	31.1	69.6	105.7	112.7	77.4	950.9
Avg. precipitation days (≥ 0.1 mm)	11	11	15	18	13	2	1	4	10	17	17	14	133

Table 1: Climate of Kigali City (Source: www.wikipedia.org)

2.4 History and settlement patterns of Kigali City

Kigali City was founded in 1907 under the advice of Dr. Richard Kandt, the first European resident of Rwanda, as a small Germany colonial outpost with little link to the outside world (Manirakiza, 2012). During the First World War, Germans lost Rwanda, since on May 6, 1919, Belgians troops entered Kigali and declared victory over them (Niyonsenga, 2012). Rwanda gained independence from the Belgians in 1962, and from 1962 to 1984, the population and the built area of Kigali expanded rapidly as the population grew at around 16% from around 6, 000 people to nearly 160,000, and the built area expanded also to 15 square kilometres (Manirakiza, 2012). Today, Kigali City has come of age as the Capital of Rwanda, has made phenomenal strides and claimed its position among the family of cities. Kigali consists of 3 districts, namely Nyarugenge, Gasabo and Kicukiro, divided into 35 sectors, 161 cells and 1061 Imidugudu (Niyonsenga, 2012). The current Kigali City is managed by Kigali City Council. The main inhabitants by race are Rwandese (99.5 %), other Africans (0.34%), Europeans (0.01%), and Asians (0.02%), other (0.13%) (NISR, 2012)

2.5 Physical planning in Kigali City

2.5.1 Land use planning

Urban land uses such as residential, commercial, industrial, and social infrastructure facilities occupy around 17% of the City's land (Kigali City Council, 2013). Agriculture occupies 64% of the land use in Kigali City (See Figure 4 and Table 2). The urban area in Kigali City today is largely centred on the existing City Centre at Nyarugenge and spreads along the east west highway towards the Kigali International Airport in the east (Ibid.).
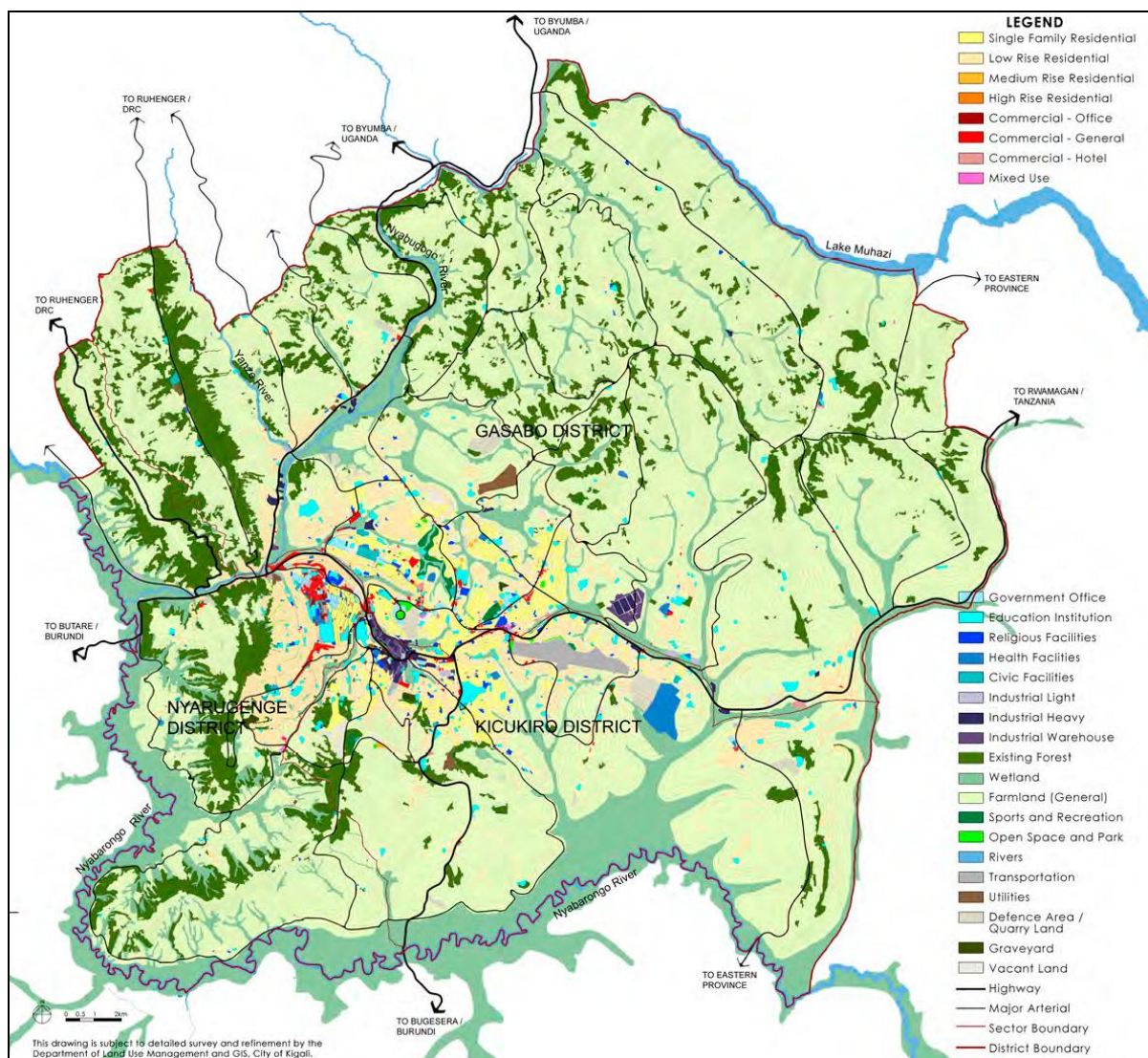
Figure 4: Land use map in Kigali City (Source: Kigali City Council, 2013)

Land use Types	Area in km^2	Percent
Residential	67.58	9.2 %
Commercial	2.85	0.4 %
Mixed Use	0.22	0.0 %
Public Facilities	13.74	1.9 %
Industries	4.41	0.6 %
Nature Area	141.98	19.4 %
Agriculture	461.37	63.1 %
Open space	2.171	0.3 %

Water bodies	2.905	0.4 %
Infrastructure/Roads	20.84	2.8 %
Special Use	13.46	1.8 %
Total Area	**731.53**	**100%**

Table 2: Existing land use distribution in Kigali City (Source: Kigali City Council, 2013)

2.5.2 Housing development planning

According to Rwanda Environmental Management Authority (2012), there are four main housing types in Kigali:

- Well-planned single-family homes, usually along summits and ridges;
- Informal, densely built urban settlements typically found along slopes;
- Imidugudu that have been newly incorporated into rural sectors; and
- Dispersed rural settlements in farming areas

According to Kigali City Council (2013), key highlights about the housing sector in Kigali City are:

- Growing Informal Settlements;
- Relatively high costs of land, construction materials, and labour;
- Limited financial resources and loans for housing;
- Scarcity of planned land in major towns supplied with infrastructure for housing;
- Shortage of locally produced building materials;
- Poor utility and water supply services; and
- Inefficient garbage collection services

The 2012-22 projections show that most housing demand in Kigali City will occur among the low-income groups, which will account for 78% of all housing demand in the city by the year 2022 (see Table 3).

Quintile	Segment	Monthly HH Income RwF		TOTAL DU	Total DU per Quintile	Proportion
		From	To			
	1	<	100.000	147.761		
	2	100.001	200.000	81.838		
Q1	3	200.001	300.000	39.266	268.865	78%
	4	300.001	400.000	22.914		
	5	400.001	500.000	14.100		
Q2	6	500.001	600.000	9.225	46.239	13%
	7	600.001	700.000	7.035		
	8	700.001	800.000	5.147		
Q3	9	800.001	900.000	3.627	15.809	5%
	10	900.001	1.000.000	2.599		
	11	1.000.001	1.100.000	1.987		
Q4	12	1.100.001	1.500.000	3.669	8.254	2%
	13	1.500.001	2.000.000	2.193		
	14	2.000.001	2.500.000	1.107		
Q5	15	2.500.001	<	1.601	4.901	1%
			TOTAL DU	344.068		

Table 3: Kigali Housing Demand 2012-2022 by income group (Source: Housing Market Demand, Housing Finance, and Housing preferences for the City of Kigali, Europe Aid)

2.6 Infrastructure services

2.6.1 Water and Sanitation

The City of Kigali has no big role in the provision of portable water in the City. This role is jointly taken by Energy, Water and Sanitation Authority (EWSA[7]) and the three districts that comprise the City of Kigali i.e. Gasabo, Kicukiro and Nyarugenge. However, the City has a major responsibility in the sanitation and waste management.

There are three water treatment plants that supply potable water to the City (Kigali City Council, 2013):

i) Kimisagara Water Treatment Plant, which is 30-years-old plant and draws its raw water supply from Yanze River. It uses the conventional clarification-filtration chlorination system. Its ultimate design capacity is 22, 000 cubic meters per day (m^3/day). It supplies mainly to the Nyarugenge District and several sectors in Gasabo and Kicukiro District such as Kimicanga, and part of Kacyiru.

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[7]EWSA is a state-owned public utility company for production, transmission and distribution of water and electricity in Rwanda.

ii) Nyabarongo Water Treatment Plant, which treats ground water from the flood plain on the east bank of the Nyabarongo River. It uses rapid filtration system followed by chlorination. Its capacity is 25, 000 cubic meters per day (m^3/day). It supplies to the entire city with the exception of the eastern part of Gasabo and Kicukiro District.

iii) Karenge Water Treatment Plant which draws its raw water supply from Lake Mugesera. It uses conventional treatment method that consists of coagulation; flocculation and clarification to treat the raw water. It produces 12,000 cubic meters (m^3) of potable water daily. It supplies mainly to Kicukiro, Masaka and part of Remera & Kanombe.

The average water consumption was found to be 184 litres per capita per day (l/ca.d) for high standing, 57 litres per capita per day (l/ca.d) for medium standing, and 20 l/cap.d for low standing (Mbateye, 2007).

The percentage of households using improved water sources in Kigali City is 89%, 50% of the households use unshared pit latrines, about 41% of the households use shared pit latrines. For sewage disposal, about 58% of the households use modern modes for sewage disposal where about 20%, use sumps about 32% use cesspools and about 6% use the main sewer (NISR, 2012).

House connections in 2005 and 2006 consumed 77% of the total consumption of water in Kigali City (See table 4)

	Consumption in 2005		Consumption in 2006		Annual change
Types of customers	Quantity (m^3)	%	Quantity (m^3)	%	%
House connections	4,705,325	77	5,044,284	77	7.2
Public standpipes	233,672	4	272,417	4	16
Administration	801,730	13	808,209	12	0.8
Industries	378,766	6	452,249	7	19.4
Total annual	6,119,493	100	6,577,159	100	7.5
Daily water consumption	16,766		18,020		7.5

Table 4: Structure of Water consumption trends in 2005-2006 (Source: Mbateye et al., 2010)

In 2013, 62, 000 Cubic meter (cu.m) of water was consumed daily in Kigali City compared to 55, 000cu.m which was consumed on daily basis in 2012. Water use in larger homes, office buildings and tourism facilities is as high as 200 litre per capita per day (l/cap.d) (REMA, 2013).The challenges facing Kigali City in the sector of water and sanitation are the lack of centralized sewerage system, the prevalence of unplanned housing and the presence of unmanaged storm water that causes erosion of usable land, flooding, and endangering private

and public infrastructure including human life[8]

2.6.2 Energy

In Kigali City, about 67% of households have access to electricity. 67.1% of the private households use electricity by EWSA as the main source for lighting while 15.6% use kerosene lamp, 12.1% use candles. Charcoal is the main source of energy for cooking and it is used by 67.4% of the private household in Kigali city. 26.8% use firewood, 1.4% use gas while 0.7% of the private households use electricity as the main source of energy for cooking (NISR, 2012). High usage of charcoal as a source of energy for cooking has environmental implications of deforestation.

Energy sector contributes highly to the emission of Greenhouse gases in Rwanda (See table 5). The GHG emissions quantified are direct gases namely: Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) and indirect gases including Carbon Monoxide (CO) and Oxides of Nitrogen (NOX)

Total Greenhouse gas (GHG) emissions (Gg) in 2002					
GHG Categories	CO_2	CH_4	N_2O	NOX	CO
Total National GHG Emissions	**-24.03**	**60.69**	**2.24**	**18.87**	**5.95**
1. **Energy**	**6947.68**	**42.34**			
A. Emission from petroleum products	259.68	0.05			
B. Emission from firewood	5918	32.5			
C. Emission from charcoal	770	9.8			
2. **Industrial process**	**52.8**				
A. Emissions from cement production	50.74				
B. Emissions from lime	2.04				

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[8]www.kigalicity.gov.rw accessed on 20/06/2014
http://www.kigalicity.gov.rw/IMG/pdf/CoK_Priorities-2.pdf

	production				
C.	Emissions from tin production	0.01			
3.	**Agriculture**		**12.53**	**1.87**	**18.7**	**0.38**
A.	Enteric fermentation		10.91			
B.	Fertiliser management			0.41	0.43	
C.	Rice farming		0.35			
D.	Cultivated soils				1.81	
E.	Savannah burning		0.11		3.01	0.05
F.	Wastes from harvest burn		0.74	0.02	15.69	0.33
4.	**Land use and forestry**	**-7024.5**	**0.64**	**0.04**	**0.17**	**5.58**
A.	Sequestration in forestry	-7517			0.17	5.58
B.	Emissions from forest conversion	492.5	0.64	0.00		
5.	**Wastes**		**5.18**	**0.36**		
A.	Emissions from waste waters		0.2			
B.	Emissions from domestic and commercial waste waters		3.48			
C.	Emissions from human wastes		1.5	0.36		

Table 5: GHG Emissions in Rwanda (Source: MINIRENA, 2005)

Note: 1Gg=1000tons

2.6.3 Health

The provision of health services in Kigali City influences housing trends because people tend to settle in places where access to health services is easy. The easy access to health services which reduces the time required to reach health services influences the choice of people on where to build their houses.

Access to healthcare in Kigali City has been increasing. When in ill health, Kigali residents are more likely to visit a healthcare center (45%) followed by a clinic (26%), a dispensary

13% and a hospital (12%) (City Council, 2013) Others are likely to visit a consultant's home (4%), while close to a half of one percent visit pharmacies (Ibid.). Close to 73% of Kigali residents have access to health insurance with national rate being closed to 70% where 60.55% is insured through mutual insurance (0.4%) is insured through their employer, while 7.6% are insured through Rwandaise Assurance Maladie (RAMA) (Ibid.)

In 2010, there were three referral hospitals, four district hospitals, one military hospital and one police hospital in Kigali City (REMA, 2012).With the growing population and increasing access to medical insurance, Kigali City will face more demand for health facilities and bed requirements in the coming years. There is currently a shortfall of health centres and district hospitals in Kigali. More such centres and institutes need to be provided to provide better health coverage to the population (Kigali City Council, 2013).

2.6.4 Education

Kigali City is closer to meeting the Millennium Development Goal of universal access to primary education. The net attendance rate for Kigali City stands at 94.1% compared with the national level of approximately 92%. Net attendance rate for Secondary school is 41% and residents between 16 and 35 years of age attend tertiary institutions at the rate of 8.6%. That is much higher when compared to the national rate of access of just 2.6% (Kigali City Council, 2013).

The provision of schools in Kigali City will influence the housing trends because when the distance between schools and houses reduces, the attendance rate increases. This will translate into a big number of houses which will be constructed closer to schools in the future.

2.6.5 Transport

In Kigali City, only 24% of the City population takes less than 20 minutes to get to a stage for public transport and over 70% of the City commuters either walk long distances to access public transport translating to not only high transport costs but also high transit time from one point of town to the other and increases therefore the cost of living in the City with a direct effect on even urban poverty[9].

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[9]www.kigalicity.gov.rw accessed on 20/06/2014
http://www.kigalicity.gov.rw/IMG/pdf/CoK_Priorities-2.pdf

The easy access to transport influences the housing trends in Kigali City because houses tend to be constructed near the roads to reduce transport cost and the costs of living. This means that the provision of roads increases the construction of houses along the road.

2.6.7 Waste management

All the waste generated in the City of Kigali is disposed of at the municipal landfill at Nduba Sector, Gasabo District after the closure of Nyanza land fill which was operating at full capacity. Solid waste is collected from individual buildings and transported to the landfill by private haulers with roll-off bin containers on a weekly basis.

There are 3 main categories of waste generated in the City (Kigali City Council, 2013):
• **Organic Waste:** Biodegradable waste is the main type of waste generated in the City. Examples of organic waste are food waste, biomass and garden waste.
• **Non-organic Waste:** Plastic, paper, glass, metal, and combustibles are the most common non-biodegradable waste. Recycling of non-organic waste is not common. However, the City Council has banned the use of plastic bag within the City to reduce the amount of plastic waste.
• **Hazardous Waste:** Any waste that poses threat to human health and the environment is classified as hazardous waste. They are mainly generated by hospitals, industries and other facilities.

The common practices of wastewater management practices found in Kigali City are (Umuhoza, 2007):
i. **Conventional Septic Tank** for commercial, industrial and some residential buildings include indoor plumbing. Wastewater flows to a septic tank where anaerobic bacteria perform the wastewater treatment;
ii**. Open Defecation** occurs mostly on the periphery of urban development in Kigali.
iii. **Direct Discharge of wastes** especially in areas close to wetlands and streams is more common. The prevalence of businesses in industrial zones in these same areas that do not treat their wastewater often results in toxic water quality in the wetlands, streams, and groundwater.

The housing sector influences the waste management in Kigali City due to wastes generated from the households. The increased number of household increases also the quantity of wastes produced. For example, in 2007, Kigali generated an average of 500 metric tonnes (t) of solid waste per day, but by 2012, figures quadrupled to 1,800 t to 2,000 t of waste and by 2013 about 1.8 kg to 2 kg of waste were generated per person, per day. Food waste accounts

for more than 65 per cent of solid waste for all Districts and low-income populations. Middle-and high-income populations produce slightly less, with 63.1 per cent and 58.9 per cent, respectively (REMA, 2013).

2.7 Stakeholders in the Kigali city management

The main stakeholders (City of Kigali, 2013) in Kigali City Management include:

- **MINALOC (Ministry of Local Government):** The parent ministry of City of Kigali and is charged with the overall policy formulation, implementation and monitoring.

This Ministry in the housing sector plays an important role through community development and social welfare programs. For example, the thatched houses (Nyakatsi) eradication campaign is part of community development and social welfare programs. The campaign aims at allowing all Rwandans to get access to decent home, thus enabling the Government to reorganize the settlement for social and economic transformation[10].

- **MINECOFIN (Ministry of Finance and Economic Planning):** Responsible for setting the overall development agenda of the country.

  The mission of this Ministry is to raise sustainable growth, economic opportunities, and living standards of all Rwandans. One of its goals is to contribute to increase living standards of the population and human development within a sustainable environment. In the housing sector, it plays an important role in ensuring that people are settled appropriately and in the creation of secondary cities which would ease migration into urban areas. It accelerates urbanization through investment and innovative financing mechanisms in terms of infrastructure, housing, and other services[11].

- **MINIRENA/REMA (Ministry of Land and Natural Resources/ Rwanda Environment and Management Authority):** Through the Environment Sector Strategic Plan, the City of Kigali recognizes its role in environmental management systems in City of Kigali. Issues of waste Management, wetland rehabilitation, sanitation, pollution control, greening have been guided by the overriding environment policies and laws developed by MINIRENA and REMA.

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[10]www.minaloc.gov.rw accessed on 21/06/2014

[11]www.minecofin.gov.rw accessed on 21/06/2014

In housing Sector, MINIRENA/REMA are the authorities in charge of supervising, monitoring and ensuring that issues relating to environment are integrated in all national housing development programs. They design guidelines intended for use by policy makers, planners, technocrats and analysts in the ministries and agencies responsible for infrastructure development, embracing the subsectors of energy, transport, water supply, housing and urban development[12].

- **MININFRA (Ministry of Infrastructure):** Infrastructure development is a key priority identified in the development plan which is an important driver towards sustainable economic development and poverty reduction. The Ministry of Infrastructure provides the strategic guidance for formulating roads, energy and housing strategies.

- **Rwanda Housing Authority (RHA)**: Its mandate is to promote housing development in Rwanda. Rwanda Housing provides the broad policy guidelines for housing development in the City of Kigali. The RHA also conducts studies on the housing sector in the City.

- **EWASA (Energy, Water and Sanitation Authority):** Though, water and energy is a preserve of the 3 districts, it is important to note that the City has undertaken major strides in trying to illuminate the City through street lighting. It is also noteworthy that though the City of Kigali does not involve directly in water and electricity connection, it has the mandate to oversee the implementation of these amenities by the districts.

- **Development Partners in Kigali City** like Belgium Technical Cooperation, UN Women, GIZ, UNDP, Arab Development Bank and Chinese Government whose role is to provide technical and financial support in the housing development sector.

2.8 Administrative structures of Kigali City

The administrative organogram of Kigali City is shown in Figure 5.

The administrative structures of the City of Kigali are:
  ➢ The Council of the City of Kigali composed of:
- Three (3) councillors elected by the National Youth Council, one at the level of each district in the City of Kigali;

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[12]www.rema.gov.rw accessed on 21/06/2014, www.minirena.gov.rw accessed on 21/06/2014

- The coordinator of the National Women Council at the level of the City of Kigali;
- Nine (9) councillors from each District of the City of Kigali

The Council of the City of Kigali forms the following commissions:

- The Commission for Economic Development
- The Commission for Women, Youth, Culture, Sport and Social Welfare
- The Commission for administration, Political and Legal Affairs
  - ➢ The Executive Committee of the City of Kigali composed of the following three (3) persons including at least one woman; and these are
- The Mayor of the City of Kigali and who is its Chairperson
- The Vice Mayor in charge of Finance, Economy and Development who replaces the Mayor of the City of Kigali in case of his or her absence
- The Vice Mayor in charge of Social Affairs.
  - ➢ The Security Committee of Kigali which comprises the following persons:
- The Mayor of the City of Kigali who is also its chairperson
- Other members of the Executive Committee
- The Executive Secretary of the City of Kigali who is also its rapporteur
- The division Commander of the armed forces in the area in which the City of Kigali is situated
- The Police Commander of the area in which the City of Kigali is situated
- District Mayors in the City Kigali
- The Prosecutor at Higher Instance in the City of Kigali
- The Immigration and Emigration officer in the City of Kigali
- Intelligence officer in the City of Kigali
- Directors of Prisons in the City of Kigali
  - ➢ The Executive Secretariat of Kigali which comprises the Executive Secretary of the City of Kigali and Staff members of the City of Kigali.
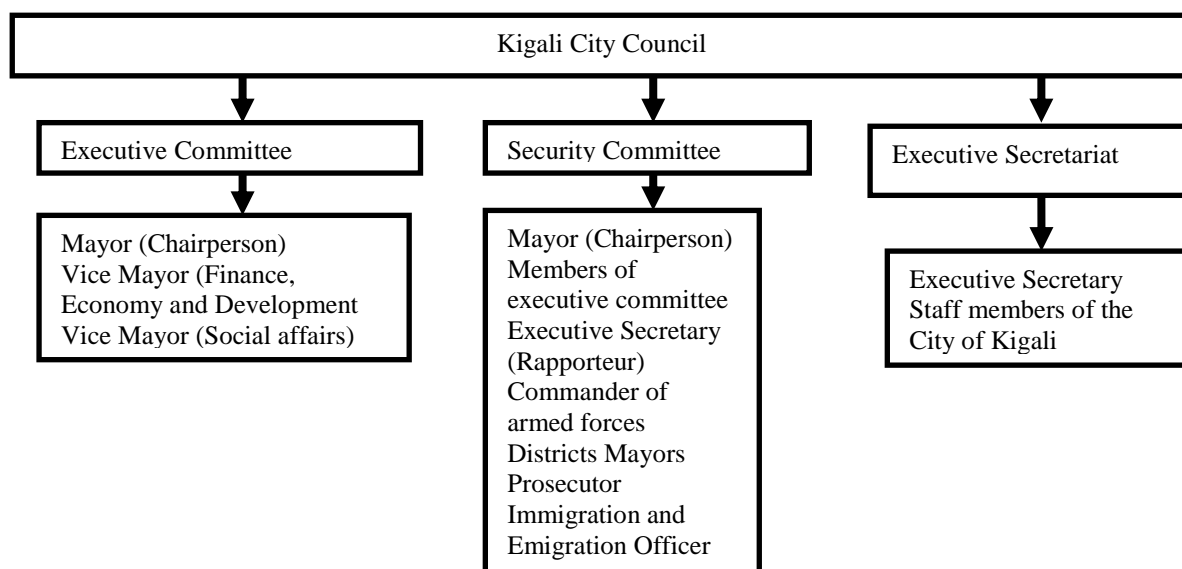
Figure 5: Administrative organogram of Kigali City (Source: REMA, 2013)

3.0 LITERATURE REVIEW

3.1 Actors in Real Estate Development

Richard Reed (2008) has considered the actors in Real Estate Development in approximately the order they appear in the development process:

- **Land owners** who actively initiate development by a desire to sell and/or improve the value of their land;
- **Developers** who make a direct financial profit from the process of development;
- **Planners** who encourage development and prevent undesirable development;
- **Financial institutions** who are providers of finance;
- **Building contractors** who construct the development scheme;
- **Agents** who form the link between the developer and the occupier;
- **Planning consultants** who negotiate with local planning authorities to obtain the most valuable permission for a development;
- **Property economics consultants/valuation surveyors** who are employed to provide a detailed analysis of the characteristics of the market in terms of the underlying demand and competitive supply;
- **Architects** who are employed to design the appearance and construction of new buildings or the refurbishment of existing buildings;
- **Construction economists or quantity surveyors** who are building accountants, their role include costing the designs produced by the architect, administering the building contract tender, advising on the most appropriate form of building contract (procurement), monitoring the construction and approving stage payments to the contractor;
- **Structural engineers** who are employed to work with the architect and quantity surveyor to advice on the design of the structural elements of the building;
- **Civil engineers** who are employed where major infrastructure works and/or ground work is required;
- **Mechanical and electrical engineers** used to design all the services within the building;
- **Project managers** who are employed to manage the professional team and the building contract on behalf of the developer;

- **Solicitors** who are needed at various stages throughout the development process, starting with the acquisition of the development site through to the completion of leases and contracts of sale;

- **Accountants** who are employed to provide advice on the complexity of tax and Value Added Tax (VAT) regulations that can have a major cost impact on a development, and;.

- **Occupiers** who occupy the building for their use and enjoyment.

Property development processes have been significantly affected by advances in technology such as the internet which has speeded up the globalisation of business and allowed best practice in sustainability and property development to be communicated rapidly around the world (Dixon et al., 2005).

3.2 Real Estate Sector and Sustainable Development in the World

Real estate is defined as the economy's stock of buildings, the land on which they are built, and all vacant land. These buildings are used either by firms, government, and non-profit organizations and so on, as workplaces, or by households as places of residence (Mouzughi et al., 2014). This definition shows that the construction of Real Estate in a country contributes highly on its economy especially in the urbanization process.

Sustainable real estate development (or Green real estate) is a thrilling new way to make property healthy and energy-efficient, with better indoor air quality, lighting and temperature controls. All kinds of commercial and home properties can be built or refurbished with green features[13]

Sustainable development has been defined in many ways, but the most frequently quoted definition is from Our Common Future, also known as the Brundtland Report where Sustainable development is defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs[14].

Four broad themes have been perceived as vehicles for achieving sustainable development objectives in Bahrain and these have been considered as maximizing the contribution of real

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[13]www.sustainabledevelopmentinfo.com accessed on 23/06/2014

[14]www.iisd.org accessed on 23/06/2014

estate construction to sustainable development. These themes were: (1) infrastructure; (2) affordable housing; (3) tourism/leisure; (4) public/private/partnerships (PPPs) (Mouzughi et al., 2014)

The contribution of the real estate sector to India's Gross Domestic Product (GDP) has been estimated at 6.3% in 2013 and the segment expected to generate 7.6 million jobs during the same period. It is also expected to generate more than 17 million employment opportunities across the country by 2025. While housing contributes approximately 5%−6% of the country's GDP, the retail, hospitality and commercial subsectors have also grown simultaneously, meeting the increasing infrastructural needs (Hiranandani & Buisman, 2013).

In USA, Real Estate plays an integral role in the U.S. economy. In 2011, real estate construction contributed less than 5% to the nation's economic output measured by Gross Domestic Product (GDP). This is down dramatically from its peak of $1.195 trillion in 2006. At that time, it was a hefty 8.9% component of GDP. Real estate construction is labor intensive. Therefore, this decline in housing construction was a big contribution to the recession's high unemployment rate[15].

Sustainable development of urban areas requires integration and coordination, including regarding land-use issues, food security, employment creation, transportation infrastructure development, biodiversity conservation, water conservation, renewable energy sourcing, waste and recycling management, and the provision of education, health care and housing (UN Habitat, 2013). For example, in South Africa the Department of Housing commissioned a study in 2003 to set up a framework for the regulation of environmentally sound building. The policy was to revise the South African Energy and Demand Efficiency Standard guidelines in order to specify which measures should be included in the energy-efficient housing package, plus any technical details required for these interventions, and to make these standards mandatory for all new subsidy-supported housing (Winkler, 2006).

The creation of low energy, ecological housing has become a key component of sustainable development. Living in harmony with the environment has become an essential component of the design of homes and neighbourhoods in the third millennium. Architects, house builders, local authorities, housing associations, lenders and others involved in providing housing have a key role to play in promoting developments that will sustain communities. No society is balanced and in harmony with nature unless housing is sustainable (Brian & Turrent, 2000).

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[15] www.usaeconomy.about.com accessed on 23/06/2014

According to UNCSD[16] (1987), sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It involves the simultaneous pursuit of economic prosperity, environmental quality and social equity. According to Chiu (2002), sustainable development aims at delivering a built environment that enhances quality of life, satisfaction, flexibility and has the potential to cater for user changes in the future as well as provides and supports desirable natural and social environments that maximize the efficient use of resources. It is reminder to all generations to conduct every activity on the planet earth with the highest degree of caution and restraint by making it sustainable (Marcuse, 1998).

3.3 Real Estate Sector and Sustainable Development in Rwanda

Construction and real estate sectors are key sectors and potential drivers of future economic growth in Rwanda, mainly due to the high demand for residential and commercial buildings for the business community[17]. Issues of habitat are of great importance in Rwanda, given the land scarcity and the dislocations caused by genocide. It is envisaged that by 2020, 70% of the population will be living in rural grouped settlements (Imidugudu) and 30% in urban areas (GOR, 2007).

Investing in Real Estate Development in Rwanda is a way of solving housing problems in Rwanda[18]. In order to organize the construction industry as a whole and to spur Economic Development and Poverty Reduction which guide Rwanda's medium-term development, Rwanda Housing Authority was established in 2010 its overall mission being to implement the National Housing, Urbanization, construction and Government Assets management policies through coordination, conception, development, monitoring and evaluation of actions and programs set out in its mission.[19]

In the year 2012, the Real Estate sector employed closer to 137 labor units, with 60.6% working in large establishments, 35% in medium establishments, 3.65% in small and 0.73% in micro establishments respectively. Women constituted 8% of the labor force whereas expatriates or foreigners constituted 0.7% (RDB, 2012). Real estate and construction sectors

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[16]United Nations Commission on Sustainable Development, also known as the Brundtland Commission of 1987. The UNCSD definition of sustainable development was adopted by the United Nations Conference on Environment and Development, UNCED in Rio de Janeiro in June 1992.
[17]www.rdb.gov.rw accessed on 23/06/2014
[18]www.csr.gov.rw accessed on 23/06/2014
[19]www.rha.gov.rw accessed on 23/06/2014

grew by over 15% in 2012, contributing close to US $ 141 million of the overall Gross Domestic Product (GDP) of Rwanda (USAID, 2012).

Investing in Real Estate Development in Rwanda has been made easy by eased mortgage financing, construction sector reforms, Banks offering loans covering as much as 90% of the cost of a house, insured loans, the ease of acquiring construction related permits, cutting the number of procedures an investor had to go through to get permits from 13 to 4 during the period 2014-2015[20].

Investment in Real Estate Development in Rwanda is also eased by Rwanda's performance in the Doing Business Rankings in recent years which has been exemplary, drawing attention from international observers and investors alike. Improvements have been made across the board. The 2013 World Bank Doing Business Report has ranked Rwanda 52nd out of 185 countries. In the overall performance, Rwanda is still the best performing country in the East African region as well as 3rd easiest place to do business in Sub-Saharan Africa (1st is Mauritius which ranks 19th globally, 2nd is South Africa which ranks 39th globally, 3rd is Rwanda which ranks 52nd globally, 4th is Botswana at 59th globally and 5th is Ghana which ranks 64th globally. A non-Sub-Saharan African country that also performed well was Tunisia at the 50th position globally[21].

The housing fabric in the developed area of Kigali is mainly composed of informal settlements. Government projects focus on an initiative by the City to provide alternative and safe housing for inhabitants of such slums; to give them an opportunity to enjoy their basic rights to basic infrastructure and public utilities. The other steps include; real estate development, sites and services schemes, upgrading and private sector involvement in housing provision are examples of ongoing initiatives[22].

3.4 Practices promoting Sustainable Housing Development in the World

Various practices promoting sustainable housing have been found in the literature review. Sustainable housing is a shelter which is healthy, safe, affordable and secure, within a neighbourhood with provision for piped water, sanitation, drainage, transport, health care, education and child development. This also includes a home protected from environmental hazards, including chemical pollution. Also important are [to meet] needs related to people's

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[20]www.independent.co.ug accessed on 24/06/2014
[21]www.rdb.gov.rw accessed on 23/06/2014
[22] See www.kigalicity.gov.rw (retrieved on 24/06/2014)

choice and control including homes and neighbours which they value and where their social and cultural priorities are met. Achieving this implies a more equitable distribution of income between nations and, in most, within nations (Mitlin & Satterthwaite, 1996).

In this study the safety, provision for piped water, sanitation, drainage, health care, education and child development have been selected as the variables which were used in investigating the practices promoting sustainable housing development in Kigali City.

According to UN-HABITAT, (2012), sustainable houses are those that are designed, built and managed as:

- Healthy, durable, safe and secure;
- Affordable for the whole spectrum of incomes;
- Using ecological low-energy and affordable building materials and technology;
- Resilient to sustain potential natural disasters and climatic impacts;
- Connected to decent, safe and affordable energy, water, sanitation and recycling facilities;
- Using energy and water most efficiently and equipped with certain on-site renewable energy generation and water recycling capabilities;
- Not polluting the environment and protected from external pollutions;
- Well connected to jobs, shops, health- and child-care, education and other services;
- Properly integrated into, and enhancing, the social, cultural and economic fabric of the local neighbourhood and the wider urban areas, and;
- Properly run and maintained, timely renovated and retrofitted.

In this study, the safety, security, connection to water, sanitation and recycling facilities, connection to jobs, shops, health care, child care, education and other services have been used as the variables while investigating the practices promoting sustainable housing development in Kigali City.

Sustainable housing is a form of affordable housing that incorporates environmentally friendly and community based practices. It attempts to reduce the negative impact that houses can have on the environment through choosing better building materials and environmental designs" (Gilkinson & Sexton, 2007). Sustainable housing is housing that meets the perceived and real needs of the present in a resource efficient fashion whilst providing attractive, safe and ecologically rich neighbourhoods (Brian& Turrent, 2000).

A typical study of environmental issues in housing, in the context of sustainability might encompass a global perspective on environmental issues, energy management, waste management, water quality and conservation, hazardous substances and indoor quality. The housing industry has responsibility to critically examine the design and development of housing to use fewer resource-intensive and polluting products to minimize the resource and energy needs to operate the building, and to foster an environmentally friendly lifestyle of inhabitants (Parrott, 1997). This study used some of the criteria proposed by Parrott (1997) such as energy management, waste management, water conservation and energy efficiency. They have been selected as the variables to be used while investigating the practices promoting sustainable housing development in Kigali City.

According to Eziyi and Dominic (2011), vital characteristics of sustainable housing are: sustainable land use planning, resisting scattered settlements, housing development closer to employment and public transport, higher residential densities, sustainable construction and high standards of energy efficient dwellings. Others are housing availability, affordability and quality, access to green areas, and a high quality residential environment. Housing development closer to employment and transport and energy efficiency were selected as the variables to be used while investigating the practices promoting sustainable housing development in Kigali City. On the other hand Abdellatif and Othman (2006) argued that sustainable housing is achieved when housing is delivered on time, cost effective in both short and long runs, has high quality, good indoor environment, durable, cheaper to maintain, and user friendly.

Various indicators of housing sustainability have been proposed in the literature. Bennett and James (1999) and Turcotte, and Ken (2010) suggested that effective housing sustainability assessment framework should consider a wide range of criteria including environmental sustainability (energy efficiency, water conservation, reduction of greenhouse gas emissions, waste management, material efficiency, pollution prevention, optimization and conservation of land, protection and enhancement of biodiversity, reduction of dependency on car). Another practical analysis of sustainable housing can be taken from Barnett and Browning (1995) and their checklist for sustainable housing:

- Make appropriate use of land
- Use water, energy, timber, and other resources efficiently
- Enhance human health
- Strengthen local economies communities
- Conserve plants, animals, endangered species and natural habitat

- Protect agricultural, cultural and archaeological resources
- Be nice to live in
- Be economical to build and operate

Among the above criteria proposed by Barnett and Browning (1995), the researcher selected the following as the variables of this study. These are energy efficiency, water conservation, and waste management, reduction of dependency on car (non motorized transport) and safety of the occupants.

Several other authors have indicated that sustainability of housing programmes can be assessed using indicators describing the impacts of building materials (Adedeji, 2005), architectural design, construction solutions and structural design (Onibokun, 1976; Fatoye and Odusanmi, 2009) .Others are environmental impact (Chen et al., 2005) and socio-cultural impact (Djebarni and Al-Abed, 2000; Lux, 2005; Mohit et al., 2010). According to Gilkinson & Sexton (2007), consideration should be given to the durability, permeability and buildability of defined material resources; the structures fixity, structural stability and acoustic attributes. Broad social elements of sustainable house construction will be met through innovative design solutions leading to social and environmental improvements.

In a rapidly changing and urbanising world, the provision of adequate and affordable housing remains a key priority for all governments. Sustainable housing is, however, yet to gain its due prominence in developing countries. It is rare that the social, cultural, environmental and economic facets of housing are addressed in an integrated development policy (UN Habitat, 2012). This is not well addressed because of the challenges that cities face in the implementation of sustainable housing development. According to Yeri (2012), these challenges are:
- Identifying relevant data to measure success for the various indicators.
- Selecting indicators that are good measures of sustainability.
- Bridging the gap between academic understanding of sustainability indicators and ecosystem functions and municipal planning of organizational structures, which have traditionally concerned themselves with land use, infrastructure and transportation, social planning, recreation and culture programming.
- Limited staff, time and resources, particularly in smaller communities.
- Availability of data from city departments or other government institutions.

In the regions where conditions and scarce resources are more challenging for tackling the slums and up-scaling sustainable housing, like in Sub-Saharan Africa, there is a need to

change the conception of housing to embrace all of the sustainability dimensions for designing more effective and sustainable housing responses.(Ibid.)

3.5 Practices promoting Sustainable Housing Development in Rwanda

In order to ensure Sustainable Housing Development in Rwanda, Policies and programs regarding Housing Development Sector have been formulated and these include:

- **National Urban Housing Policy** developed in December 2007 (MININFRA, 2008). In that Policy, housing is recognized as a basic right for its citizens as stated in international declarations such as the Istanbul Declaration of June, 1996, the Millennium Development Goals (February, 2002), and the World Summit on Sustainable Development held in Johannesburg in July-August 2002 (National Urban Housing Policy for Rwanda, 2008).

The main objective of the "Urban Housing Policy" of Government is to contribute towards improving the conditions of living of the urban population through controlled and harmonized development of urban areas and provision of affordable housing to all sectors of the population. The Government aims to engage the private sector and promote its active participation in driving housing and real estate development in the country (Rwanda National Construction Industry Policy, 2009).

National Urban Housing Policy also facilitates access to decent housing and basic infrastructure facilities for the population. It recognizes also the need to provide affordable shelter for people of all income groups. It also aims at upgrading unplanned settlements and developing urban areas within the framework of sustainable socio-economic development. It must be implemented within the framework of sustainable development while meeting the needs of the people and contributing to their social and economic development with due regard to environmental sustainability (National Urban Housing Policy for Rwanda, 2008).

The major problems facing the environment in Kigali City are pressures from the growing population on the natural resources such as land, water, flora and fauna and other non-renewable resources. This is most evident in land degradation, soil erosion, decline in soil fertility, deforestation, wetland degradation, loss of biodiversity and pollution (ROR, 2004).

- **Vision 2020** whose objectives in infrastructure development are to reorganize and consolidate land so as to create adequate space for modern and viable farming, increase the proportion of those living in town and cities from 12% to 30% of the population who will be living in planned areas with access to basic infrastructure

necessary to ensure sustainable development, extended and improved reliable and safe transport network, access to internet at all administrative levels and all secondary schools and for a large number of primary schools, 35% of the population will be connected to electricity (from 6%) and the consumption of wood will decrease from the current 94% to 50% of national energy consumption, make drinkable water available to the whole population of Rwanda from 52% currently, rural and urban areas will have sufficient sewerage and waste disposal systems where each City will be endowed with an adequate unit for treating and compressing solid wastes for disposal and this will contribute to the sustainable development of the country among other objectives (MINECOFIN, 2000). Among the above stated criteria, the researcher has selected access to internet, access to drinkable water and access to sewerage and waste disposal systems.

- **Economic Development and Poverty Reduction Strategy (EDPRS)** that specifically emphasizes planning and development of urban and rural human settlement in conformity with the criteria of environmental viability through the reorganization of national space. According to EDPRS, urban areas must develop through the creation of market opportunities for rural economies so as to ensure sustainability and progress (MININFRA, 2008).

- **Rwanda Green Growth and Climate Resilience Strategy- National strategy for Climate Change and Low Carbon Development** that outlines an ambitious long-term development vision 2050 for Rwanda to be a developed climate-resilient, low carbon economy by 2050. Objective of this strategy are:
  - ✓ To achieve Energy Security and a Low Carbon Energy Supply that supports the Development of Green Industry and Services and avoids deforestation
  - ✓ To achieve Sustainable Land Use and Water Resource Management that results in Food Security, appropriate Urban Development and preservation of Biodiversity and Ecosystem Services
  - ✓ To ensure Social Protection, Improved Health and Disaster Risk Reduction that reduces vulnerability to climate change impacts (Republic of Rwanda, 2012). In the above stated criteria, the researcher selected to use water efficiency, energy efficiency and disaster risk reduction (reducing the vulnerability of places to climate change impacts) considered in this study as safety.

- **Kigali Conceptual Master Plan** adopted in 2008 presents the most advanced sustainability in land use, infrastructure, environment, society and economy[23]. This Master plan is predicated on the basic principles of sustainable urbanism: compact, mixed use and dense urban design that efficiently utilises the hilly landscape of Kigali; structured by greenway networks that provide healthy open space and quality of life for residents, protect its wetlands, and manage water runoff[24].

Currently, a research is being conducted in Rwanda on sustainable building material and construction using local materials, additives and mixing agents which have to be minimized to maintain affordability, the material which is to be produced manually with relative ease and the bricks which are to be produced without a heating source. All of the mixtures were based on 80% or more of locally available clay, 10 to 15% sand, 0 to 5% of cement and/or lime, and a minimal amount of chemical additives[25].

3.6 The role of sustainable housing in development

Housing plays a crucial role in integrated physical and economic development, environmental sustainability, natural disaster mitigation and employment generation as well as wealth creation (Erguden, 2001). In this line, housing initiatives to be sustainable, they must be economically viable, socially acceptable, technically feasible and environmentally compatible (Choguill, 2007).

The Review of the literature has revealed multiple benefits of sustainable housing. For example, according to UN HABITAT (2012), the following are the benefits of sustainable housing:

- Improved quality of life and dignity of residence;
- Affordable access to housing;
- Improved health and lower incidents of illness, fatalities and material losses, better labour productivity;
- Better conditions for human development, employment, creativity and economic growth;
- Durability and low maintenance cost;
- Protection against natural hazards;

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[23]www.rdb.gov.rw accessed on 24/06/2014
[24]www.newtimes.co.rw see the New Times, March 19, 2014
[25]http://gggi.org/rwanda-seeks-to-improve-access-to-affordable-and-sustainable-housing/ accessed on 24/06/204

- Improved efficiency and savings on the use of energy, water and other physical resources;

- Better environmental protection and sanitary conditions,

- Contribution towards climate adaptation and mitigation,

- More sustainable and socially inclusive urban growth,

- Social cohesion and political stability.

It is only through sustainable solutions that the tensions between economic development, social welfare and equality, urban growth, housing provision, access to clean energy, good quality residential services, and environmental conditions can be alleviated (UN HABITAT, 2012).

The review of the literature has revealed various impacts of Housing Development on the environment. Housing generally has profound influence on the socio-economic wellbeing of the human society and sustainability of the physical and cultural environment during its production and consumption (Ibem & Azuh, 2011). There is a high need to consider Sustainability as far as Housing Development is concerned. According to Sara (2008), Climate change and global warming have been linked to manmade emissions of greenhouse gases into the atmosphere. Carbon dioxide is a greenhouse gas and is given off during the consumption of fossil fuels such as oil and gas.

Concern for the environment is imperative in Sustainable Housing. This is particularly important in the face of changes in climatic conditions occasioned by human activities, which are likely to have significant impact on man. The phenomenon of climate change and global warming has arisen from the continued emission of carbon dioxide and other Green House Gases into the atmosphere. The reduction of carbon dioxide emissions in house construction and domestic housing is thus a critical issue in environmental management (Gilkinson & Sexton, 2007). In addition to that, at the global level, Climate Change (CC) related impacts will be more destructive in urban areas since there is a greater concentration of people, buildings and infrastructure (Paulo, 2009).

The Intergovernmental Panel on Climate Change identified buildings as offering the most significant opportunity for cost-effective emissions reductions worldwide (Hossain, 2000).

The relationship between housing and environment is very important and has to be taken into account while dealing with housing sustainability. According to UN Habitat (2012), there are three types of the relationships between housing and the environment:

- House building and operation require various environmental resources, such as building materials, water, energy and land;

- Residential activities in human settlements have direct ecological impacts on local areas in terms of air and water pollution, waste and damage of natural ecosystems;

- Homes and their residents are also themselves exposed to varied environmental hazards, which may emerge due to human activities (e.g. air and water pollution, lack of sanitation), due to natural factors (e.g. landslides, vector-borne diseases such as malaria), or due to the combination of natural and human-made factors (e.g. climate change)

The multi faceted components and impact of housing suggests that the issue of sustainability is central to its production and consumption; and thus can contribute significantly to sustainable development (Ibem & Azuh, 2011).When real-estate developers make choices about the size, location, and layout of buildings, they shape our landscapes for decades to come. They help define our sense of place and often, through their decisions about whether or not to preserve open space, they determine the future of local ecologies. Given the outsized importance of real-estate developers in shaping the ways that land and energy are used and the growing salience of environmental challenges like climate change, it seems important to ask if real-estate developers, under regulatory pressure, will build in environmentally concerned ways (Beuschel & Rudel, 2007).

According to Frances (2009), as a condition of development approval, city officials may require developers to provide exactions, pay impact fees and limit the use of their property. If owners and occupiers are concerned for both the well-being of the planet and for the role and reputation they have for acting responsibly in the face of climate change, then they may tend to shun properties that are environmentally poor in favour of more environmentally acceptable assets (Ibid.)

3.7 International Standards for a Green Real Estate

In order to measure the sustainability level of green building and provide best practice experience in their highest certification level, rating systems have been developed. Benchmarks are given and the design, construction and operation of sustainable buildings are certified. The literature review has revealed the common international rating systems which use several criteria compiled in guidelines and checklists covering aspects of the building approach to sustainability.

They are the following:

- **Building Research Establishment Environmental Assessment Method (BREEAM)**

BREEAM is a voluntary measurement rating for green building that was established in the United Kingdom by the Building Research Establishment (BRE) to address wide ranging environmental and sustainability issues and to enable developers, designers and building managers to demonstrate the environmental credentials of their buildings to clients, planners and other initial parties (Smiciklas et al., 2012).

- **Leadership in Energy and Environmental Design (LEED)**

Leadership in Energy and Environmental Design (LEED) is a voluntary, consensus-based standard to support and certify successful green building design, construction and operations guiding architects, engineers, building owners, designers and real estate professionals to transform the construction sector into one of sustainability (Schwarz, 2007).

- **Green Star**

Green Star is a rating system for green building that was launched in 2002 by the Green Building Council of Australia to drive the transition of the Australian property industry towards sustainability by promoting green building programs, technologies, design practices and operations as well as the integration of green building initiative into mainstream design, construction and operation of buildings (Smiciklas et al., 2012).

- **German Sustainable Building Council (DGNB)**

The German Sustainable Building Council (DGNB – Deutsche Gesellschaft für Nachhaltiges Bauen) was founded in 2007 by 16 initiators from various subject areas within the construction and real-estate sectors. The aim was to promote sustainable and economically efficient building even more strongly in future.[26]

As a tool for the assessment and certification of sustainable buildings, it is one of the leading systems worldwide, mainly due to its comprehensive quality concept, which takes equal account of economics, ecology, and socio-cultural aspects and is based on a holistic view of the building's entire life cycle (Smiciklas et al., 2012).

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[26] http://www.dgnb.de/en/council/dgnb/ accessed on 07.03.2015

The above discussed standards for green buildings have different countries of origin, aspects of assessment, building type, level of certification and weighting summarized in table 6.

System	BREEAM	LEED	GREEN STAR	DGNB
Country of origin	Great Britain	USA	Australia	Germany
Initiation	1990	1998	2003	2007
Key aspects of assessment	-Management -Health & well being -Energy -Water -Waste -Material -Site ecology -Pollution -Transport -Land consumption	-Sustainable sites -Water efficiency -Energy & atmosphere -Material & Resources -Indoor air quality -Innovation and design	-Management -Indoor comfort -Energy -Transport -Water -Material -Land consumption & ecology -Emissions	-Process quality -Technical quality -Ecological quality -Economical quality -Social quality
Building type and version	Courts, ecoHomes, Education, Industrial, Healthcare, Multi-residential, Offices, Prisons, Retail	-New construction -Existing buildings -Commercial interiors -Core and Shell -Homes -Neighbourhood development - School -Retail	-Office: Existing building Interior design Design	- Offices - Existing Buildings - Retail - Industrial - Portfolios - Schools
Level of certification	Certified: 30 points Good: 45 points Very good: 55 points Excellent: 70 points Outstanding: 85 points	Certified: 40-49 points Silver: 50-59 points Gold: 60-79 points Platinum: >=80 points	4 Stars: Best Practices: 45-49 5 Stars: Australian Excellence: 60-74 6 Stars: World Leadership: 75-100	Bronze: 50-60% Silver: 60-80% Gold: 80-100%
Weighting	-Management: 12% -Health & wellbeing: 15% -Energy: 19% -Water: 6% -Waste: 7.5% -Material: 12.5% -Land use and ecology: 10% -Pollution: 12% -Transport: 8%	-Sustainable sites: 26% -Water efficiency: 10% -Energy & atmosphere: 35% -Material & Resources: 14% -Indoor air quality: 15% -Innovation and design: 6%	-Management: 10% -Indoor comfort: 20% -Energy: 25% -Transport: 10% -Water: 12% -Material: 20% -Land & ecology: 8% -Emissions: 5%	-Process quality: 10% -Technical quality: 22.5% -Ecological quality: 22.5% -Economical quality: 22.5% -Social quality: 22.5%

Table 6: International rating systems for green buildings (Source: Schwarz, 2007)

These rating systems are important tools for the achievement of green building especially in their countries of origin because they have been developed in the local context. However, they should suit the local context and in the case of this study, they should suit Rwandan context especially Kigali City context in order to be used for residential estate houses which are considered for this study.

3.8 Summary of Literature reviewed, Gaps in Knowledge and focus of the study

In summary, literature reveals that:

- **Sustainability considerations in housing development** should include: economical viability, social acceptability, technical feasibility and environmental compatibility (Choguill, 2007). Also delivery of housing on time, cost effectiveness, high quality, good indoor environment, durability, permeability, buildability; structures fixity, structural stability and acoustic attributes cheaper to maintain, and user friendliness are key considerations (Abdellatif & Othman, 2006; Gilkinson & Sexton, 2007).

- Sustainable houses should have **vital characteristics of sustainable housing** which are: sustainable land use planning, resisting scattered settlements, housing development closer to employment and public transport, higher residential densities, sustainable construction, high standards of energy efficient dwellings, housing availability, affordability and quality, access to green areas, and a high quality residential environment (Eziyi & Dominic (2011).

- Assessing housing sustainability should be based on the following indicators: energy efficiency, water conservation, reduction of greenhouse gas emissions, waste management, material efficiency, pollution prevention, optimization and conservation of land, protection and enhancement of biodiversity, reduction of dependency on car (Bennett &James, 1999; Turcotte & Ken,2010). There are also checklists for assessing sustainable housing: Makes appropriate use of land; Uses water, energy, timber, and other resources efficiently; Enhances human health; Strengthens local economies communities; Conserves plants, animals, endangered species and natural habitat; Protects agricultural, cultural and archaeological resources; Being nice to live in; Being economical to build and operate (Barnett & Browning, 1995). The assessment indicators should describe the impacts of building materials (Adedeji, 2005), architectural design, construction solutions and structural design (Onibokun, 1976; Fatoye and Odusanmi, 2009). Others are environmental impact (Chen et al., 2005) and socio-cultural impact (Djebarni and Al-Abed, 2000; Lux, 2005; Mohit et al., 2010).

- Benefits of sustainable housing include: Improved quality of life and dignity of residence; Affordable access to housing; Improved health and lower incidents of illness, fatalities and material losses, better labour productivity; Better conditions for human development, employment, creativity and economic growth; Durability and low maintenance cost; Protection against natural hazards; Improved efficiency and savings on the use of energy, water and other physical resources; Better environmental protection and sanitary conditions; Contribution towards climate change adaptation and mitigation; More sustainable and socially inclusive urban growth; Social cohesion and political stability (UN Habitat, 2012).

The review of the literature has revealed a gap in the existence of practical approaches promoting sustainable housing development in Kigali City. The practices promoting sustainable housing development were discussed generally and the present research is focused on a small urban centre which is Kigali City. This study contributed to filling this gap by making a focused investigation of practices facilitating the implementation of the concept of sustainability into Housing Development processes. The approaches to improve housing sustainability in the literature review are addressed generally. There was a need to conduct a focused research to a small urban centre.

The practices promoting sustainable housing development in the literature review are proposed but there is lack of how practically these practices are being applied in promoting sustainable housing development. There is a need to investigate the specific challenges faced by cities in the implementation of the proposed practices promoting sustainable housing development in the context of a selected City. This study is filling this gap by assessing how these practices are being applied in Kigali City and by assessing the gaps that need intervention for successful implementation of sustainable housing development agenda in Kigali City. In the literature review, there is also a gap in the strategies and interventions aiming at promoting sustainable housing development in Kigali City context. This study contributed to filling this gap by proposing a strategy and interventions which will contribute to sustainable housing sector development.

The rating systems for the green building in the literature review do not suit the Rwandan context and they are supposed to be developed in Rwandan context for them to be easily applied. They should also be implemented from the preliminary stages of the design and consider the whole building life cycle. This study filled this gap by proposing criteria to be followed while assessing the sustainability of housing projects in Kigali City context which have been found to be common from the literature review and this will contribute to the development of criteria to be used while assessing the sustainability of residential houses in

Rwandan context in the future. Hence, this study contributes to the development of key aspects of assessment of sustainability of residential houses in cities in Rwandan context.

3.9 Theoretical and Conceptual Framework

3.9.1 Theoretical Framework

3.9.1.1 Malthusian Theory of Population

This Research was based on Malthusian Theory of Population which states that:'' Population if unchecked increases 'geometrically' or exponentially while subsistence increases arithmetically. Thus, population increases along the order of 1, 2, 4, 8, 16, 32..., whereas subsistence limps along at the rate of 1, 2, 3, 4.......''(Malthus, 1798) This is very important as far as resources consumption considered as variables in this research are considered and these are water, energy and other construction materials. Kigali's population has increased from 6,000 at independence in 1962 to 600,000 by 2000 and continued to grow quickly, swelling by almost 50 per cent between 2002 and 2012, increasing at an average rate of 4 per cent a year which was 1.4 per cent faster than Rwanda as a whole. By 2012, the city's population was 1.169 million and according to high projections, could reach 3 million by 2020 (REMA, 2013).

By the end of 2012, Kigali City hosted 10.8% of the country's population and its population density is 1,548 persons per square kilometer (NISR, 2012). The population growth trend in the city is largely attributed to rural-urban migration in pursuit of opportunities and better services. The trend leads to resource scarcity and is clearly unsustainable (Lookman, 2013).

Urban growth in Rwanda is an inevitable. On the basis of the urban growth rate, the annual housing requirement in Kigali was estimated at between 8,500 and 10,000 units in 2008. According to the Housing Market Study 2012, the City of Kigali has a supply gap of 344,068 units by 2022 in different housing typologies. This translates to an average of over 30,000 units which must be constructed every year to meet this demand (Kigali City Council, 2013). New housing demand in Kigali City is primarily driven by population growth. If pace of growth continues and if City policies remain unchanged, the population in 2040 will reach 5,347,178 inhabitants (Housing Market Demand, 2013).

3.9.1.2 Distance Decay Theory

Distance decay is a geographical term which describes the effect of distance on cultural or spatial interactions. The distance decay effect states that the interaction between two locales declines as the distance between them increases. Once the distance is outside of the two locales' activity space, their interactions begin to decrease[27].

The Distance Decay Theory is very important in this study because location reflecting distance from the Central Business District (CBD); employment opportunity in an area; accessibility (proximity) to amenities and services (schools, health, shopping, recreation, and other services); road infrastructure and transport facilities increase the housing demand, energy and water in a City (USAID, 2013) and this increases the demand for land and other resources.

The Distance Decay Theory can be used also to explain the large difference in population densities in urban areas compared to rural areas where urban districts have the highest densities of population, in particular the districts of Nyarugenge 2,124 inhabitants/ km^2, Kicukiro (1,911 inhabitants/ km^2), Gasabo (1,234 inhabitants/km^2) (Kigali City), and Rubavu (1,039 inhabitants/km^2), and those with the lowest density are Bugesera (280 inhabitants/ km^2), Gatsibo (274 inhabitants/km^2), Nyagatare (242 inhabitants/km^2), Kayonza (178 inhabitants/ km^2) (East Province) (NISR, 2012). The higher population densities in Kigali City increases the demand for housing, water, energy food and other natural resources required to sustain the population of Kigali City.

The Distance Decay theory is suitable to this study because driving forces for environmental change in Kigali include population growth and distribution, employment, education, health, poverty and economic activities (REMA, 2013).

3.9.2 Conceptual Framework

The DPSIR (Drivers-Pressures-States-Impact-Responses) Framework has been selected to be used in this study because it helps to organize information about the state of the environment. It is used to evaluate the sustainability of development initiatives. This framework has been

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[27]www.wikipedia.org accessed on 26/06/2014

adopted by the European Environment Agency (EEA) in 1999 to assess and manage environmental problems by describing the interaction between the society and the environment.

The Driver-Pressure-State-Impact-Response (DPSIR) scheme is a flexible framework that can be used to assist decision makers in many steps of the decision process. It was initially developed by the Organisation for Economic Cooperation and Development and has been used by the United Nations and European Environmental Agency to relate human activities to the state of the environment. DPSIR has been widely used for many applications including Management of water resources, River basin management, Wetlands, Marine systems, Agro-environments, Sustainable development, Air pollution, Climate change, Biodiversity and Invasive species[28]

The DPSIR framework has also been used in South Africa in 1999 for identifying core indicators for inland waters. The main drivers of change on inland waters and the main areas of impact of these drivers were presented in the 1999 State of Environment Report for South Africa and they were:

- Limited freshwater resources (surface and ground water)
- Changing freshwater quality (surface and ground water)
- Degradation and loss of freshwater ecosystem integrity
- Flood and drought management of inland water resources
- Inadequate and Inequitable distribution of services (reflected on inland waters)
- Conflicting interests over water sharing (national and international) (reflected on inland (Peter, 2004)

This framework has been also used in Ghana in the assessment of environmental degradation in northern Ghana (Isaac, 2007).

In this study, the population pressure (considered as independent variable in this framework) and the shrinking ecosystem services are considered as the drivers. The population pressure leads to demand for ecosystem services of water, energy, land and building material (considered as dependent variables). In housing development sector, the population growth increases the demand for housing as well as the need for natural resources used during housing construction and operation. These will result in pressures consisting of human interventions in the environment. The example is the emission of greenhouse gases like carbon dioxide emitted during the burning of fuel to produce electricity and heat buildings.

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[28]http://www.epa.gov/ged/tutorial/docs/DPSIR_Module_2.pdf accessed on 26/06/2014

Carbon dioxide also comes from the cutting down and burning trees before implementation of housing development projects. The carbon dioxide is also emitted during industrial and manufacturing processes like when producing cement and certain chemicals used in housing construction. The other gases are methane emitted from landfills especially from the wastes produced from the households. The other category of greenhouse gases is the chlorofluorocarbons coming from anthropogenic sources such as production or use of foams, refrigerants and solvents.

The greenhouse gases result in the change in state of the environment as in form of depletion of ozone layer, climate change as well as global warming. Serious impacts on the environment will result such as changes in the patterns of floods, droughts and diseases and result in impact on human well being causing for example sickness and death, ill health and food insecurity. The environmental impacts may also degrade or compromise the quality of the living environment and this requires response in terms of efforts which are taken to address the drivers and pressures.

The responses are the waste reduction or minimization (through energy and water use efficiency/ conservation), waste recycling and technological innovation (to find alternative means amidst the pressures, for example change of construction materials. Once the responses are not well addressed, the cycle will restart with the population pressure and once the responses are well addressed by all concerned stakeholders in housing development sector, the housing sector will be sustainable and this will improve the housing development sector, reduce the emission of greenhouse gases, improve the state of environment (reduced depletion of ozone layer, climate change and global warming mitigation) and enhance the human well being. Figure 6 indicate the conceptual framework used in this study.
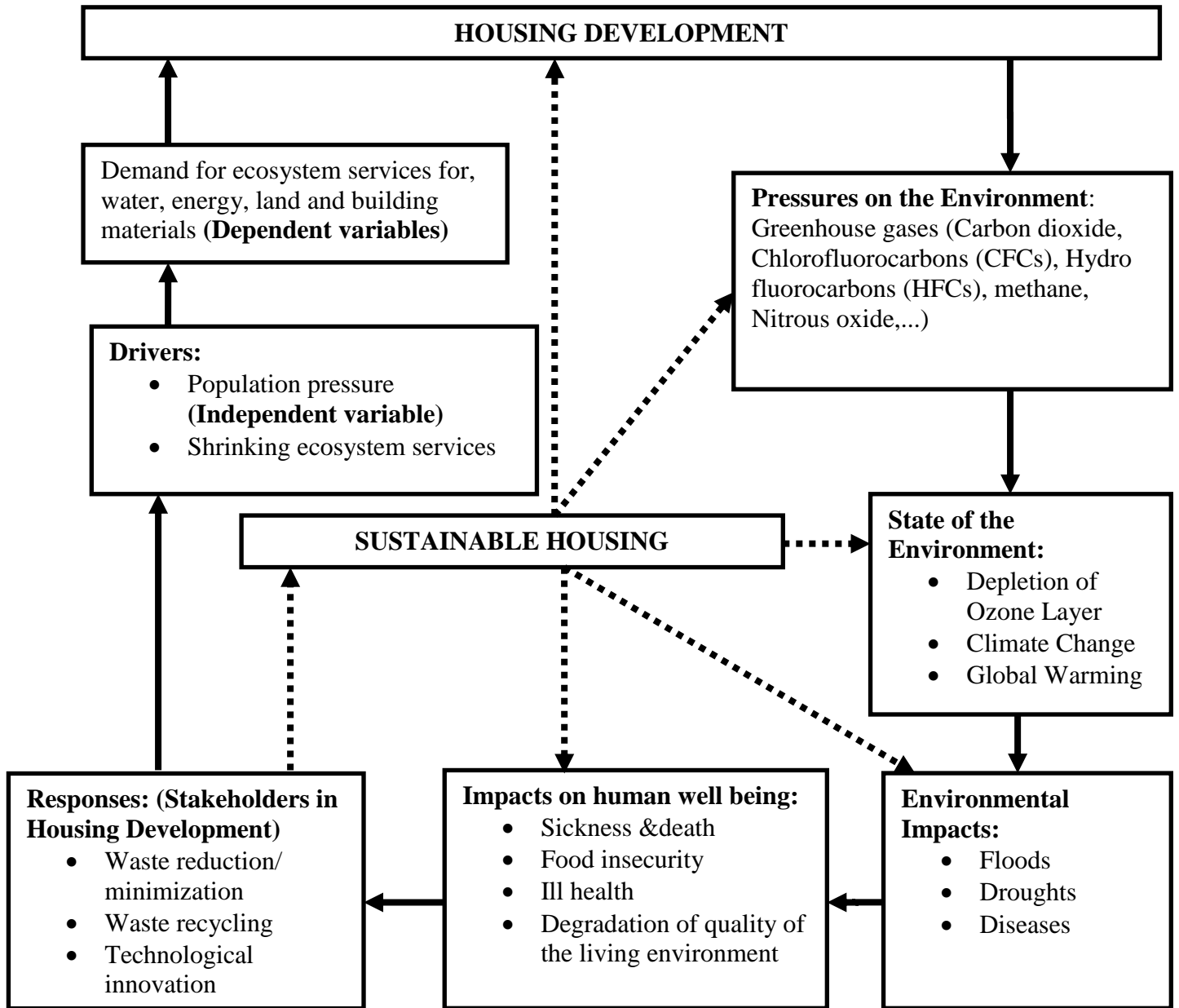
Figure 6: Conceptual Framework (Source: Adapted after Matheus & Campuzano, 2008)

4.0 METHODOLOGY

4.1 Study design

The research applied a cross-sectional design that employed a survey approach to collect data. This type of design has been also used and applied successfully by Christine Mary Ambasa Kupeka in determining the Factors indicating the sustainability of housing projects in Kenya (Kupeka, 2013). Proportionate sampling and systematic random sampling methods have been used to sample the respondents for the administration of questionnaires (See details on section 4.4 of this study). Both qualitative and quantitative approaches were used. This study was guided by selected practices from the literature review in sustainable housing development in Kigali City context. The study collected data from the households from estates located in the urban part of Kigali City. Only households from estates (High-middle-low income) located in the urban part of Kigali City Districts have been considered.

The advantage of this design is that cross-sectional studies are relatively inexpensive and take up little time to conduct and because the sample is taken from across a wide section of the population, the prevalence of outcomes can be predicted from cross sectional studies.
In this design, there is also no loss to follow-up. Routinely collected data in this study suffice and this allows for quick and easy data gathering even for a large target population. On the other hand, the situation may provide differing results if another time-frame had been chosen because the design is only a snapshot.
This design is appropriate for the study to investigate the current practices promoting sustainable housing development in Kigali City within the specific cross-section (Nyarugenge, Kicukiro and Gasabo Districts) and generalized about the larger population (Kigali City)

4.2 Target population

This study targets the urban population in Kigali City living in three categories of residential real estates in the urban areas of Kigali City. These categories are high income estates, middle income estates and low income estates. Only households in estates in the urban areas of Kigali City Districts were considered. Table 7 below indicates the targeted population and its distribution in estates from the three Districts of Kigali City.

| Type of Estate | District/Households | | | Total |
	Gasabo	Nyarugenge	Kicukiro	
Low-income	142	76	131	349
Middle-income	156	81	108	345
High-income	223	103	187	513
Grand Total	521	260	426	1207

Table 7: Distribution of Households in Estates in the urban area of Kigali City Districts (Source: Researcher, 2014)

4.3 Study variables, types and sources of data

4.3.1 Study variables

In this study, primary data was collected by the use of questionnaires which have been designed in such a way that they allow the collection of the information on housing development industry with respect to the selected variables in the study which were:

- Energy efficiency
- Water conservation
- Security and safety
- Connection to water and sanitation
- Connection to social amenities

These variables have been selected by the researcher among the ones proposed in the literature review because they form the basis for sustainable housing development and they can fit in the Rwandan context. They are also ideal for such kind of study which considers the sustainability of housing projects in their operational phase. Others in the literature review were about the design, implementation or demolition phases. The data collected was in nominal form. The unit of measurement was the household.

4.3.2 Types and source of data

The primary data were collected by the use of questionnaires during a field survey. The following are the data which were collected about each of the variables above.

- Energy efficiency:

This section covered the installation of energy efficient systems in the house, the design of the house which allows the house to benefit from solar gain with larger main windows oriented towards the south and smaller windows to the North, the use of energy efficient light bulbs and the access of the house to daylighting.

- Water conservation:

This covered the availability of water conservation systems (grey water system and rainwater harvesting system).

- Security and safety

This section covered the crime in the neighbourhood, negative impacts of climate change and the presence of traffic noise.

- Connection to water and sanitation:

This section covered the access of the house to tap water, solid waste removal, and local wastewater treatment plant and storm water disposal.

- Connection to social amenities:

This section covered access to social amenities such as health care, childcare facility, social centre, restaurants, schools, bus stop, and recreational facility, place of worship, markets, financial institutions, parks and cyber cafe.

These data were collected in the selected houses from all categories of estates; high, middle and low income estates. In Rwanda, the high income group is composed of people earning more than 900, 000 Rwf per month, the middle income group is composed of people earning between 200,000 and 900,000 Rwf per month while the lower income group is composed of people earning less than 200,000 Rwf per month (NISR, 2012)

In the case of Key Informants interview, the following key informants have been purposively selected.

- ➢ Director of Housing planning and Development Division: This Director has been selected from the public sector because of the influence of the Department on the Housing Development in Kigali City. This Division has the general responsibility of the coordination and supervision of all the activities in all Directorates under the

Division of Housing Planning and Development and ensure that all projects are environmentally friendly[29]

The targeted data from this Director was qualitative data about which policies, rules and regulations are put in place by Rwanda Housing Authority to green the housing sector in Kigali City, RHA's activities greening the housing sector in Kigali City and opportunities and challenges of implementing sustainable housing development agenda in Kigali City.

In the group of Real Estate developers/ Building contractors, the researcher selected Urban Sustainability Rwanda LTD.

> Director, Urban Sustainability Rwanda LTD: This study selected this Company because of its four years of experience in providing services especially in Real estate development, sustainable urban planning, sustainable design, sustainable architecture, environmental and green economy services. This experience is of paramount importance in providing the information about improving sustainable housing development in Kigali City.

The targeted data from this Director were about the Company activities which are being put in place to green the housing sector in Rwanda, opportunities and challenges in the implementation of sustainable housing development agenda and proposed strategy to promote sustainable housing development in Kigali City.

The third group of informants is the one of the academia. The researcher selected them because of their important role in research and design of Sustainable Houses in Kigali City. The role of researchers in the construction of sustainable houses in Kigali City is also of paramount importance considering their experience and the results from their past researches. The researcher selected them as the following:

> Dean, Faculty of Architecture and Environmental Design, College of Science and Technology, University of Rwanda: The researcher selected him because of his experience in Architecture as a professional architect and as a researcher in the field of the design of sustainable houses.

The targeted data from the Dean were the activities undertaken by the school of architecture and environmental design and other schools generally to green housing development in Kigali City, opportunities and challenges in implementing sustainable housing development agenda in Kigali City and proposed strategy to promote sustainable housing development in Kigali City.

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[29]www.rha.gov.rw retrieved on 29/06/2014

In the group of professional community, the researcher selected Architect in One Stop Centre of Nyarugenge District in Kigali City. The researcher selected him because of his role in the approval of housing projects in Kigali City. His experience is of paramount importance in the process of assessing the current practices promoting sustainable housing development. His experience as an architect is also important in the successful completion of this study.

The Architect was to provide qualitative data about what rules are in places promoting sustainable housing development in Kigali City and the opportunities in place to facilitate sustainable housing development in Kigali City. The appendix 2 indicates the topics addressed during the Key Informants Interview.

Table 8 illustrates how the researcher selected the respondents according to the reasons above:

Key informants	Responsibility	Number
Public Sector	Director of Housing planning and Development Division	1
Real Estate developers/Building contractors	Director, Urban Sustainability Rwanda LTD	1
Academia	Dean, Faculty of Architecture and Environmental Design, College of Science and Technology, University of Rwanda	1
Professional community	Architect, One Stop Centre, Nyarugenge District	1
Total		4

Table 8: Key informants selection (Source: Researcher, 2014)

4.4 Sample design

The sample size for this study was determined using the Nasiurma (2000) formula which states that:

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

Where:

N= Population

Cv = Coefficient of variation (take 0.5)

e= Tolerance at the desired level of confidence (take 0.05 at 95% confidence level) (KIM, 2009)

By substituting in the formula with the population of 1207 house units in estates, a sample size of 92 households was arrived at from the total population of 1207.

The next step was to proportionalize the sample size to each District. The proportionate sample size for each District was calculated by dividing grand total number of households from each District by the Grand total population (1207) times the sample size (92). Table 9 indicates the proportionate samples to the Districts of Kigali City with respect to the sample size. The results are presented in table 9 below.

District	Households sample
Gasabo	40
Nyarugenge	20
Kicukiro	32
Grand Total	92

Table 9: Proportionate samples to the District (Source: Researcher, 2014)

The following step was to proportionalize the Districts samples further to get the number of households from each income category of estate. The household sample in each District was calculated by dividing the total number of households in each income category in every District by the population size (1207) times the sample size (92) to low-middle-high income categories in each and every District. Table 10 illustrates the results of the proportionalization to the different categories of estates:

| Type of Estate | District/Households samples | | | Total |
	Gasabo	Nyarugenge	Kicukiro	
Low-income	11	6	10	27
Middle-income	12	6	8	26
High-income	17	8	14	39
Grand Total	40	20	32	92

Table 10: Proportionate samples to categories of estates in each District

The lists of physical addresses (from the Government officials and real estate developers) for each estate have been randomized to remove the source of bias and the selection of actual households for the administration of questionnaires in each income category was done by using systematic random sampling method using a sampling interval of 13.

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This study has then used sample size of 92 households as per table 11.

Type of estate	Households sample size
High income estate	39
Middle income estate	26
Low income estate	27
Total	92

Table 11: Households sample size used for the research (Source: Researcher, 2014)

Each of the households where classified and given codes for easy entry of data into an analysis system.

4.5 Methods of data collection

4.5.1 Housing survey

A semi-structured questionnaire (see appendix 1) was administered to selected systematic random samples of 92 heads of households in a housing survey. The questionnaire was designed based on the study variables in section 5.3. The researcher's administered questionnaire consisted of two parts: Part I: General information where the location of the house, age, monthly income, as well as gender of the respondent are recorded.
Part II: Semi-structured questions on study variables in section 5.3.

4.5.2 Key informant interviews

The purpose of key informant interviews was to collect data that could not be captured by the survey questionnaire and hence complement the questionnaire. Key informants were selected on the basis that they held a specific kind of information that could only be obtained from them by virtue of their rank in society or role in the housing sector management. A tailor-made key informant interview schedule (see appendix 2) was used to capture data from them on one-on-one conversation. This allowed the researcher to collect rich, reliable and accurate data needed to answer the specific research questions and also to achieve the specific objectives of the research. Table 8 indicates the key informants selected.

4.5.3 Field observations

Observations employed an observation schedule (see appendix 3) to collect data related to the physical state of houses and verify some of the information obtained by the survey questionnaire, key informant interviews, and focus group discussions. The observation schedule consisted of a checklist relating to aspects of the study variables whose data could not be collected using either a questionnaire or an interview. Observation data complemented questionnaire data.

4.5.4 Focus group discussions

Focus groups were designed to combine elements of interviewing and observation. A focus group comprised a group of 8-12 individuals with common characteristics with respect to the study topic. The group was set in a room and drawing on group dynamics, data were obtained from members using a pre-determined topic guide (see appendix 4). A moderator (group leader) guided the participation and the direction of the discussion. The proceedings of the discussions were recorded and later analyzed for appropriate information.

The moderator first gave a copy of the topic guide to each of the participants and gave them about 20 minutes to reflect on topics. Then the moderator commenced the focus group by asking members to hear each other's responses, to speak only when allowed by the moderator, and be free to make additional comments to what other people have to say. The moderator was particularly keen on stimulating interaction, new perspectives and new thought among participants as well as illuminating on conflicting opinions.

The study conducted 2 focus groups discussions. One was with tenants and the other one was with public sector (officer from the Rwanda Housing Authority, officers in charge of settlements) and officials from private sector organizations.

4.5.5 Collection of secondary data

Secondary data were collected from documents on real estate development in Rwanda, Housing development in Rwanda, official documents related to Housing Development in Kigali City like urban housing reports, Kigali City conceptual Master Plan, Environmental organic law, Guidelines for environmental audit in Rwanda, Kigali City website, reports, UN Habitat Reports, internet and journals and documents from NISR.

4.6 Methods of data analysis

4.6.1 Preparation of data for analysis

After collecting the data, they were prepared for analyses using following procedure:

First of all the collected data were edited and missing data points filled up. The questionnaires that had mistakes that can affect data analysis were corrected accordingly by editing them or by calling back on the data sources to help the researcher to correct mistakes. There were checks for gaps and irregularities in order to make necessary adjustment.

After editing the field data, the second step was to code the data so that it is in a suitable formant for entry into an analysis system.

After coding, the data was entered into an analysis system. In this study, the SPSS is the analysis system which was used to analyse the data obtained from the house survey and the observation schedule. The data was then stored in a suitable format to allow their analysis using procedures in the SPSS system.

4.6.2 Analytical procedures

4.6.2.1 Stakeholder analysis

Stakeholder Analysis method was used to analyse the data obtained from key informants interview and focus group discussions. Stakeholder analysis is a process of systematically analyzing qualitative information to determine whose interest should be taken into account when developing/ implementing a policy/ program.

This procedure was used in this study to identify all the stakeholders involved in housing development sector in Kigali City and to propose the best interventions to achieve sustainable housing development taking into account the role and expectations of the stakeholders in the housing sector. Content analysis method has been used to complement stakeholder analysis method.

4.7 Limitations and delimitations of the study

This study faced the limitation of criteria assessing sustainability of houses in Kigali City. Rwanda does not have criteria for assessing and examining sustainability of houses in a local context. Some of the criteria in the literature are generic and not immediately relevant to the Rwandan situation and the researcher selected the criteria that fit in Rwandan context among the ones proposed from the literature review. However, the study got moral support from several stakeholders who are keen on pursuing sustainable housing in Rwanda. This increased their participation in the process of data collection.

5.0 RESULTS AND DISCUSSION

5.1 Introduction

The main objective of this study was to investigate existing practices promoting sustainable housing development in Kigali City. The specific objectives were to map the roles of key stakeholders involved in housing development sector in Kigali City, to determine activities being pursued by stakeholders to green the housing sector and to assess the gaps (from the expectations of the stakeholders and existing literature) that need interventions to increase uptake of sustainable housing sector development in Kigali City. This section presents the results of the study based on the objectives. Also, the section interprets results into findings, and discusses the findings based on the literature presented in section 3.0

5.2 Characteristics of the Household survey sample

This study identified respondents according to gender, age, employment status and monthly salary of the heads of the families. In the house survey questionnaire, there were 59 males (64.1%) and 33 females (35.9%). Figure 7 illustrates the age of the respondents.
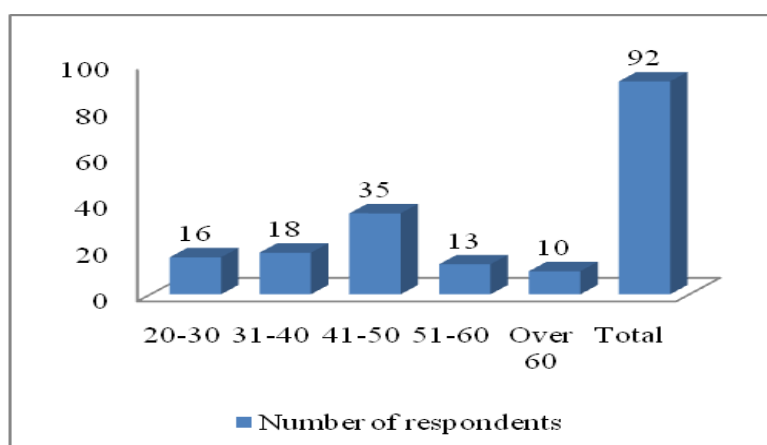
Figure 7: Identification of the respondents according to their ages (Source: Results of the research, 2014)

The study considered also the employment status of the heads of the families in the households surveyed and 55(58%) heads of families were employed while 37 (42%) were unemployed during the survey. The employment status was different across the surveyed estates (See Figure 8).
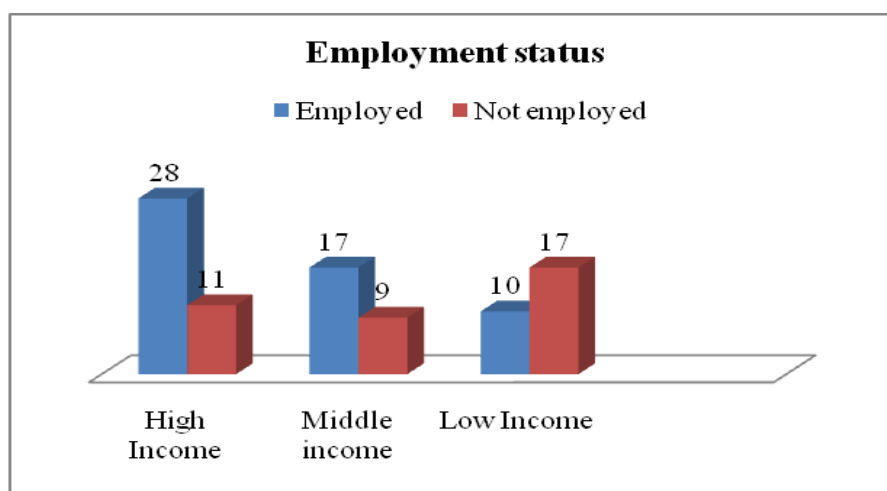
Figure 8: Employment status of the heads of families for the surveyed households (Source: Researcher, 2014)

Figure 9 indicates the monthly salary of the heads of families employed at the time of the survey.
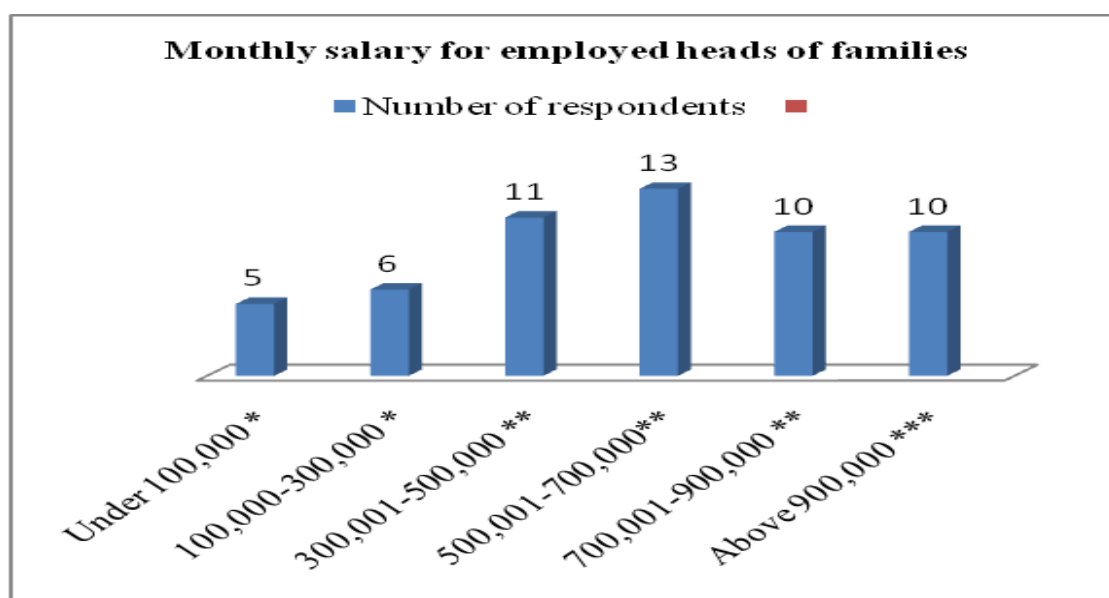
Figure 9: Income categories of respondents [*high income; **middle income; *low income]   (Source: Field data, 2014)**

5.3 Key stakeholders involved in housing development sector in Kigali City and their roles

The study has revealed that key stakeholders involved in housing development in Kigali City are grouped into five main categories including public sector agencies, private sector, civil society academia, and end users.

5.3.1 Public Sector Agencies

The Public Sector plays the role of providing policies, plans, programmes, and strategies in the Housing sector. In this regard, the Ministry of infrastructure (MININFRA) has the responsibility of providing houses to Kigali City dwellers in cooperation with the Ministry of Economy and Finance, which coordinates and facilitates economic planning and finance of housing projects. For successful completion of this responsibility, Rwanda Housing Authority assists the MININFRA in the implementation of the policies, plans, programmes, and strategies in the housing sector. Rwanda Bureau of Standards (RBS) plays the role of providing standards for quality of construction materials in Rwanda. National Land Centre plays a role of paramount importance in the provision of guidelines for formulating policies, plans, and strategies for housing development projects in Kigali City. Kigali City Council centralizes policies, plans, programmes, and strategies in coordination with Rwanda Housing Authority in Kigali City and at the local level with One Stop Centres of each District within Kigali City.

5.3.2 Private Sector

The private Sector plays the role of providing finance to housing projects and providing houses especially private real estate developers. These are banks (KCBR, BPR, BRD, Equity Bank, BK) industries providing services linked to housing delivery like construction and building materials industries (Rwanda Cement Manufacturing Company Limited, Ruliba Clays Limited), professional community (Rwanda Engineers Board, Rwanda Association of Architects), land owners, business organizations, housing construction material suppliers, property management agencies, real estate developers (Urban sustainability Rwanda Limited, Horizon Construction, Fair construction Rwanda).

5.3.3 Civil Society

The Civil Society plays the role of advocacy in the housing sector in Kigali City. This group of stakeholders includes international agencies, donors, aid agencies, charities and humanitarian agencies whose focus is on housing development projects.

5.3.4 Academia

This group of stakeholders includes the Universities and schools providing adequate knowledge and skills to students in the field of housing design and construction. This is the responsibility of University of Rwanda and Technical and Vocational Training Centres as well as other private schools that train and equip future engineers, architects and other professionals in the field of housing development. They conduct studies and researches in the housing development industry especially Kigali Institute of Science and Technology in the Faculty of Engineering (Department of Civil Engineering and Environmental Technology) and the Faculty of Architecture and Environmental Design (Department of Architecture and Estate Management and Valuation).

5.3.5 End users

The end users are tenants, users and occupiers of constructed houses in Kigali Cit. These stakeholders make use and enjoyment of the constructed houses in Kigali City. Table 12 indicates the stakeholder organogram and mutual dependencies.

Stakeholder Analysis method was used in this research to identify the engagement of all of the stakeholders in the housing development in Kigali City. This method has also been used to help the researcher in identifying the gaps from the expectations of the stakeholders that need intervention if sustainable housing development is to be achieved. It also helped the researcher to propose a required strategy to be used for promoting sustainable housing development in Kigali City. This analysis also provides potential information to policy makers about the possibility of promoting sustainable housing development in Kigali City. Policy makers can use the results from this Stakeholder Analysis to develop their action plans.

5.3.6 Stakeholder organogram and mutual dependencies

Stakeholder mutual relation analysis is done to understand the characteristics of networks that increase the possibility of promoting sustainable housing development in Kigali City. In this study, the informal and indirect relationship between stakeholders is also considered and this helps to understand the stakeholders' power, influence and ability to participate for an effective sustainable housing development agenda.

To be able to easily analyse these mutual relations, the table 12 has been divided into five main parts: Public Sector, Private Sector, Civil Society, Academia and End users.

From table 12 it can be observed that there are intra-relations within each side and interrelations between stakeholders in both sides. For example, in the public sector, the MININFRA works internally with RHA, REMA, MINECOFIN as well as other public agencies in the case of rules and regulations about housing development in Kigali City. Most of the stakeholders bare relations of dependencies to each other. There are also the mutual interdependencies that exist between different stakeholders. This is useful for establishing a strategy promoting sustainable housing development in Kigali City because the interdependency of the stakeholders can be utilized by competent council dealing with sustainable housing development in Kigali City to promote its implementation.

Responsibility for housing provision was delegated on the Ministry of Infrastructure (MININFRA), which in 2011 formed the Rwanda Housing Authority (RHA) to implement national housing, urbanization, construction and asset management policies.
At the national level, policies are coordinated by MININFRA with the Ministry of Economy and Finance, which oversees economic planning, finance and development cooperation.
General planning, policies and regulations for the City of Kigali are centralized by the City of Kigali Council which coordinates with the Rwanda Housing Authority (RHA) and, at the local level, with the District Offices. The different department form different Ministries have to work collectively in policy making and implementation to promote sustainable housing development in Rwanda generally and in Kigali City particularly.

It is very important to consider all types of relationships and take them into account to be able to promote sustainable housing development in Kigali City. In addition to that, all concerned stakeholders have to be informed by a competent authority about the benefits and advantages of sustainable housing development. This will help them to have a common understanding of the benefits of sustainable housing development and the best practices for achieving it in a way that takes into account stakeholder's interests. For example, the private real estate developers should be aware of the benefits of sustainable housing development while making profit from their housing development projects. The Universities and schools have to consider sustainable development units and incorporate sustainable housing development in their curricula and this will help to train competent and skilled future policy makers and implementers in housing development sector. The common understanding of the benefits of sustainable housing by all of the concerned stakeholders at all levels will help in the design

and implementation of housing projects that are environmentally friendly, socially acceptable and economically feasible.

Public Sector: Policies and regulations
Ministry of Infrastructure (MININFRA)
- Rwanda Housing Authority (RHA)
- Rwanda Environment Management Authority (REMA)
- Ministry of Land Forestry and Natural Resources (MINIRENA)

Other Government Entities:
- Ministry of Economy and Planning
- National Land Centre

City of Kigali:
- Districts One Stop Centres (OSC)

Private Sector: Housing Finance and Delivery
- Housing Finance Providers (Banks)
- Property Developers
- Construction Industry
- Building Supplies Industry
- Professional Community
- Land Owners

Academia: Research and Studies
- University of Rwanda
- Kigali Institute of Science and Technology
- Technical and vocational Training Centres
- Researchers in the housing industry

Civil Society: Advocacy
- NGOs
- Donors

End users

Table 12: Stakeholder Organogram and mutual dependencies (Source: Researcher, 2014)

5.4 Stakeholder activities in greening the housing sector in Kigali City

Table 13 illustrates the different types of activities by the stakeholders greening the housing sector in Kigali City with respect to the selected criteria used from this study. These data were collected from the key informant's interview and the focus group discussion:

Variable of study	Stakeholder	Activities
Energy efficiency	End users, public, private sector, academia	-Use of energy efficient light bulbs -Design houses to allow solar access and daylight to internal space of house -Integration of sustainable development course into school curricula for engineers and architects. -Design houses to allow natural ventilation
Water conservation	Public, Private, end users	-Use of rain water harvesting tanks -Use gardens with plants with low watering needs -Implementation of wastewater treatment plants in all estates -Reduce the amount of water needed for operation
Security and safety	Public, private, end users	-Ensure security of users of the houses in the estate -Minimize potential for traffic noise intrusion from outside -Promote security in the surrounding of residential estates -Avoid construction of houses in sites exposed to natural hazards
Water and sanitation	Public Sector, Private Sector, end users	-Implementation of Kigali City Master Plan -Provision of piped water to all residents in the estates -Reduce-reuse-recycle household wastes -Implementation of wastes management plan
Connection to social amenities	Public Sector, private sector	-Implementation of Kigali City Master Plan -Provide utility infrastructures to Kigali City dwellers

Table 13: Stakeholder activities in greening the housing sector in Kigali City (Source: Results of the survey, 2014)

The practices promoting sustainable housing development in Kigali City have been investigated based on the selected criteria which are presented and discussed below.

5.4.1 Energy efficiency and water conservation

The data collected during the study about the energy efficiency and water conservation practices are presented in table 14. The study looked at the practices maximizing the use of natural energy and reducing the need for non-renewable energy. These included the use of

solar water heater, wind energy, solar panels, biogas plant, energy efficient light bulbs and access to daylighting.

In all the surveyed households, there was no use (0%) of wind energy and biogas plants in all estates. Solar water heaters were used at very low levels (23%) in high income estates houses, 15% in middle income estate houses and they were not used (0%) in low income estate houses. Solar panels were also used used at very low levels (36%, 27% and 11%) alternatively from high, middle and low income estate houses. Energy efficient light bulbs are largely used in low income estate houses (70%) compared to high (31%) and middle income estates (46%)

Access to day lighting is greater in high (90%) and middle (69%) income estates as compared to low income estate (40%). There is low use of rain water harvesting tanks in high income estates (26%) while it used used at 23% in middle income estates and 85% in low income estates. The respondents were also asked if there was any grey water system in place for toilet flushing, irrigation or other non-potable use. This grey water system was not available (0%) in all the categories of estates surveyed. Table 14 gives the details of the results of the survey in the practices promoting sustainable housing development in Kigali City considering selected variables in energy efficiency and water conservation practices.

Selected Criteria	HIGH INCOME ESTATE				Total		MIDDLE INCOME ESTATE				Total		LOW INCOME ESTATE				Total	
	F		%		F	%	F		%		F	%	F		%		F	%
	Yes	No	Yes	No			Yes	No	Yes	No			Yes	No	Yes	No		
Energy efficiency																		
Solar water heater	9	30	23	77	39	100	4	22	15	75	26	100	0	27	0	100	27	100
Wind energy	0	39	0	100	39	100	0	26	0	100	26	100	0	27	0	100	27	100
Solar panels	14	25	36	64	39	100	7	19	27	73	26	100	3	24	11	89	27	100
Biogas plant	0	39	0	100	39	100	0	26	0	100	26	100	0	27	0	100	27	100
Benefit solar gain	37	2	95	5	39	100	23	3	88	12	26	100	17	10	65	35	27	100
Energy efficient light bulbs	12	27	31	69	39	100	12	14	46	54	26	100	19	8	70	30	27	100
Access to daylighting	35	4	90	10	39	100	18	8	69	31	26	100	11	16	40	60	27	100
Water conservation																		
Grey water system	0	39	0	100	39	100	0	26	0	100	26	100	0	27	0	100	27	100
Rain water harvesting	10	29	26	74	39	100	6	20	23	77	26	100	24	3	85	15	27	100

Table 14: Energy efficiency and water conservation practices in estates (Source: Results of the survey, 2014)

Energy and water efficiencies are critical in ensuring sustainable housing development. According to Barnett and Browning (1995) sustainable housing has to use water, energy and other resources efficiently. Contrary to this, most of the surveyed houses in all income categories of estates were highly depending on non-renewable source of energy. Energy efficiency is the most important criteria of any sustainable house. The study has revealed the limited use of renewable energy sources and this promotes the use of non renewable energy which in turn contributes to the production of green house gases which contribute to climate change. In this study, none (0%) of the surveyed households was using wind energy or biogas plant. In addition to that out of 92 households surveyed only 14.13% were using solar water heaters against 85.87% which were not using solar water heaters especially the low income group (0%). Solar panels were used by 26.09% of the total population surveyed against 73.91% which were not using the solar panels. Energy efficient light bulbs were used only by 46.74% of the surveyed households against 53.26% which were not using them.

The limited use of renewable sources of energy discussed during this study was attributed to the fact that the residents in high and middle income estates are rich and able to pay for electricity bills. To some of them, the electricity bills are fully paid by their employers and there is no need for one to stress and pay money looking for alternatives. This is considered as low awareness of the benefits of sustainable housing development.

On the other side, the limited use of renewable form of energy is a result of high installation cost especially in low income estates houses. Some of the respondents in low income estate houses agreed that renewable sources of energy are the best option but they don't have financial ability to buy them. Various methods for on-site renewable energy production are encouraged to reduce the overall footprint of the houses in the surveyed estates in Kigali City. Passive solar design, use of solar panels and wind energy in this case have to be promoted as efficient ways to reduce the use of non- renewable forms of energy.

The results obtained from this study are not consistent with what has been done in South Africa where the Department of Housing commissioned a study in 2003 to set up a framework for the regulation of environmentally sound building. The policy was to revise the South African Energy and Demand Efficiency Standard guidelines in order to specify which measures should be included in the energy-efficient housing package, plus any technical details required for these interventions, and to make these standards mandatory for all new subsidy-supported housing (Winkler, 2006). These guidelines are not in place in Kigali City and they

should be implemented to specify which measures to include in the energy-efficient housing design and construction.

The design and implementation of housing projects in Kigali City have to reduce the amount of water used for their operations and this will increase water efficiency within the houses in all residential estates. The water efficiency in the houses can also be improved by putting in place grey water and black water treatment facilities which will reduce the use of potable water for irrigation purposes or for other uses which do not need drinking water such as cleaning and watering of the gardens. In the surveyed estates, only 43.48% of the households were using rainwater harvesting tanks against 56.52% which were not using rainwater harvesting tanks. There were very few houses performing well in water efficiency. This is highly observed in high and middle income estates where there was limited use of rain water harvesting tanks (26% and 23%) respectively from high and middle income estates observed during the time of the survey. In most of the surveyed houses in high and middle income estates, there were use of water storage tanks which were used to store water from EWSA and use it just in case of water shortage (Plate 1). The study did not investigate the quality of the water from the rainwater harvesting tanks however; this water is used for several non-drinking functions such as irrigation and watering gardens, washing clothes and cars among others.

Plate 1: Water storage tanks in Rebero Hill View Estate. (Source: Researcher, 2014)

There is a difference in the use of rain water tanks in high, middle and low income residential estate houses and this is due to the difference in the design and implementation of housing projects. In low income estate, almost all the houses (85%) were designed with rain water harvesting tanks. This is a Government initiative in providing water to low income earners in the residential estates. This means that the same can be applied to high and middle income estates. One of the respondents agreed that the fact that high and middle income earners have the ability to pay easily for the water bills reduces the need to use water harvesting tanks. This has been considered as low awareness of the benefits of water conservation practices in housing development. The domestic rainwater harvesting system used is the rainwater harvesting tanks. In low income estates, it is the Government initiative to provide rainwater harvesting tanks and in high and middle income estates, individuals use rainwater harvesting tanks at their own will. There are no rules about the use of rainwater harvesting tanks as such but the Government encourages the use of such tanks in the country.

5.4.2 Security and safety

The respondents were asked if they experience crime in their neighbourhood and if their house was affected by any of the listed climate change consequences (Excessive floods, landslides, bushfires, storm or any other). Only 3 out of 39 respondents, 4 out of 22 respondents respectively from high and middle income experienced crime while 15/27 respondents from the low income estate experienced crime. Table 15 highlights the key findings from the security and safety variable in the selected households from residential estates.

Type of estate	Crime			Climate change impact			Traffic noise		
	Yes	No	Total	Yes	No	Total	Yes	No	Total
High income estate	3	36	39	0	39	39	14	25	39
Middle income estate	4	22	26	0	6	26	12	14	26
Low income estate	15	12	27	11	16	27	14	13	27

Table 15: Security and safety in the selected estates (Source: Results of the survey, 2014)

Less than a half of the houses from the low income estates (40.7%) were affected by climate change consequences especially landslides while none of the houses from high and middle income estate were affected by selected climate change consequences (Excessive floods, landslides, bushfires, storm or any other). Fifty six percent and 46% alternatively from high and middle income estates were experiencing excessive traffic noise against 52% from the low income estate houses (See table 15).

Security and safety of the occupiers of designed houses in the estates is of paramount importance in the successful implementation of a sustainable housing development project. Sustainable houses are those designed, built and managed as safe and secure (UN habitat, 2012). This study has revealed that security of the residents was given priority. In all of the surveyed houses only 23.91% of the residents experienced crime in their neighbourhood against 76.09% of the respondents who did not experience crime in their neighbourhood. However, there is a clear difference in the way this security is promoted from the high and middle income estates and low income estates. On one hand, most of the residents in high and middle income estates are rich people, there is the use of trained and equipped security officers. This significantly reduces the crime and insecurity in these areas. On the other hand, in low income estates, a well organized police community locally known as Irondo ensures security of the residents.

According to UN Habitat (2012) Sustainable houses are designed, built and managed as resilient to sustain potential natural disasters and climatic impact. This was not observed in low income estates where 40.7% of the surveyed houses were experiencing climate change consequences especially landslides. This was due to the site selection and landscaping. The real estate developers should select good location and density for residential areas which will ensure health, safety and well being of the residents. Soil erosion has to be controlled in these areas to ensure security and safety of the residents.

5.4.3 Connection to water, sanitation and social amenities

The respondents were asked if their houses were getting access to tap water and selected sanitation services (Solid waste removal, storm water disposal and wastewater treatment plants). All of the surveyed houses (100%) were connected to tap water, solid waste removal and storm water disposal. All of the houses in high and middle income estates (100%) were connected to wastewater treatment plant while none of surveyed houses in low income (0%) estates was connected to the wastewater treatment plant (See table 16). The respondents were

also asked whether their houses were connected to the proposed basic social amenities within two kilometers. Most of the houses were connected to most of the proposed basic social amenities apart from the park which was not available at the time of the survey. In low income estate, only 48% of the respondents had access to job opportunities against 82% in high income estate houses and 69% in middle income estate houses. The detailed results on connection to proposed social amenities are presented in table 17 below.

Selected Criteria	HIGH INCOME ESTATE						MIDDLE INCOME ESTATE						LOW INCOME ESTATE					
	F		%		Total		F		%		Total		F		%		Total	
					F	%					F	%					F	%
	Yes	No	Yes	No			Yes	No	Yes	No			Yes	No	Yes	No		
Water and sanitation																		
Tap water	39	0	100	0	39	100	26	0	100	0	26	100	27	0	100	0	27	100
Solid waste removal	39	0	100	0	39	100	26	0	100	0	26	100	27	0	100	0	27	100
Storm water disposal	39	0	100	0	39	100	26	0	100	0	26	100	27	0	100	0	27	100
Wastewater treatment plant	39	0	100	0	39	100	26	0	100	0	26	100	0	27	0	100	27	100

Table 16: Connection to water and sanitation services in the surveyed houses (Source: Results of the survey, 2014)

Selected Criteria	HIGH INCOME ESTATE				Total		MIDDLE INCOME ESTATE				Total		LOW INCOME ESTATE				Total	
	F		%		F	%	F		%		F	%	F		%		F	%
	Yes	No	Yes	No			Yes	No	Yes	No			Yes	No	Yes	No		
Connection to Social amenities																		
Healthcare	25	14	74	26	39	100	19	7	73	27	26	100	15	12	56	44	27	100
Childcare facility	27	12	69	31	39	100	15	11	57	43	26	100	10	17	37	63	27	100
Restaurant	20	19	51	49	39	100	17	9	65	35	26	100	14	13	52	48	27	100
School	31	8	79	21	39	100	15	11	57	43	26	100	17	10	63	47	27	100
Bus stop	24	15	62	38	39	100	18	8	69	31	26	100	13	14	48	52	27	100
Recreational facility	16	23	41	59	39	100	7	19	27	73	26	100	5	22	19	81	27	100
Place of worship	29	10	74	26	39	100	18	8	69	31	26	100	16	11	59	41	27	100
Financial institutional	27	12	69	31	39	100	19	7	73	27	26	100	9	18	33	67	27	100
Market	24	15	62	38	39	100	13	13	50	50	26	100	13	14	48	52	27	100
Park	0	39	0	100	39	100	0	26	0	100	26	100	0	27	0	100	27	100
Cyber cafe	18	21	46	54	39	100	14	12	54	46	26	100	5	22	18	82	27	100
Access to job opportunities	32	7	82	18	39	100	18	8	69	31	26	100	13	14	48	52	27	100
Non motorized transport	29	10	79	21	39	100	17	9	65	35	26	100	10	17	37	63	27	100

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Table 17: Connection to the proposed basic social amenities (Source: Results of the survey, 2014)

The provision of water and sanitation facilities is critical in the process of sustainable housing development. In Kigali City, the access to tap water has been recorded to be at 100% in all houses from the three different categories of income. This is due to the Government initiative which aims at providing water to all urban dwellers. In connection to water and sanitation part, all of the houses performed nearly equally and this is linked to the checklist proposed by Kigali City during the application for construction permit. The applicant must submit detailed plumbing and drainage drawings, detailed design of storm water management system and detailed design for waste water management systems. However, there was limited accessibility (0%) of the residents from the low income estate houses to wastewater treatment plants. This is due to the fact that the houses in low income estates were designed with ventilated improved pit latrines hence reducing the need for wastewater treatment plant.

In connection to social amenities, Sustainable housing has to provide necessary infrastructure and basic services to the occupiers and users. According to Mitlin & Satterthwaite (1996), sustainable housing is a shelter with provision for piped water, sanitation, drainage, transport, health care, education and child development, protected from environmental hazards. The results from this study are consistent with this statement because nearly most of the houses were connected to most of the proposed basic infrastructures. However, all of the surveyed houses performed poorly in the connection to park (0%). This is an important facility which has to be considered during the design and implementation of housing projects.

The connection to job opportunities has been considered in this study because sustainable housing has to be well connected to job in order to ensure economic development of the residents. In this study, the results have been different across all categories of residential estates. High income estates have performed well (82%) compared to middle (69%) and low income estates (48%). This was connected to the fact 28/39 of heads of families in high income estate were employed, 17/26 respondents in middle income estates were employed while only 10/27 of the low income estates residents were employed. There is a need to create employment opportunities for low income earners for the sustainable housing agenda to be achieved.

This study has also considered the access of the residents to non motorized transport. This is an important factor to consider because it can minimize the green house gases associated with transport. 79% of the houses in high income estates have access to non motorized transport, 65% had access to non motorized transport in middle income estates against 37% in low

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income estate. The houses did not perform equally and this was attributed to the development of roads facilitating the use of non motorized transport in middle and high income estate and which are not yet developed for low income estates.

The results obtained from this study are consistent with the Distance Decay theory used in this study. According to the distance decay theory, the interaction between two locales declines as the distance between them increases[30]. According to USAID (2013), location reflecting distance from the Central Business District (CBD); employment opportunity in an area; accessibility (proximity) to amenities and services (schools, health, shopping, recreation, and other services); road infrastructure and transport facilities increase the housing demand, energy and water in a City. In this study, most of the houses surveyed were connected to the proposed social amenities and it is seen that the availability of social amenities and basic infrastructures attracts real estate investors and promotes housing development within an area. The rural-urban migration in the search for job, employment opportunities and access to basic infrastructure and social amenities increase the demand for housing and the population numbers in Kigali City, hence, the results are also consistent with the Malthusian theory of population which has been used in this study. The increased demand for housing is due to the population growth in the City.

5.5 Opportunities in the implementation of sustainable housing agenda in Kigali City

The key informants' interview, the focus group discussion and the observation have revealed that there are opportunities in the implementation of a sustainable housing agenda in Kigali City. The opportunities have been described as the existing policies promoting sustainable housing development by the public sector especially in the National urban housing policy, the Kigali City conceptual master plan, the Vision 2020, Economic Development and Poverty Reduction Strategy, National Strategy for Climate Change and low carbon development and organic law No 04/2005 of 08/04/2005, determining the modalities of protection, conservation and promotion of environment in Rwanda. The construction of houses in the form of residential estates in Kigali City is an under way process and there is hope that the new housing projects can comply with policies, plans and programmes which can be developed with regard to sustainability of housing projects. It is easier to apply housing sustainability aspects in a developing City than in an already developed City. The issuance of

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[30] www.wikipedia.org accessed on 26/06/2014

construction permits in Kigali City is also an opportunity to achieve sustainable housing development because one has to comply with rules and regulations before implementing a housing project. The compliance of the private sector to the policies plans and programmes promoting sustainable housing development is hence an important opportunity towards sustainable housing development.

The Civil society especially international NGOs with best examples of practices promoting sustainable housing development in other urban areas outside Kigali City is an important opportunity for implementation of sustainable housing development agenda in Kigali City based on best examples from outside. The integration of Sustainable Development course in all academic programs by all academic institutions has been raised as an important opportunity to achieve sustainable housing development because future engineers, architects and policy makers will be equipped with necessary skills and knowledge from course work and researches conducted in the field of sustainable housing development.

5.6 Challenges in the implementation of sustainable housing development agenda in Kigali City

The results of the study have indicated that there are challenges in the implementation of the sustainable housing agenda in Kigali City. Table 18 indicates the challenges in the implementation of sustainable housing development agenda in Kigali City with respect to the group of stakeholders involved in housing development sector.

Stakeholder	Challenges	F	%
Public Sector	Lack of clear policy indicating best practices for sustainable housing development	7	87.5%
	Lack of a code for sustainable houses in Rwandan context	5	62.5%
	Limited knowledgeable and experienced staff in sustainable housing design and construction	7	87.5%
	Limited financial resources to invest in sustainable housing technologies	6	75%
	Limited provision of sanitation facilities to low income estate dwellers	5	62.5%

Private Sector	Limited knowledge and skills in sustainable housing aspects	7	87.5%
	Limited public-private partnership in sustainable housing projects	4	50%
Academia	Few researches on sustainable housing design and construction	5	62.5%
	Limited funds to train engineers and architects on sustainable housing aspects abroad	5	62.5%
	Design and construction of housing with high water and energy consumptions	8	100%
Civil Society	Limited donors in sustainable housing projects	4	50%
End users	Limited awareness about best sustainable housing practices	7	87.5%
	Inefficient use of water and energy	8	100%
	High installation cost of renewable forms of energy	6	75%
	Limited financial ability to reuse household wastes	3	37.5%

Table 18: Challenges in the implementation of sustainable housing agenda in Kigali City (Source: Researcher, 2014)

The stakeholder analysis and content analysis have been used in the analysis of the gaps that need interventions to increase uptake of sustainable housing development in Kigali City. The key informants interview and focus group discussions have revealed the challenges faced in the implementation of sustainable housing development agenda (Table 18). The challenges found during this study have been grouped into four main categories which are: lack of awareness and understanding of sustainable housing concept, limited financial resources to invest in sustainable housing development, limited knowledgeable and experienced staffs in the field of sustainable housing development and lack of clear laws, rules and regulations dealing with sustainable housing development. The stakeholder analysis helps to analyse these challenges with respect to concerned stakeholders.

- **Lack of mainstreaming of the concept of sustainability in the housing sector**

In this study, 87.5% of members of the focus group discussion argued that the lack of awareness and understanding of sustainable housing development affects negatively the successful implementation of sustainable housing development agenda. According to them Sustainable development is a common term used in Rwanda these days but sustainable housing is a new term and concept whose benefits and implementation strategies have to be communicated to all concerned stakeholders in the housing development sector for its successful implementation. The public sector has to inform the public and key stakeholders about the benefits of sustainable housing development and its implementation strategies. The low awareness about the benefits of sustainable housing development in the public sector, private sector, academia and end users is one of the causes of the limited use of renewable energy sources in houses developed in residential real estates.

- **Limited financial resources to invest in sustainable housing development**

The study revealed that high cost of sustainable housing practices is a challenge to the implementation of sustainable housing development agenda. The limited use of wind energy or solar panels in the estates has been linked to the high cost of the installation and maintenance of these forms of energy. In addition to that sustainable housing projects implementation requires high capital compared to conventional housing development projects. The design of the energy and water efficient houses requires more investments compared to the design of the conventional houses. This is consistent with what Yeri (2012) has said about the challenges facing cities in the implementation of sustainable housing development agenda. According to him, the limited resources particularly in smaller communities are a challenge in achieving sustainable housing development agenda. In low income residential estates, the houses were designed with rainwater harvesting tanks and one respondent from that estate mentioned that he is not able to buy the rainwater harvesting tanks himself. This is a good initiative from the Government sector in helping the lower income earners with rainwater harvesting tanks. This can also be applied to other practices like solar panels and wind energy.

- **Widespread inexperience in sustainable housing design**

Training and education in sustainable housing has been found to be a stressing challenge in the implementation of sustainable housing development agenda in Kigali City. Engineers, architects, designers and housing constructors have to be well equipped with the required

knowledge in sustainable housing aspects and failure to this leads to lack of experienced technicians in the design and construction of sustainable houses. This is also one factor which leads to high cost of sustainable housing projects because one has to hire expensive experts from abroad to design and construct sustainable houses. There is also a lack of researches on sustainable housing design and construction in academia group. The interview with the Dean, Faculty of Architecture and Environmental Design, University of Rwanda, has revealed that this problem will be solved soon due to the fact that the sustainable development course is to be integrated in all academic programs and there is hope that the engineers, architects as well as technicians will have required knowledge in sustainable housing development solving this challenge of lack of expertise and limited knowledgeable and experienced staff in sustainable housing design and construction.

- **Weak regulatory framework on sustainable housing**

The sustainable housing development sector to be successful needs clear regulatory framework about its concepts. Public rules and policies in the housing sector are in place but there are more concerned with conventional way of housing and there is no special emphasis on sustainable housing development. Most of the available policies, plans and programs in housing development sector in Rwanda are much concerned with the housing affordability rather than sustainable housing development. For example, there is no code for sustainable houses in the Rwandan context. This is due partly to the lack of awareness and understanding of the benefits of sustainable housing development from the part of policy makers and implementers and to the limited knowledge and skills in the sustainability concepts. There are also no indicators that are good measures of sustainability in the housing development sector. According to Yeri (2012), this is a common challenge faced by cities in sustainable housing development agenda in addition to the limited knowledgeable staff and resources in this sector.

5.7 Hypothesis testing

The following are the hypotheses which have been tested in this research.

Hypothesis 1:

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the use of energy efficient light bulbs across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the use of energy efficient light bulbs across the estates in Kigali City

Hypothesis 2:

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the use of rainwater harvesting tanks across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the use of rainwater harvesting tanks across the estates in Kigali City

Hypothesis 3:

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the rates of crime across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the rates of crime across the estates in Kigali City.

5.7.1 Hypothesis One

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the use of energy efficient light bulbs across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the use of energy efficient light bulbs across the estates in Kigali City

The results from the survey are used to test this hypothesis. The Chi-square test is done to test the above stated hypothesis.

The table 19 indicates the observed frequencies for the use of energy efficient light bulbs across the estates:

Category of estate	Use energy efficient light bulbs	Do not use energy efficient light bulbs	Total
High income	12	27	39
Middle income	12	14	26
Low income	19	8	27
Total	43	49	92

Table 19: Observed frequencies in the use of energy efficient light bulbs (Source: Results of the survey, 2014)

CROSSTABS
CROSSTABS /TABLES= Income_cate BY Energy_eff /FORMAT=AVALUE TABLES PIVOT
/STATISTICS=CHISQ /CELLS=COUNT ROW COLUMN TOTAL.
Summary.

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Income_cate * Energy_eff	92	100.0%	0	0.0%	92	100.0%

Income_cate * Energy_eff [count, row %, column %, total %].

Income_cate	Energy_eff		Total
	Use energy efficient light bulbs	Do not use energy efficient light bulbs	
High income	12.00	27.00	39.00
	30.77%	69.23%	100.00%
	27.91%	55.10%	42.39%
	13.04%	29.35%	42.39%
Middle income	12.00	14.00	26.00
	46.15%	53.85%	100.00%
	27.91%	28.57%	28.26%
	13.04%	15.22%	28.26%
Low income	19.00	8.00	27.00
	70.37%	29.63%	100.00%
	44.19%	16.33%	29.35%
	20.65%	8.70%	29.35%
Total	43.00	49.00	92.00
	46.74%	53.26%	100.00%
	100.00%	100.00%	100.00%
	46.74%	53.26%	100.00%

Chi-square tests.

Statistic	Value	df	Asymp. Sig. (2-tailed)
Pearson Chi-Square	10.06	2	.007

Table 20: Results of the Hypothesis One testing (Source: Researcher, 2014)

With alpha= 0.05, degree of freedom =2, the calculated Chi-square was 10.06 (Table 20). From the Chi-square table, at 2 df and alpha = 0.05, the Chi-square value is 5.44. The calculated value is greater than the critical value, the Null Hypothesis is rejected and the Alternative Hypothesis is adopted. Hence, there is a relationship between the income category and the use of energy efficient light bulbs across the estates in Kigali City. This means that in the surveyed estates, the use of energy efficient light bulbs is dependent on the income category.

5.7.2 Hypothesis Two

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the use of rainwater harvesting tanks across the estates in Kigali City.

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the use of rainwater harvesting tanks across the estates in Kigali City.

The results from the survey are used to test this hypothesis. The Chi-square test is done to test the above stated hypothesis. The table 21 indicates the observed frequencies for the use of energy efficient light bulbs across the estates:

Category of estate	Rainwater harvesting tanks	No rainwater harvesting tanks	Total
High income	10	29	39
Middle income	6	20	26
Low income	24	3	27
Total	40	52	92

Table 21: Observed frequencies in the use rainwater harvesting tanks (Source: Results of the survey, 2014)

The results:

CROSSTABS
CROSSTABS /TABLES= Income_cate BY Rain_wat /FORMAT=AVALUE TABLES PIVOT
/STATISTICS=CHISQ /CELLS=COUNT ROW COLUMN TOTAL.
Summary.

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Income_cate * Rain_wat	92	100.0%	0	0.0%	92	100.0%

Income_cate * Rain_wat [count, row %, column %, total %].

Income_cate	Rain_wat		Total
	Use rainwater harvesting tanks	Do not use rainwater harvesting tanks	
High income	10.00	29.00	39.00
	25.64%	74.36%	100.00%
	25.00%	55.77%	42.39%
	10.87%	31.52%	42.39%
Middle income	6.00	20.00	26.00
	23.08%	76.92%	100.00%
	15.00%	38.46%	28.26%
	6.52%	21.74%	28.26%
Low income	24.00	3.00	27.00
	88.89%	11.11%	100.00%
	60.00%	5.77%	29.35%
	26.09%	3.26%	29.35%
Total	40.00	52.00	92.00
	43.48%	56.52%	100.00%
	100.00%	100.00%	100.00%
	43.48%	56.52%	100.00%

Chi-square tests.

Statistic	Value	df	Asymp. Sig. (2-tailed)
Pearson Chi-Square	32.11	2	.000

Table 22: Results of the Hypothesis Two testing (Source: Researcher, 2014)

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With alpha= 0.05, degree of freedom =2, the calculated Chi-square was 32.11 (Table 22). From the Chi-square table, at 2 df and alpha = 0.05, the Chi-square value is 5.44. The calculated value is greater than the critical value, the Null Hypothesis is rejected and the Alternative Hypothesis is adopted. Hence, there is a relationship between the income category and the use of rainwater harvesting tanks across the estates in Kigali City. This means that in the surveyed estates, the use of rainwater harvesting tanks is dependent on the income category.

5.7.3 Hypothesis Three

Null Hypothesis: There is no relationship between the income category (High income, middle income and low income) and the rates of crime across the estates in Kigali City

Alternative Hypothesis: There is a relationship between the income category (High income, middle income and low income) and the rates of crime across the estates in Kigali City

The results from the survey are used to test this hypothesis. The Chi-square test is done to test the above stated hypothesis. The table 23 indicates the observed frequencies for the use of energy efficient light bulbs across the estates:

Category of estate	Crime	No crime	Total
High income	3	36	39
Middle income	4	22	26
Low income	15	12	27
Total	22	70	92

Table 23: Observed frequencies in security variable (Source: Results of the survey, 2014)

The results:

CROSSTABS
CROSSTABS /TABLES= Income_cate BY Crime /FORMAT=AVALUE TABLES PIVOT
/STATISTICS=CHISQ /CELLS=COUNT ROW COLUMN TOTAL.
Summary.

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Income_cate * Crime	92	100.0%	0	0.0%	92	100.0%

Income_cate * Crime [count, row %, column %, total %].

Income_cate	Crime		
	Experience crime	Does not experience crime	Total
High income	3.00	36.00	39.00
	7.69%	92.31%	100.00%
	13.64%	51.43%	42.39%
	3.26%	39.13%	42.39%
Middle income	4.00	22.00	26.00
	15.38%	84.62%	100.00%
	18.18%	31.43%	28.26%
	4.35%	23.91%	28.26%
Low income	15.00	12.00	27.00
	55.56%	44.44%	100.00%
	68.18%	17.14%	29.35%
	16.30%	13.04%	29.35%
Total	22.00	70.00	92.00
	23.91%	76.09%	100.00%
	100.00%	100.00%	100.00%
	23.91%	76.09%	100.00%

Chi-square tests.

Statistic	Value	df	Asymp. Sig. (2-tailed)
Pearson Chi-Square	21.54	2	.000

Table 24: Results of the Hypothesis Three testing (Source: Researcher, 2014)

With alpha= 0.05, degree of freedom =2, the calculated Chi-square was 21.54 (Table 24). From the Chi-square table, at 2 df and alpha = 0.05, the Chi-square value is 5.44. The calculated value is greater than the critical value, the Null Hypothesis is rejected and the Alternative Hypothesis is adopted. Hence, there is a relationship between the income category and the rates of crimes across the estates in Kigali City.

The results from the hypotheses testing have shown that there is a relationship between the income category (High income, middle income and low income) and the use of practices promoting sustainable housing development in Kigali City. The hypotheses tested between the income category and the use of selected practices promoting sustainable housing development in Kigali City (Use of energy efficient light bulbs, use of rainwater harvesting tanks and security) have shown that the practices promoting sustainable housing development in Kigali City depend on the category of income. It can then be concluded that the income type dictates the choice of practices promoting sustainable housing development in Kigali City.

6.0 SUMMARY OF KEY FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of key findings

The main objective of this study was to investigate existing practices promoting sustainable housing development in Kigali City. The specific objectives were to map the roles of key stakeholders involved in housing development sector in Kigali City, to determine activities being pursued by stakeholders to green the housing sector and to assess the gaps (from the expectations of the stakeholders and existing literature) that need interventions to increase uptake of sustainable housing sector development.

The practices promoting sustainable housing development in Kigali City have been investigated based on the variables which have been selected by the researcher among the best practices promoting sustainable housing development from the literature review. These variables were: energy efficiency, water conservation, security and safety, water and sanitation and connection to social amenities.

The main stakeholders involved in housing development in Kigali City have been found to be the public sector (providing policies, plans, programmes, and strategies in the Housing sector), private sector (Housing finance and delivery), the academia (Researches, studies and trainings in housing sector), the civil society (advocacy) and the end users (users, occupiers and tenants). There are activities greening the housing sector in Kigali City. These have been found to be the provision of policies, plans and programmes promoting sustainable housing development by the public sector. The promotion of best practices promoting sustainable housing development mainly by the public sector especially in the provision of rain water harvesting tanks to residents in low income estates, the provision of public infrastructures, water and sanitation facilities to Kigali City dwellers. The academia has decided to introduce the Sustainable development unit as a compulsory course to all students and this will help to train future professionals in sustainable design of the houses as well as competent policy makers in the field of sustainable housing.

In energy efficiency, the study found that most of the surveyed houses did not perform well. There is limited use of proposed renewable energy forms (only 26.09% use solar panels, 46.74% use energy efficient light bulbs and only 14.13% use solar water heater) and there was no use of wind energy or biogas plant in the estates surveyed and this implies that they are using non- renewable source of energy which is not sustainable and which consequently

contributes to the green house gases which leads to climate change consequences. The common practice promoting sustainable housing development in energy efficiency variable was the design of the houses promoting the access to daylighting as well as the design to benefit from solar gain. The other important fact is the high cost associated to the installation and maintenance of renewable source of energy and also lack of awareness on the benefits of these forms of energy in the housing sector.

In water conservation, this study found that only 43.48% of 92 surveyed estates were using rainwater harvesting tanks. Especially, 85% of the surveyed houses in low income estates are using rain water harvesting tanks. The considered estate was a success and Government has provided rain water harvesting tanks to the residents of the low income estate in order to assist them to pay water bills and to protect them from water shortage. This should be applied to all estates considering the benefits of such tanks in water conservation.

Security in estates has been found to be good and well ensured. The residents in low income estates were experiencing some of the climate change consequences especially landslides. The housing development sector in Kigali City should be done based on the site which offers resilience to climate change impact.

In connection to water and sanitation variable, all of the houses performed nearly equally. All of the surveyed houses were connected to tap water (100%) and connection to sanitation facilities is linked to the checklist proposed by Kigali City during the application for construction permit. The applicant must submit detailed plumbing and drainage drawings, detailed design of storm water management system and detailed design for waste water management systems. Connection to social amenities has also been found to be good in all houses from the three estates. This was linked to the Government initiative to provide adequate infrastructures to the residents of Kigali City.

The challenges faced in the implementation of sustainable housing development agenda in Kigali City have been found to be lack of mainstreaming of the concept of sustainability in the housing sector, limited financial resources, widespread inexperience in sustainable housing design and a weak regulatory framework on sustainable housing are the main barriers hindering sustainable housing development in Kigali City. The study concludes that stakeholders have adopted activities for greening the housing development sector but recommends a removal of existing barriers in order to accelerate sustainable development in Kigali's housing sector. This study recommended also appropriate interventions for achieving sustainable housing development in Kigali City. There is a need to ensure investment in new

technologies and researches especially in energy and water efficiencies and all investments in this sector have to be greatly supported and encouraged. There is also a need to improve access of Kigali City residents to social amenities, sanitation facilities and to safe, secure and health houses. The resilience of the housing projects to climate change consequences has to be improved. The proposed strategy to achieve sustainable housing development is a participatory approach in which the stakeholders in housing development sector have to work together to ensure sustainability of housing projects. The study proposed an implementation of an authority called Rwanda Sustainable Housing Development Authority which will implement the code for sustainable houses in a Rwandan context and which will develop a checklist for real estate development permit in a Rwandan context which is currently lacking.

6.2 Conclusions

From the analysis of the results generated within this study, the following conclusion can be drawn:

The key stakeholders in housing development in Kigali City are the public sector, private sector, civil society, academia and end users. There exist activities of the stakeholders greening the housing sector in Kigali City.

This study found that there was limited use of the proposed renewable forms of energy in the estates surveyed. This study concludes that there is a low use of renewable energy form in estates in Kigali City. The existing practices promoting energy efficiency are the design of the house maximising the use of natural lighting and ventilation and the use of energy efficient light bulbs.

In water conservation practices, the study found that there was no system in place for grey water treatment in all surveyed residential estates. The study concludes that the only water conservation practices among the proposed ones in this study was the use of rainwater harvesting tanks which were used at low levels (43.48% in all the surveyed estates).

The safety of residents in Kigali City against climate change consequences is ensured by avoiding housing development in high risk zones. The security of the residents in estates is ensured by trained and equipped security officers in high and middle income estates while in low income estates, the security is insured by organized community police locally known as "Irondo".

The results from the hypothesis testing show that there is a relationship between the income category and the practices promoting sustainable housing development in Kigali City. This study concludes that income affects existing practices promoting sustainable housing development in Kigali City especially the use of energy efficient light bulbs, the use of rainwater harvesting tanks and practices promoting security of the residents in estates in Kigali City.

The challenges faced in the implementation of sustainable housing development agenda in Kigali City are the lack of awareness and understanding of sustainable housing concept, limited financial resources to invest in sustainable housing development sector, limited knowledgeable and experienced staff in sustainable housing design and construction and lack of clear laws, rules and regulations in sustainable housing development sector.

The introduction of a special authority aiming at spearheading sustainable housing development agenda will facilitate the successful implementation of sustainable housing development in Kigali City. Participatory approach is proposed as the best strategy for achieving sustainable housing development agenda in Kigali City since it proposes the participation of all stakeholders in sustainable housing development and it considers also the pillars of sustainable development which are economic, social and environmental.

6.3 Recommendations

6.3.1 Recommendations for policy makers:

The study recommends the following to the policy makers:

The study found that there was limited use of renewable forms of energy in all the surveyed houses from the different categories of income and limited use of practices promoting water efficiency. Hence, this study recommends the promotion and use of renewable source of energy and efficient use of water in all estates. The Government should promote the use of biogas, solar and wind energy in housing sector and reduce the use of non-renewable sources of energy. The limited use of these forms of energy were identified as the high cost of installation as well as the low awareness of the benefits associated with the use of these forms of energy. The Government should empower the residents with limited ability by subsidizing the cost for renewable energy installation. The use of rainwater harvesting tanks should also be promoted by Government together with real estate developers in order to ensure efficient use of water which is critical to sustainable housing development in Kigali City. The

Government should support and encourage investments in new technologies and researches especially in energy and water efficiencies as well as technological innovation aiming at finding alternative means of survival amidst the population pressures.

This study has identified the lack of clear policies, plans and programmes with emphasis on sustainable housing development as one of the challenge facing the implementation of sustainable housing development agenda. This study recommends a creation of a special competent and well organized authority (See appendix 5) in charge of sustainable housing development (whose name is proposed as Rwanda Sustainable Housing Development Authority) which will have a mandate of ensuring that all housing development projects are sustainable by:

- Developing a code for sustainable houses in Rwandan context which is currently lacking and setting criteria to be followed while assessing the sustainability of housing projects in Kigali City

- Developing a check list promoting sustainable housing development for application of construction permit especially in real estate development which is currently not in place

- Ensuring monitoring and evaluation of housing development projects in all phases with more emphasis on their sustainability

6.3.2 Recommendations to Kigali City Management:

Among the challenges facing the implementation of sustainable housing development agenda, there was low awareness on the sustainable housing development concept and its benefits. Therefore, this study recommends creation of awareness on the benefits of sustainable housing to the stakeholders involved in housing development in Kigali City. The Government should use seminars, radios, television and other media to provide information about sustainable housing concepts and the best practices promoting the sustainability of housing projects in Kigali City.

6.3.3 Recommendations for private sector:

The study found that there was limited use of renewable forms of energy and rainwater harvesting tanks. Hence this study recommends the private sector to promote the use of renewable energy sources such as solar panels, wind energy and biogas. The supplied houses

should promote water efficiency and conservation by especially installing systems for grey water and black water treatment and by providing rainwater harvesting tanks which were very few in high and middle income estate during the time of the survey.

6.3.4 Recommendation for end users:

This study found that successful implementation of sustainable housing development agenda in Rwanda requires adoption and use of renewable sources of energy and water conservation practices especially by the end users. They are the ones making use and enjoyment of constructed houses in Kigali City and their behaviour in resources consumption plays a role of paramount importance in the implementation of sustainable housing development agenda in Kigali City. They have to be responsible and to adopt the practices promoting sustainable housing development to the maximum level possible.

6.3.5 Recommendation for further research:

This study found that there were very few researches done on sustainable housing in Kigali City. Hence it recommends further research to work on the design and construction of houses in estates with renewable energy use. This study was conducted in the houses from the three categories of income in operation phase, the future research should be done on early stage of housing projects in order to ensure energy and water efficiencies at all stages of housing projects.

Further research should also concentrate on the investigation of practices promoting sustainable housing development in Kigali City during the construction stage in order to ensure that sustainability of housing projects is taken into account even during construction.

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Appendices

Appendix 1: House Survey Questionnaire

Objective:

The questionnaire aims on getting information about current practices promoting sustainable housing development considering economic, social and environmental aspects of Housing Development in Kigali City. The findings will contribute in providing the basis for policy makers and other actors involved in Housing Development in the City of Kigali and all other urban centres throughout the country to make informed decisions on which approach to consider during Sustainable Housing Development towards Green Real Estate Development in Rwanda.

This questionnaire is for research purpose only!

Interviewer: …………………………………………………………………………….

Interviewee: …………………………………………………………………………

Position: ……………………………………………………………………………

Date:……./……../2014

I. General information

- Location:

District:

Sector:

Cell:

Umudugudu:

- Employment status

Does the head of family have a job?   Yes ⬭   No ⬭

If yes, how much is the monthly salary?

Under 100 000 RWF   ⬭   100 001– 300 000 RWF   ⬭

300 001 – 500 000 RWF ⬭   500 001 – 7000 000 RWF   ⬭

98

700 001-900 000   RWF   ☐   Above 900 000 RWF   ☐

- Age: In which age bracket do you fall?

20-30 ☐   31-40 ☐   41-50 ☐   51-60 ☐   Over 60 ☐

- Gender: Male   ☐   Female   ☐

II. Practices improving sustainable housing

1. Energy efficiency

  1.1 Are any of the following systems installed in your house?

Solar water heaters   ☐   Wind energy   ☐

Solar panels   ☐

Biogas   ☐   None   ☐

1.2 Is your house designed to benefit from solar gain, with larger main windows orientated towards the South and smaller windows to the North?

    Yes ☐   No   ☐

Additional comments: ....

1.3 Do you use energy efficient light bulbs?   Yes   ☐   No   ☐

  Additional comments: …………………………………………………………………

1.4   Does your house have access to day lighting? Yes ☐   No   ☐

  Additional comments: …………………………………………………………………….

2. Water conservation

2.1 Is there any grey water system in place for toilet flushing, irrigation or other non- potable uses?

 Yes   ☐   No ☐

Additional comments: ....

2.2 Is rainwater harvested in a cistern for toilet flushing, irrigation or other uses?

        Yes ☐   No   ☐

Additional comments: ....

3. Security and safety

3.1 Do you experience crime in your neighbourhood?

Yes ☐   No   ☐

If yes, what is the main cause of crime in your area?

Unemployment   ☐   Drug abuse   ☐

Poverty   ☐   Alcohol abuse   ☐

Others please specify..

3.2 Is your house affected by any of the following climate change consequences?

Yes ☐   No ☐

Excessive floods ☐   Bushfires ☐

Landslide ☐   Storm ☐   others, specify...............................

3.3 Is your house affected by traffic noise?   Yes ☐ No ☐

Additional comments: ....

4. Connection to water and sanitation

Is your house getting access to the following services?

Tap water ☐   Solid waste removal ☐

Storm water disposal ☐   Local wastewater treatment plant ☐

Connected to both ☐

5. Connection to social amenities

5.1 Is your house located within 3 kilometres of the listed destinations?

Health care ☐   School ☐   Financial institution ☐

Childcare facility ☐   Bus stop ☐   Market/ shop ☐

Recreational facility ☐   Park ☐

Restaurant ☐   Place of worship ☐   Cyber cafe ☐

5.2 Does your house allow easy access to job opportunities?   Yes ☐   No ☐

Additional comments: ....

5.3 Do you find it easy for walking and/ or cycling from your home?

       Yes ☐   No ☐

Additional comments: ....

"Thank you very much for helping me with my research!"

Appendix 2: Key Informants Interview

Objective

The questionnaire aims on getting information about current practices promoting sustainable housing development based on economic, social and environmental aspects of Housing Development in Kigali City. The findings will contribute in providing the basis for policy makers and other actors involved in Housing Development in the City of Kigali and all other urban centres throughout the country to make informed decisions on which approach to consider during Sustainable Housing Development towards Green Real Estate Development in Rwanda.

This questionnaire is for research purpose only!

Interviewer: …………………………………………………………………………

Interviewee: …………………………………………………………………………

Position: …………………………………………………………………………..

Date:……./…….../2014

1. a. Who are the key stakeholders in the provision of Houses to Kigali City dwellers? What are their roles in housing development sector in Kigali City?

....
....

b. What are your activities that are greening the housing sector in Kigali City?

....
....

c. What are the opportunities and challenges of implementing sustainable housing development agenda in Kigali City?

....
....

2. According to you, is it possible to design and build sustainable houses in Kigali City?

Yes ▭   No ▭

If No, why? ....

According to you, what are the appropriate interventions for achieving sustainable housing development in Kigali City?

....
....

3. Do you have examples of sustainable houses in Kigali City?

Yes ▭

No ▭

4. Any comments and general remarks

....
....
....

"Thank you very much for helping me with my research!"

Appendix 3: Observation Schedule

The observation was a good methodology for data collection since it helped the researcher to observe the setting of the houses which was very important in the investigation of the practices promoting sustainable housing development in the study areas. This helped the researcher to observe the physical planning of the environment within which the research took place.

This also helped the researcher to identify the group and behaviour of people in the selected estates.

The camera, notebooks and pens were used to record data during the field work.

The following are the important things that were observed:

1. Orientation of larger main windows towards the South and smaller windows to the North

....
....
....

2. Access of the house to daylighting

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3. Availability of water harvesting systems

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....

4. Availability of systems for reusing wastewater

Appendix 4: Focus Group Discussion Topic Guide

The following are the main topics which formed the basis for the focus group discussion:

    i.   Key actors/stakeholders in Housing Development in Kigali City and their roles

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    ii.   Stakeholders' activities greening the housing sector in Kigali City.

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    iii.   Opportunities and challenges in greening the housing sector in Kigali City.

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    iv.   The strategies promoting sustainable housing development in Kigali City

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....
....

"Thank you very much for helping me with my research"

Appendix 5: Proposed strategy for sustainable housing development in Kigali City (Participatory Approach)

The results from this study show that for sustainable housing agenda to be successful there is a need to take maximum advantage of existing opportunities in the implementation of sustainable housing and to remove barriers hindering sustainable housing development in Kigali City as revealed during interviews (Table 18). In this study, the way forward has been proposed taking into account the stakeholders involved in the housing development sector and their roles in the same sector. The participatory approach has been proposed as a best way to sustainable housing development in Kigali City. According to the Director of Housing Planning and Development Division, "Sustainable housing is not a one stakeholder's task". This approach takes into account the responsibilities and roles of each and every stakeholder in the housing development sector in Kigali City. The proposed approach is on Figure 10.

The Stakeholder Analysis helped the researcher to propose a strategy for sustainable housing development in Kigali City after analysing the organogram and mutual dependencies between the stakeholders. This proposed strategy has been considered taking into account the opportunities and barriers in the implementation of sustainable housing development agenda in Kigali City as well as the variables of this study. The study has proposed an implementation of Rwanda Sustainable Housing Development Authority (RSHDA) which will be working under the MININFRA and which will be dealing with sustainability of housing development projects together with all the stakeholders in order to make sure that all housing development projects are socially acceptable, environmentally friendly and economically feasible (Fig. 10)
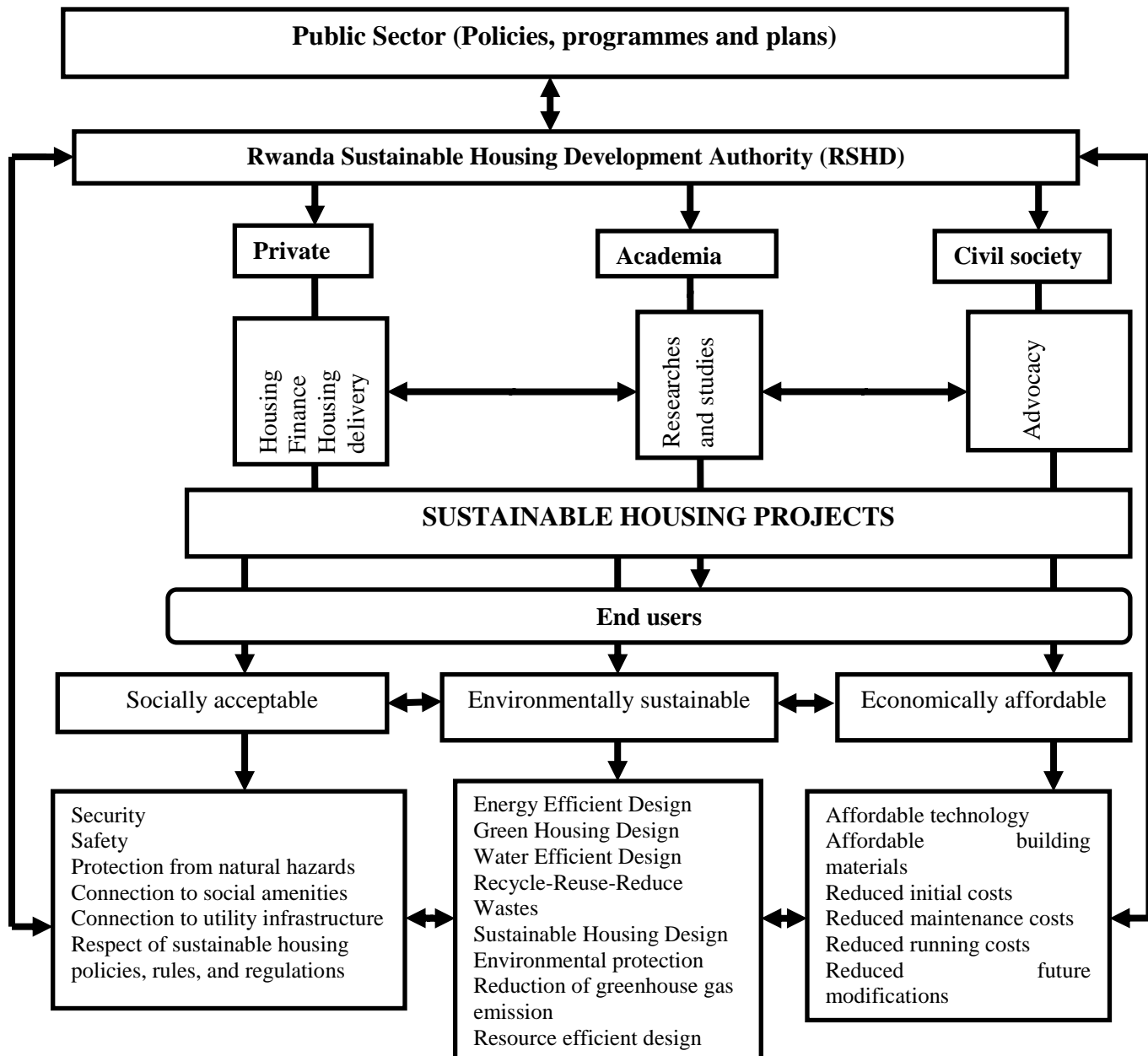
Figure 10: Proposed strategy for sustainable housing development in Kigali City (Participatory approach) (Source: Researcher, 2014)

The public sector has to integrate sustainable housing aspects into all policies, rules and regulations related to housing development. Private sector has to consider sustainability of the different housing projects and universities and schools have to conduct researches and studies aiming at improving sustainable housing development. The end users have to change their behaviour in as far as housing development aspects are concerned. In this proposed approach, each and every stakeholder should make sure that the housing projects keep on being socially acceptable, environmentally sustainable and economically feasible.