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ASSESSMENT OF ENVIRONMENTAL SUSTAINABILITY OF IHDP-DEVELOPED BUILDINGS

the case of Mekanisa-Kotari Condominium Housing

Thesis Submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) Postgraduate Program Office in Partial Fulfillment of the Requirement of
Master of Science in Housing and Sustainable Development

Submitted by

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Addis Ababa, ETHIOPIA

Declaration

I, the candidate, declare that this thesis is prepared for the partial fulfillment of the requirements for the degree of Masters of Science in Housing and Sustainable Development entitled, **“Assessment on Environmental Sustainability of IHDP-Developed Buildings, The case of Mekanisa-Kotari Condominium Housing”** is my original work prepared by my own effort with the close advice and guidance of my advisor. I also declare that this thesis has not been presented in any university and all sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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Confirmation

This thesis has been submitted for examination with my approval as an Institute’s advisor.

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This thesis is submitted to the Ethiopian Institute of Architecture, Building Construction and City Development (EiABC) and to the School of Graduate Studies of Addis Ababa University for partial fulfillment of requirements of Master of Science in Housing and Sustainable Development.

Title of thesis: **Assessment of Environmental Sustainability of IHDP Developed Buildings:
The Case Of Mekanisa-Kotari Condominium Housing**

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“Psalms 28:7

The LORD is my strength and my shield; my heart trusted in him, and I am helped: therefore my heart greatly rejoices and with my song will I praise him.”

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ABSTRACT

Ethiopia is a second most populous land locked country found in east Africa. With the fast growing economy, urbanization and population the country's need to housing increased rapidly. Due to the increase urban population there is a high need of standard housing. The government is forced to introduce a new program called Integrated Housing development program (IHDP). Since 2006 it provides housing opportunities for low and middle income families while fulfilling other objectives related to housing. The mass housing provision of the IHDP developed building must be assessed for sustainability in order to evaluate the effectiveness of the building in the long run. This study of assessment on environmental sustainability of the IHDP developed building is to examine and measure the environmental sustainability of the Mekanisa-kotari condominium site. In order to answer the research questions the research takes a case study method performed in Mekanisa-kotari condominium with a quota sampling technique of non-probability sampling used for qualitative data based on sustainable/Green/ building components compiled from international standards chosen for this research due to the lack of the country's sustainable assessment tools. According to the data analysis the sites green area development, non-polluted air, good environmental quality on natural lighting, air quality, thermal comfort and quality view are the components which have a positive experience among the residents. This should be enhanced and supported by professionals and government. The other components such as water efficiency, use of recycled material, solid waste disposal system, dampness conditions of the building, durability of the building parts and the operation & maintenance are impacting the environmental sustainability of the site. This components needs a quick interventions starting from policy, programing and planning, design and also use & operation of the buildings. Finally the study recommends some solutions to implement based on the assessed data on the current use and operation stage of the building.

Keywords: Sustainability; Environment; Environmental sustainability; Housing; IHDP; Assessment

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Abbreviations

AAHA - Addis Ababa Housing agency

AAHDPO - Addis Ababa Housing Development project office

BREEAM -Building Research Establishment Environmental Assessment Methodology

BSA-Building Sustainability Assessment

CAD- Computer-aided design

CCM - Common Carbon Metric

CEN/TC350- Committee European de Normalization/Technical Committee 350

DECoRuM - Domestic Energy, Carbon Counting and Carbon Reduction Model

DGNB - Deutsche Gesellschaft für Nachhaltiges Bauen

Elev- Elevation

EPRDF - Ethiopian People’s Revolutionary Democratic Force

GTP - Growth and Transformation Plan

GTZ – German Technical cooperation

HDPO -Housing Development Project Office

HQE- High Quality of Environment

IEQ-Indoor Environmental Quality

IHDP-Integrated Housing Development Program

iiSBE - International Initiative for a Sustainable Built Environment

LCA - Life-cycle assessment

LDP –Local Development Plan

LEED -Leadership in Environmental & Energy Design

MBR - Membrane Bio Reactor

MWUD -Ministry of Works and Urban Development

NABERS - National Australian Built Environment Rating System

NHD – Neighbourhood design

PASDEP - Plan for Accelerated and Sustained Development to End Poverty.

QSAND - Quantifying Sustainability in the Aftermath of Natural Disasters

SBTool- Sustainable Building Tool

SD -Sustainable development

UN - United Nations

Local Terms

Ato - Mr.

Kebele - The list Administrative units

Kiray betoch

W/rit - Miss

W/ro - Mrs.

Woreda – The list Administrative units containing more than two Kebeles

General Notes

Unless specified, all pictures are taken by the Author

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The UN estimates that 55% of the global population lives in urban areas a figure that is projected to rise to 68% by 2050. With few exceptions, cities are expected to become bigger and more numerous. As urbanization speeds up, particularly in Asian and African countries, here are five of the biggest challenges confronting the future of cities: Environmental threats, Resources, Inequality, Technology, Governance (World Economic Forum, 2018). According to Compassion international (2020) publication Ethiopia is one of the nine countries which are expected that half of the world's population growth will be concentrated till 2050. Such changes are affecting the areas of economy, social condition, and environment.

An urban area of African cities by 2017 was almost 472 million people. The current population of Ethiopia is about 114,427,730 as of April, 2020 based on Worldometer elaboration the latest United Nations data. Ethiopia ranks number 12 in the list of countries by population. 21.3 % of the population is urban (24,463,423 people in 2017). Rapid urbanization in many industrializing countries is caused by factors such as displacement due to violent conflict and a worsening of livelihoods due to natural disasters, including climate change. The mass migration into cities can also be accepted to the attractive pull factors of urban areas from improved access to food, healthcare and education and perceived prospects of a better life. With more than 80% of global GDP generated in cities, urbanization can contribute to sustainable growth if managed well by increasing productivity, allowing innovation and new ideas to emerge. (The world Bank group,2021)

According to United Nations Human Settlements Program the New Urban Agenda(HABITAT III) will aim for city sustainability, shaping our livability, homes and neighborhoods. The agenda responds to the urban century. It recognizes the growth energized by

cities but also their spatial, social, cultural and economic inequalities. Action is urgently called for to tackle inequality.

. Due to the fast growing population by natural growth and migration, there is a high demand in housing, there for the city administration of Addis Ababa is undertaking a massive integrated housing development program to address the acute housing problem of the city since 2006. Housing supply is not the only goal of this program; instead its ultimate desire is to use Integrated Housing Development Program (IHDP) as a tool to reduce urban poverty, which is one of the prime concern of the city. Through this program, the government has been implementing a large scale condominium housing project, targeting at low- and middle-income households. The project is financed by the city government. By March 2019, the city administration of Addis Ababa distributed at least 175,000 houses to the beneficiaries.

The “Brundtland Commission” report, *Our Common Future*. Famously defines sustainable development as: *development that meets the needs of the present without compromising the ability of future generations to meet their own needs* (McManus, 2014). The Commission successfully unified environmentalism with social and economic concerns on the world’s development agenda. Sustainability is a holistic approach that considers ecological, social and economic dimensions, recognizing that all must be considered together to find lasting prosperity.

Sustainability assessment is being increasingly viewed as an important tool to aid in the shift towards sustainability. The aim of sustainability assessment is to ensure that “plans and activities make an optimal contribution to sustainable development” (Verheem, 2002).

“Sustainability assessment Is a tool that can help decision-makers and policy-makers decide what actions they should take and should not take in an attempt to make society more sustainable” (Devuyst, 2000)

Box 1: Sustainability Assessment

As Buildings, the majority of which are in residential use (BPIE, 2011), accounting for 19 percent of global total final consumption (IEA, 2014), are a major contributor to environmental degradation. The building sector is estimated to consume 40 percent of the world's energy and materials while the construction industry, and its supporting industries, account for 16 per cent of the world's water used (Hoffman & Henn, 2008; Roodman et al., 1991; Dixit et al., 2010). There for the condominium Buildings as part of sustainable development of the city, need to be assessed from this dimension. This study tries to assess the environmental sustainability of buildings in the Mekanisa-kotari condominium neighborhoods as a case study area.

1.2 Statement of the Problem

Rapid urbanization means increased use of resources and non-renewable energy and an increased built area. A high rate of rural urban migration accounts for about 40 percent of the growth. Coupled with rapid natural population growth, Addis Ababa has become one of the fastest growing cities on the continent, and faces multiple challenges, including environmental deterioration (UN HABITAT, 2008).

A massive housing development program is taken as one of the major intervention sectors in Ethiopia to reduce the poverty level of cities. This housing development program is not meant only to supply housing, rather it is envisioned to improve the wild urban poverty. Modern buildings in cities have high levels of energy consumption. Thus unplanned and unsustainable urban development will lead to severe environmental pressures.

During different visits of the Mekanisa-Kotari condominium sites the researcher encountered deposited broken pipes and gutters, fractured stairs which were a danger for children and falling wall finishes. There is no document of environmental impact assessment done before it was constructed and also no sustainability research on the site. Therefore the IHDP buildings which are seen as part of the urbanization process of the city to solve the city's housing problem; on the way, to improve the urban environment must be assessed for sustainability.

1.3 Objective of the study

1.3.1 Principal Objective

The principal objective of this research is to examine and measure the Environmental sustainability of the IHDP Mekanisa-Kotari condominium buildings.

1.3.2 Specific Objectives

- Study the Building practice and activities of Mekanisa-kotari site of IHDP Building.
- Analyze factors that affect the environmental sustainability of the selected site.
- Evaluate the impact of the Mekanisa-kotari condominium building on environmental sustainability.

1.4 Research Questions

- What is the building practice and activities of the IHDP buildings of Mekanisa-Kotari condominium?
- Which characteristics of IHDP contribute to sustainable development?
- What are the environmental impacts of the IHDP buildings at the study site?
- To what extent are the IHDP buildings of the site environmentally sustainable?

1.5 Scope of the Study

1.5.1 Spatial Scope

This research is conducted in one of the sites of the integrated housing development program which is around Haile Garment called Mekanisa kotari condominium neighborhood.

1.5.2 Thematic Scope

The scope of this study is to evaluate the sustainability of a specific case study namely Mekanisa-Kotari site of IHDP around Haile garment within Addis Ababa, with regard to lessons about environmental sustainability

The type of impact assessment of this research is environmental which will be done in local level .The targets of the impact assessment are projects regulation and agreements and the timing is after construction assessment.

1.6 Significance of the Study

The significance of this environmental sustainability assessment is to gather and report information for decision-making during different phases of the construction, design, and use of a building. Contemporary housing literatures tend to take into account the importance of sustainability in the development of housing. It is important that sustainability be considered in everything that is being implemented as it affects the environment, which is especially essential in the case of housing.

As the new sustainable constructions and design focuses on the issues of minimization of resource consumption it is significant to assess the existing condition of our public buildings. This researches output is beneficial for the AAHDPO as it evaluate the effectiveness of its buildings in the Mekanisa-kotari site.

1.7 Motivation

This research is motivated by the gap between theory and application of the concept of sustainability to solving practical problems in the production and consumption of housing in developing countries.

1.8 Limitations of the study

Most building assessment methods are based on already existing methods, which have been upgraded or adapted to the circumstances and regulations in individual countries. Methods are adapted to the countries in which they have been developed as they follow national legislation, climate conditions, level of development and the economic status as well as other characteristics unfortunately Ethiopia do not have assessment method yet there for There are large differences between them so the use of a method outside its home country is usually limited there for this research will not consider every categories of the assessment.

The other limitation of the study will be the knowledge and ability of the residents selected for the interview to interpret the question based on their experience.

1.9 Organization of the paper

This research has six chapters. The first chapter introduces the subject and provides the background introduction and gives information about the problem statement, purpose, objective, research question, scope and significance of the study. The second chapter states how the study was carried out and what methodology was used regarding each objective of the research. The third chapter reviews literature on the environmentally sustainable building concept from the definition of that we mean by environmentally sustainable building to its components. Chapter four provides a brief history of housing in Addis Ababa, discusses the condominium housing project IHDP, presents the case studies of selected sites, location ,physical situation and a comparison of the condominium buildings in terms of how they match up to the concept of environmentally sustainable buildings. The Mekanisa-Kotari condominium buildings are selected for this study. Chapter five the analysis and the interpretation of the results are presented finally, in the sixth chapter, the conclusion and important recommendations are provided which Contains the suggests ways based on the research on what could be done to make the condominium project environmentally sustainable and technically feasible.

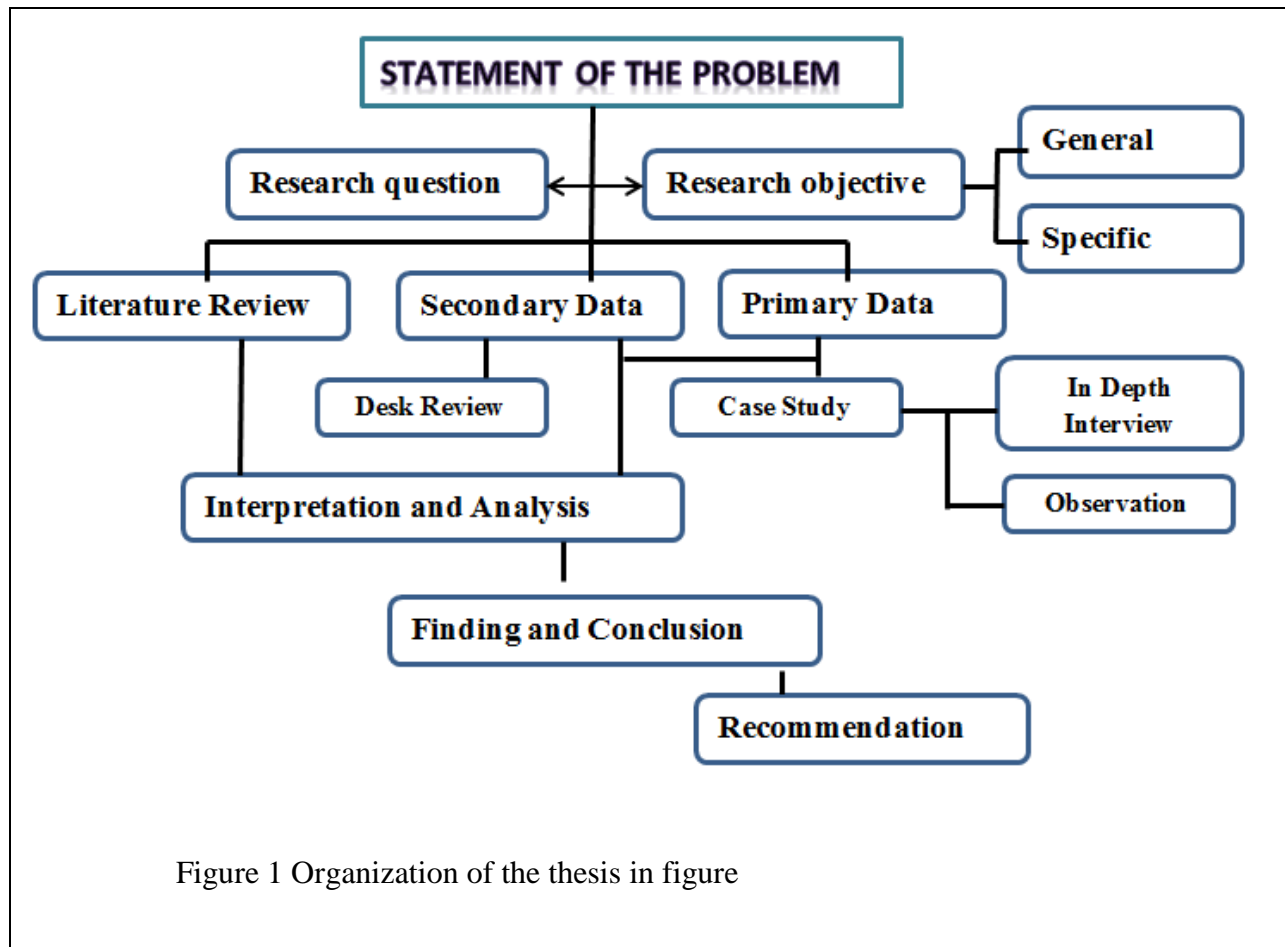


Figure 1 Organization of the thesis in figure

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The literature review section discuss about definition of Sustainability, sustainable development, housing, sustainable housing, assessing building sustainability, sustainability assessments, environmental sustainability and principles of environmentally sustainable design and finally establish a frame work for the environmental sustainability assessment of the thesis.

2.1 SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT

There are several definitions of the term “sustainability”. The definition given by the UN Commission on Economic Development in its 1987 Brundtland report seems to be generally acceptable. In its report titled *Our Common Future*, sustainability is defined as that which “meets the needs of the present without compromising the ability of the future generations to meet their own goals” (WCED, 1987). A building project is considered sustainable when the three pillars of sustainability are meet which are Environment, Social and the economic aspects.

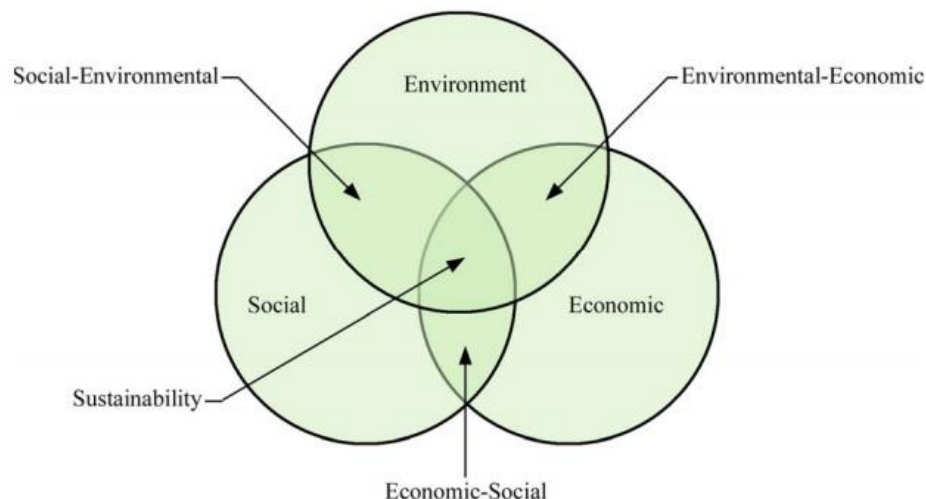


Figure 2: Three spheres of sustainability (Rodriquez, et.al. 2002)

The three approaches to sustainable development: **Environmental, Economic and Social dimension** are defined as follows

- Environmental (ecological approach) Sustainability:- ‘The ecological approach is concerned with maintaining the resilience and robustness of biological and physical systems. According to this approach, sustainable development is about maintaining the essential ecological processes and life support systems; the sustainable use of species and ecosystems; and also the conservation of genetic diversity’ (Rogers et al., 2008). Environmental sustainability means the capacity to increase and bring up the value of the environment and its components , while assuring the protection and the renewal of natural resources,
- Economic Sustainability –‘ sustainable economic development is directly concerned with increasing the standards of the poor, which can be measured by education, real income, increased food, health care, sanitation and water supply, and is only concerned indirectly with economic growth’ (Rogers et al., 200). Economic Sustainability can be defined as the capacity of an economic system to generate a constant and improving growth of its economic indicators.
- Social Sustainability (socio-cultural approach) –The socio-cultural approach is concerned with maintaining “the stability of social and cultural systems” (Rogers et al., 2008). Social Sustainability can be defined as the ability to guarantee welfare (security, health, education), equitably distributed among social classes and gender. Within a territory, Social Sustainability means the capacity of the different social actors (stakeholders), to interact efficiently, to aim towards the same goals, encouraged by the close interaction of the Institutions, at all levels.

The concept of sustainable development is based on a political and ethical principle. This principle implies that the social and economic dynamics of modern economies are compatible both with the improvement of life conditions and the ability of natural resources to reproduce in an indefinite manner. As the Rio declaration on environment and development principle 1 stated

“human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.” (UN Commission on Human Rights, 1994). A balance needs to be reached between all three approaches and these approaches should be considered equally in order to achieve sustainability. This means that sustainable human settlements should take the environment into account at all times; should not cost excessive amounts of money; and also meet the need to provide the people with running water, sanitation and other household services. It can be proven that developing sustainable houses will decrease effects in the long run.

2.2 Housing and Sustainable Housing

The concept of housing requires a new understanding to effectively address the demanding issues of slums, the urban division, economic and human development, and climate change. It is no longer regarded as simply a roof over one’s head; housing today plays a crucial role in achieving sustainable development.

John Turner argues houses shouldn't be treated as a mass produced consumer product, that Human values must be substituted for material values; he defines the term housing both as a noun and as a verb (Turner, 1977). The former describes the physical aspect of housing as a market good while in the latter housing is conceived as a process that yield a product and other non-physical attributes. He argues that the value of housing should be understood in “what it does” for users rather than “what it is” which is merely the description of physical aspect of housing. (Turner & Ward, 2000)

Regarding the Potential contribution of housing to sustainability, Singh & Pande Wrote: *it is pertinent to note housing sector can significantly contribute to sustainability because of its close association with environmental aspects:*

1. *Buildings consume large amounts of natural and man-made resource in construction, maintenance and continued use by society.*
2. *Buildings are a fixed asset with a long operational lifespan.*
3. *Buildings are among the fundamental necessity for a good quality of life, and thus have Implications beyond housing affecting transport, health, employment and community.*
4. *Buildings are amenable to numerous ways in which recycled materials can be reused for construction.*
5. *Large number of innovations are available for efficiently operating the buildings including use of recycled material for construction, wastewater treatment and use, energy efficiency, solar heating, passive solar heating, creating urban green spaces in proximity to compact housing ” (Singh & Pande 2012) .*

Box 2: Housing in relation to environment

Housing development is one of the sectors of urban development; and it has the potential to change the pattern of economic growth in cities if complimented with good land use policy. Beside the land use, it is by and large influenced by governments housing policy and a number of external factors, such as the socio-economic and demographic situation and political, administrative and legal factors. These external variables, together with the housing policy, shape the role, aims and characteristics of housing (*HABITAT III, 2016*)

Sustainable housing is often considered mostly from *green* perspective but there is more holistic approach, which recognizes the multiple functions of housing as both a physical and socio-cultural system and which seeks to enhance and harmonize the environmental, social, cultural, and economic dimensions of housing sustainability to ensure prosperous residential neighborhoods and equitable cities.

Sustainable housing has the potential to produce good quality housing at a price that is affordable both in the short and long term. The livability of a neighborhood depends on the sustainability of housing Pruitt-Igoe homes could be an example of negative experience due to lack of social sustainability. The Pruitt-Igoe was eventually dynamited by the city not because of structural flaws but because it was an unlivable environment (Dreier, 1994). Singapore’s public

housing could be a positive experience of being sustainable housing. This achievement has made Singapore one of the top 5 most livable places in the world even though the country is highly crowded. (Centre for Livable Cities, 2014). Thus, sustainable housing must aim at economic, social and environmental sustainability from planning to implementation phase and at the same time result in housing that is affordable, accessible and environmentally less damaging.

2.3 Assessing Building Sustainability

“Adopting contributions to sustainability as a key objective and test in environmental assessment clearly implies that minimization of negative effects is not enough Assessment requirements must encourage positive steps – towards greater community and ecological sustainability, towards a future that is more viable, pleasant and secure” (Gibson, 2001).

Box 3: Building Sustainability Assessment

The primary role of building sustainability assessment methods is to verify and present the building’s characteristics with the use of selected and verifiable standards. A building is assessed on the basis of an extensive selection of criteria from various domains which try as best they can to keep to the goals and principles of sustainable development by taking into account environmental, economic and social aspects.

There are different reasons behind the development and use of these assessment methods. In the first place, there is the demand for a public and transparent recognition of the quality of projects showing good practice. As construction legislation only prescribes minimal demands, projects that surpass these legally prescribed standards and are therefore of a higher quality are not rewarded. With the use of building assessment methods it is possible to evaluate the actual quality of the project [König et al., 2010]. The other reason in favor of building assessment is greater ecological awareness of investors and familiarity with the negative potential of buildings. In their complete life cycle, buildings have a large influence on the environment due to their use of raw materials, the creation of waste and emissions. Buildings use 40 % of total final energy in

the EU for their functioning alone and also produce a similar portion of greenhouse gas emissions (European commission, 2020). Buildings use 30 % of raw material sources and 20 % of water. Buildings are responsible for the creation of 30 % of waste [Eurostat, 2012; Lowe & Ponce, 2008]. There are an increasing number of warnings from scientists and experts concerning the reaching and surpassing of our planet's limits as a result of human activity (Rockstroem et al. 2009). The key problems connected with this are climate change, atmospheric aerosol loading, and water use, the depletion of the ozone layer, chemical pollution and the loss of biodiversity.

The use of building assessment methods encourages a reduction in the negative effects of buildings on the environment and also has other advantages [Ebert et al., 2011]

- demands represent planning guidelines and help investors specify the desired building quality when the project is being tendered;
- The quality of living in the building is improved;
- The building incurs smaller expenses in its entire lifecycle;
- There is greater transparency in the planning process;
- The market value of the building is greater due to the proven quality;
- The quality of different buildings can be compared on the basis of the final evaluation.

Building Sustainability Assessment (BSA) methods can be oriented to different scales of analysis: building material, building product, construction element, independent zone, building and the neighborhood.

According to a research the following goals can be found in several building sustainability assessment methods: optimization of site potential, preservation of regional and cultural identity, minimization of energy consumption, protection and conservation of water resources, use of environmentally friendly materials and products, a healthy and convenient indoor climate, and optimized operational and maintenance practices (Akadiri et al., 2012). Global interest in the concept of sustainable development (SD) in industrialized countries and the increasing concern about global warming have created a need to assess whether building construction projects in urban areas that are promoted as sustainable are really significantly different to “business as usual” building projects.

2.4 Sustainability Assessments

The purpose of sustainability assessments is to gather and report information for decision-making during different phases of the construction, design, and use of a building. The sustainability scores or profiles, based on indicators, result from a process in which the relevant phenomena are identified, analyzed, and valued.

The development of assessment methods and tools are a challenge since due to the complexity and Variety. A major issue is that of managing the flows of information and knowledge between the various levels of indicator systems. A variety of sustainability assessment tools are globally available on the construction market.

- Building Research Establishment Environmental Assessment Methodology (BREEAM) of United Kingdom ,
- Leadership in Environmental & Energy Design (LEED) by the U.S. Green Building Council ,
- Sustainable Building Tool (SBTool) by International Initiative for a Sustainable Built Environment (iiSBE) and
- The Deutsche Gesellschaft für Nachhaltiges Bauen(DGNB)

This are the most commonly known assessment and benchmarking tools and there are also many tools which differ in scale, scope status and cost some of them are listed below

- ;Common Carbon Metric (CCM) ,
- Committee European de Normalization/Technical Committee 350(CEN/TC350) ,
- Domestic Energy, Carbon Counting and Carbon Reduction Model (DECoRuM),
- High Quality of Environment (HQE™) Certification ,
- National Australian Built Environment Rating System (NABERS)
- Quantifying Sustainability in the Aftermath of Natural Disasters (QSAND) .

There are also Life-cycle assessment (LCA)-based tools available that are especially developed to address the building as whole,

- Eco-Quantum (Netherlands),
- Eco Effect (Sweden),
- ENVEST (U.K.),
- BEES (U.S.),
- ATHENA (Canada) and
- LCA House (Finland).

Some criteria and aspects of the four widely used assessment tools are presented in Table 1 below.

2.5 Environmental (Ecological) sustainability

The ecological sustainability of housing is concerned with the impacts of housing on the environment and climate change, as well as the impacts of the environment on housing itself. There are different relationships between housing and the environment ;House building and operation require various environmental resources, such as building materials, water, energy and land and 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 in addition Homes and their residents are also exposed to diverse environmental hazards, which may emerge due to human activities and natural factors. (UNHSP, 2012)

Most studies shows that the environmental issues share, in common, concerns. The environmental pillar refers to the laws, regulations, and other policy mechanisms concerning environmental issues. These issues include air and water pollution, solid waste management, ecosystem management, maintenance of biodiversity, and the protection of natural resources, wildlife and endangered species.(Benchmark ESG,2020)

categories	criteria	BREEAM	LEED	DGNB	SBTool
environmental aspect	strain on the environment / pollution	✓	✓	✓	✓
	materials / sources	✓	✓	✓	✓
	waste	✓	✓	✓	✓
	water	✓	✓	✓	✓
energy aspect	CO ₂ emissions	✓	✓	✓	✓
	efficiency of energy use	✓	✓	✓	✓
	renewable energy sources	✓	✓	✓	✓
	energy efficiency of the building's outer layer	✓	✓	✓	✓
	technical equipment of the building	✓	✓	✓	✓
	control over energy use	✓	✓	✓	✓
	intermediate counters and meters	✓	✓		
	equipment with electric appliances	✓	✓		✓
economic aspect	building's costs throughout its lifecycle	✓	✓	✓	✓
	preservation of the property's value			✓	
socio-cultural aspect	security and safety	✓	✓	✓	✓
	accessibility to physically handicapped persons	✓		✓	✓
	regional and social aspects	✓	✓	✓	✓
	possibility of control by user	✓	✓	✓	✓
functional aspect	effective use of space			✓	✓
	possibilities for rearrangement			✓	✓
design and innovation	architectural quality			✓	
	inclusion of art			✓	
	innovation	✓	✓		
technical aspect	fire safety			✓	
	quality of the exterior	✓		✓	✓
	cleaning and simplicity of maintenance			✓	
	resistance to the effects of weather			✓	✓
process	planning process	✓	✓	✓	
	course of construction work	✓	✓	✓	
	ordering	✓	✓	✓	
	operation	✓	✓	✓	✓
location	micro-location	✓	✓	✓	✓
	traffic connections	✓	✓	✓	✓
	comfort for cyclists	✓	✓	✓	✓
	neighbourhood	✓	✓	✓	✓
	possibility of extensions			✓	
	use of space	✓	✓	✓	
	protection of nature and the building plot	✓			✓
	biodiversity	✓	✓		✓

Table 1 A comparison of included criteria in BREEM, LEED, DGNB and SBTool methods

Source: [Ebert et al. 20011]

The following goals can be found in several building sustainability assessment methods: optimization of site potential, preservation of regional and cultural identity, minimization of energy consumption, protection and conservation of water resources, use of environmentally friendly materials and products, a healthy and convenient indoor climate, and optimized operational and maintenance practices. The following figure shows the different approaches of assessment which was a green building assessment method in the first generation becomes a sustainable building approach in the second generation by including social, urban planning and economical aspects therefor the green building approaches can be used as an environmental sustainability assessment of a building which is one of the three pillars of sustainability and the scope of this research.

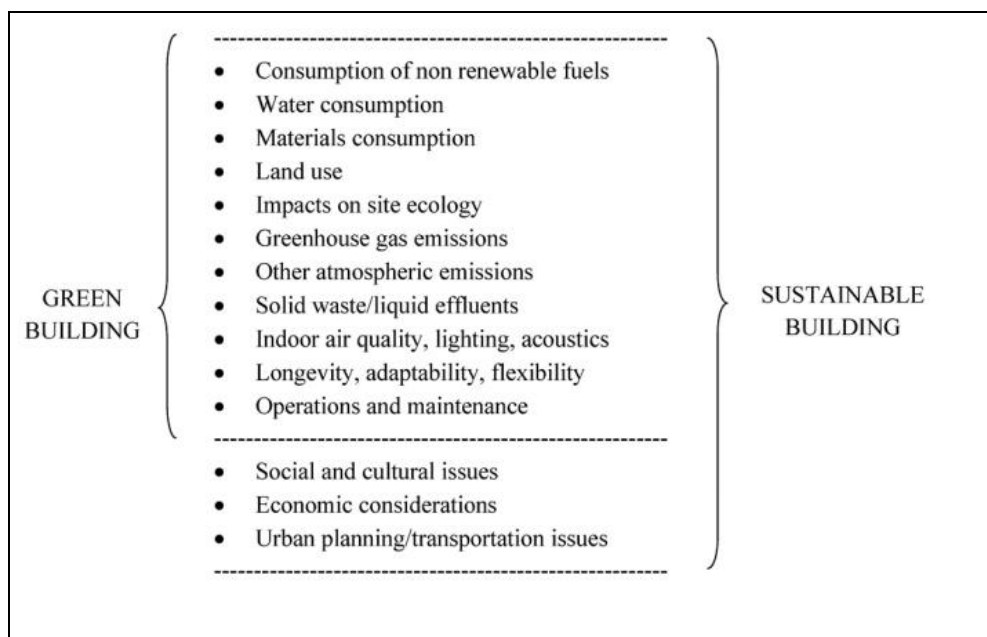


Figure 3: Aspects of assessment in first generation green building methods and in second generation sustainable building methods, adopted from (Lowe, 2009)

As US Environmental protection Agency(EPA) Green building is also known as green construction or sustainable building refers to both a structure and the application of processes that are environmentally responsible and resource efficient throughout a building's life cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. A green building places a high priority on health, environmental and resource conservation performance over its life cycle.

Environmentally sustainable design, Green building, environmentally friendly building and environmentally oriented design are much intertwined concepts which can be used as a substitute to one another. Most green buildings are high quality buildings they last longer, cost less to operate and maintain and provide greater occupant satisfaction than standard development and emphasize a number of new environmental, resource and occupant health concerns:

- Reduce human exposure to noxious materials.
- Conserve non-renewable energy and scarce materials.
- Minimize life cycle ecological impact of energy and materials used.
- Use renewable energy and materials that are sustainable harvested.
- Protect and restore local air, water, soil, flora & fauna
- Support pedestrian, bicycles, mass transit and other alternatives to fossil-fuelled vehicles.

2.6 Principles of Environmentally sustainable design

In Architecture there are many ways a building may be "green" and respond to the growing environmental problems of our planet. Sustainable architecture can be practiced still maintaining efficiency, beauty, layouts and cost effectiveness. Achieving greater sustainability in the field of construction is particularly important, because building construction consumes more energy and resources than any other economic activity. Not only does a home represent the largest financial investment a family is likely to make, but it also represents the most resource- and energy-intensive possession most people will ever own. (Johansen et al., 2019)

An environmentally sustainable design must also be environmentally oriented and environmentally friendly building which is designed and built to be in harmony with its occupants, nature, environment and ecosystem. It should be designed and built according to the region it is located in, keeping in mind the climate, material, availability and building practices.

Making homes more sustainable, then, has a tremendous potential to contribute to the ability of future generations to meet their own needs. The National Institute of Building Sciences listed six fundamental principles of sustainable design. (Curren & Metzger, 2018)

1. Optimize Site Potential
2. Optimize Energy Use
3. Protect and Conserve Water
4. Optimize Building Space and Material Use
5. Enhance Indoor Environmental Quality (IEQ)
6. Optimize Operational and Maintenance Practices

The sustainability indicators for a building project are also much related to the above principles of sustainability and they are selected from various lists prepared at the level of the government, sector, and community. Agenda 21 states that the framework of relevant issue areas should be based on the assumption that a sustainable building approach includes all factors that may affect the natural environment or human health.

Among the different assessment criteria's or rating systems listed previously LEED which is the most widely used method for assessing green buildings is in use in the largest number of different countries. It was formed in 1993 by the U.S. Green Building Council (USGBC) and First launched in 1998 several versions were released since then the current version is LEED v4, adopted in 2014. LEED rating schemes have eight credit categories, The British BREEAM method is the oldest building assessment method. It was developed by the Building Research Establishment (BRE) and has been in use since 1990 (Kajikawa et al., 2014, p. 435) The BREEM method of assessment is the most used method by number of certified projects and the guidelines for green buildings by Yudel'son's Green Building A to Z, Understanding the language of Green Building is presented in table format as follows (Table 2):

Table 2: Criteria’s included in the guidelines for green buildings in an international context
Source: Researcher’s own compilation

LEED	BREEM	J. Yudelson
<ul style="list-style-type: none"> • Location and transportation • Sustainable sites • Water efficiency • Energy and atmosphere • Materials and resources • Indoor environmental quality • Innovation • Regional priority 	<ul style="list-style-type: none"> • management • health and wellbeing • energy • transport • water • materials • waste • health and wellbeing • pollution • innovation 	<ul style="list-style-type: none"> • Environmental site planning • Energy-efficient building design • Water conservation • Carbon dioxide emission reduction • Use of recycled and locally sourced • materials • Healthy buildings

In spite of some differences between the lists of indicators, most of them deal directly or indirectly with the principles of sustainability. Choosing sustainable building design can help to reduce operation costs and carbon footprints as well as increase building resilience.

2.7 Frame work for environmental sustainability assessment

The complete Building Sustainability Assessment (BSA) comprises the ways in which built structures and facilities are procured and erected, used and operated, maintained and repaired, modernized and rehabilitated, and finally dismantled and demolished, or reused and recycled. The ecological assessment of buildings during their long life-cycle is a part of the assessment of their sustainability. For this study of environmental (Ecological) sustainability assessment the following criteria’s are chosen from the LEED method of Existing building operation and maintenance by the U.S green building council which was updated January 5, 2018 for assessing green buildings and green building components as weighing parameter.

- Location and transportation
- Sustainable sites
- Water efficiency
- Energy and atmosphere
- Materials and resources
- Indoor environmental quality
- Longevity, Adaptability and Flexibility
- Operational and Maintenance
- Regional priority
- Innovation

2.7.1 LOCATION AND TRANSPORTATION

The intent is to reduce pollution and land development effects from automobile use for transportation and to avoid development on inappropriate sites to reduce vehicle distance travelled, to enhance livability and improve human health by encouraging daily physical activity. (Gelowitz & McArthur, 2018,) Sustainable transportation is the capacity to support the mobility needs of a society in a manner that is the least damageable to the environment and does not impair the mobility needs of future generations by Supporting pedestrian, bicycles, mass transit and other alternatives to fossil-fuelled vehicles.

2.7.2 SUSTAINABLE SITES

The intent of these criteria is to preserve ecological integrity and encourage environmentally sensitive site management practices that provide a clean, well-maintained, and safe building exterior while supporting high-performance building operations and integration into the surrounding landscape. (Gelowitz & McArthur, 2018) it includes site management policy, site development to protect or restore habitat, rainwater management, heat island reduction, light pollution reduction, site management, site improvement plan and joint use of facilities

2.7.3 WATER EFFICIENCY

A sustainable building should use water efficiently, and reuse or recycle water for on-site use, when feasible. Conserving water means using our water supply wisely and be responsible. As every individual depends on water for livelihood, we must learn how to keep our limited supply of water pure and away from pollution. Keeping our water supply safe and pure will protect the water for the generations to come. This requires the use of strategies that includes reducing wastage, prevent damaging water quality, and improve water management. The LEED criteria considers the indoor water use reduction, building-level water metering, outdoor water use reduction and water metering

2.7.4 ENERGY AND ATMOSPHERE

Improving the energy performance of existing buildings is important to increasing our energy independence. Operating net zero energy buildings is one way to significantly reduce our dependence on fossil fuel-derived energy. The LEED criteria consist of energy efficiency best management practices, minimum energy performance and renewable energy and carbon.

2.7.5 MATERIALS AND RESOURCES

As the world population continues to grow; the use of natural resources and the demands for them continues to increase. A sustainable building is designed and operated to use and reuse materials in the most productive and sustainable way across its entire life cycle. Resource efficiency means using the Earth's limited resources in a sustainable manner while minimizing impacts on the environment. It allows us to create more with less and to deliver greater value with less input. The LEED criteria add Solid Waste Management.

2.7.6 INDOOR ENVIRONMENTAL QUALITY

Indoor Environmental Quality (IEQ) refers to the quality of a building's and has a significant impact on occupant health, comfort, and productivity. Among other attributes, a sustainable building maximizes day lighting, has appropriate ventilation and moisture control, and optimizes acoustic performance, thermal comfort air quality. It is also the creation of something new that

improves performance in the three dimensions of sustainable development. The LEED criteria add quality views and occupant comfort.

2.7.7 LONGEVITY, ADAPTABILITY AND FLEXIBILITY

Flexibility is defined as the capacity of a building to undergo modifications and accept changes of function with limited structural interventions. More than 40% of the activities housed in a flex building can continue to function during modification. Adaptable building is a building that has been designed with thought of how it might be easily altered to prolong its life' (Douglas, 2006). The capacity of buildings to offer functionally valuable spaces for a long time is defined as its durability or longevity (Wacław, 2014)

2.7.8 OPERATIONAL AND MAINTENANCE

Designers can specify materials and systems that simplify and reduce maintenance requirements; require less water, energy, and toxic chemicals and cleaners to maintain; and are cost-effective and reduce life-cycle costs.

2.7.9 REGIONAL PRIORITY

It is the fulfillment of demands that are specific to the region. The intent of these criteria is to provide an incentive for the achievement of credits that address geographically specific environmental, social equity, and public health priorities. (Gelowitz & McArthur, 2018)

2.7.10 INNOVATION

The intent of these criteria is to encourage projects to achieve exceptional or innovative performance. (Gelowitz & McArthur, 2018) it is the creation of something new that improves performance in the three dimensions of sustainable development: social, economy and environment.

2.8 Summary

Reviewing the literatures of Sustainability and Sustainable Development, Housing and Sustainable Housing, Sustainability Assessment, Environmental sustainability and Principles of Environmentally sustainable design, it shows that the relevance of sustainability assessment is very significant. The problems associated with sustainable development are global as a result, the issues need worldwide attention.

Many countries have developed their own sustainability assessment tools. Unfortunately Ethiopia do not have one so sustainability assessment tools of different countries have been viewed. After considering sustainable design components and green building design criteria with the assessment tools the researcher selected the most common and essential parameters. The Frameworks are 10 to weigh the IHDP buildings environmental sustainability. Depending on the nature of the topic the conducted study will use a qualitative method. In General the evaluation conducted will be for the purpose of Improvement on the environmental sustainability of the IHDP buildings.

CHAPTER THREE

DISCRIPTION OF THE STUDY AREA AND RESEARCH METHODOLOGY

3.1 Description of the study area

The selected site for the study of sustainability of IHDP building is Mekanisa kotari condominium which is usually known as Garment condominium. It is found in Addis Ababa at Nifas Silk Lafto sub city which is one of the 10 sub cities of Addis Ababa and is located in the southwestern suburb of the city, under woreda1. The site was constructed by Gulele sub city housing agency as an expansion site.



Figure 5: Map Addis Ababa



Figure 4: Arial map of Nifas silk Lafto s.c

The neighborhood have a total area of 19,600m² located near to the Haile garment and the Nifas Silk sub city main office building bounded by local coble stone streets and neighboring a residential buildings and a condominium building built by another project in a different time which is called lebu 1 condominium. In the geographic position the site is located in

($8^{\circ}56'11.79''\text{N}$ & $38^{\circ}43'49.45''\text{E}$) elev 2238.8m in the upper corner and ($8^{\circ}55'52.03''$ & $38^{\circ}43'57.03''\text{E}$) elev 2219.9m in the lower corner of the site.

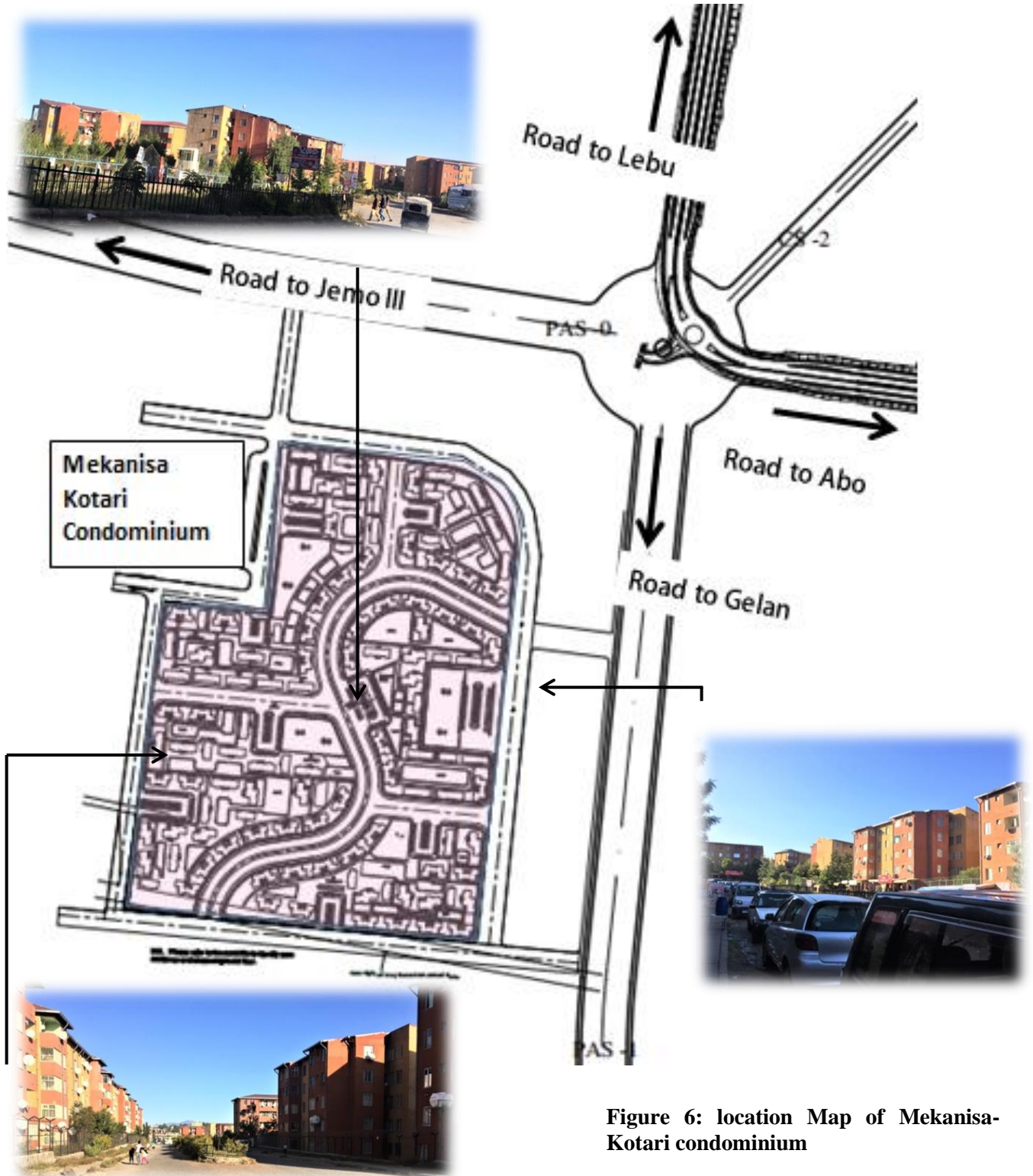


Figure 6: location Map of Mekanisa-Kotari condominium

3.2 Research Methodology

According to Kothari *“Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. In it we study the various steps that are generally adopted by a researcher in studying the research problem”* (Kothari, 2009). The methodology consists of procedures and techniques for conducting a study. Thus, research methodology consists of all general and specific activities of research. Mastery of the research methodology invariably enhances understanding of the research activities.

A mixed methodology (both qualitative and quantitative approach) is used for this research. Mixed methods involve combining or integration of qualitative and quantitative research and data in a study. The core assumption of this form of research is that the combination of qualitative and quantitative approaches provides a more complete understanding of a research problem than either approach alone (Creswell, 2014).

This approach is used because the study deals with the qualitative aspects such as the description of the existing situation of the Mekanisa kotari condominium buildings & site, the building practice & activities and the practice of the residents. It also includes quantitative data such as the number of buildings and households in the site. In this study mainly the qualitative approach takes a larger amount than the quantitative. However, both approaches are equally important. Accordingly, both approaches are used for a better understanding of the problem, which helps in providing a solution.

3.3 Research Data Type

The major broad category of data which is collected from the Households living at Kotari condominium is qualitative data. It is used to describe the quality and the characteristics of the IHDP buildings. The data collected from Nifas silk Lafto sub city project office and housing agency will be quantitative data. Therefore, the research is basically qualitative based on the area

of study. The quantitative data collected is used to support the results but not as a major source of data or information to reach conclusion.

Research data takes many different forms, the formats that this research takes includes field notes, images and photographs, drawings of CAD files, maps and Baseline maps, and interview notes.

3.4 Source of Data

According to the research questions the study will use both Primary and Secondary data. Primary data will be collected from the residents of garment condominium and Nifas silk-Lafto sub city and Ns/L sub city Woreda 1 government officials for all the three research questions presented. Primary data is a firsthand data which will be collected by the researcher itself, there for its an original data with the assumption of the data given by the respondents are fact.

Secondary data is a type which is already been collected by different agents. It is collected to answer the first research question from the various policy documents, proclamations, legislations, urban development plans, strategy documents, official documents, project documents, progress reports and other relevant published and unpublished documents applicable for the issue understudy.

3.5 Data collection Method and Tools

A case study method is chosen to investigate the problem for this research. The case study method is a very popular form of qualitative analysis. The case study places more emphasis on the full analysis of a limited number of events or conditions and their interrelations (Kothari, 2004). This method is of immense relevance when the focus of a study is on extensively exploring and understanding rather than confirming and quantifying (Kumar, 2011). Since the objective of this research is to assess the environmental sustainability of the IHDP buildings and to provide recommendations on how to improve the sustainability of the environment; the case study method is a more appropriate method. This method provides a deep

exploration and understanding of the site. In addition, it helps to create interrelation among the data obtained, which helps to provide recommendations on ways for improving the environmental quality to insure the resident health and wellbeing.

The fundamental reason for choosing a case study approach was to investigate principles for detailed and composite analysis of framework for environmental sustainable design. Simons summarizes this view, stating that “A case study is an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, program or system in ‘real life’ context. It is research based, inclusive of different hoods and is evidence led. The primary purpose is to generate in depth understanding of a specific topic” (Simons, 2009).

. In case study methods, a researcher is able to go beyond the quantitative statistical results and understand the behavioral conditions through the actor’s perspective. By including both quantitative and qualitative data, case study helps explain both the process and outcome of a phenomenon through complete observation, reconstruction and analysis of the cases under investigation (Tellis, 1997). Case study method enables a researcher to closely examine the data within a specific context. In most cases, a case study method selects a small geographical area or a very limited number of individuals as the subjects of study and conducts an in depth study of issues.

3.4.1 In-depth Interview

The researcher interviewed different levels of respondents starting from the Nifas silk-Lafto sub city and Ns/L sub city Woreda 1 government official to the end user of the building in order to get deep and elaborated answers. The Interviews are two types structured and non-structured type of interview depending on the area of the study and the research questions. The research questions discuss about their uses of the natural resources, environmental protection activities on the area and the buildings indoor and outdoor environmental quality.

The professionals of the environmental protection and green area development office were asked on the activities done by their department. The compound committees were also interviewed about their responsibilities in the environmental sustainability and about the rules and regulation of the site.

3.4.2 Observation

The other type of data collection for the primary data will be Observation. In this method the researcher visit the Mekanisa-Kotari site in a planned manner in order to gather information which is necessary to meet the objective that if the buildings are physically sustainable and if they are used for their intended purpose, durability of materials and adequacy of the buildings. Mapping and photographs will be used and Data gained will be recorded systematically.

3.4.3 Focus Group Discussion

Focus group discussions were used for the collection of data of this research, the focus groups are the committee members of each condominium compounds which are also residents of the neighborhood. There was five focus groups of the five condominium compound. The focus group discussion was helpful to get the general story and description of the site. It also gives a deeper understanding of the issues raised for the individual households. This helps in making sure of the respondents or the house holds of the condominium understand the questions asked in the area of environmental sustainability assessment and will insure the validity of the data gathered from the individuals.

Objectives	Data collection Method			
	Primary Data			Secondary
	Observation	Interview	Drawing	Data
Objectives 1				
Objectives 2				
Objectives 3				

Table 3: Relationship of data collection method with the objectives

3.4.2 Others

Other data collection methods such as images and photographs, drawings of CAD files, maps and Baseline maps will be collected from the Nifas silk-Lafto sub city, Woreda 1 and the different government officials who are part of the project and have information to provide.

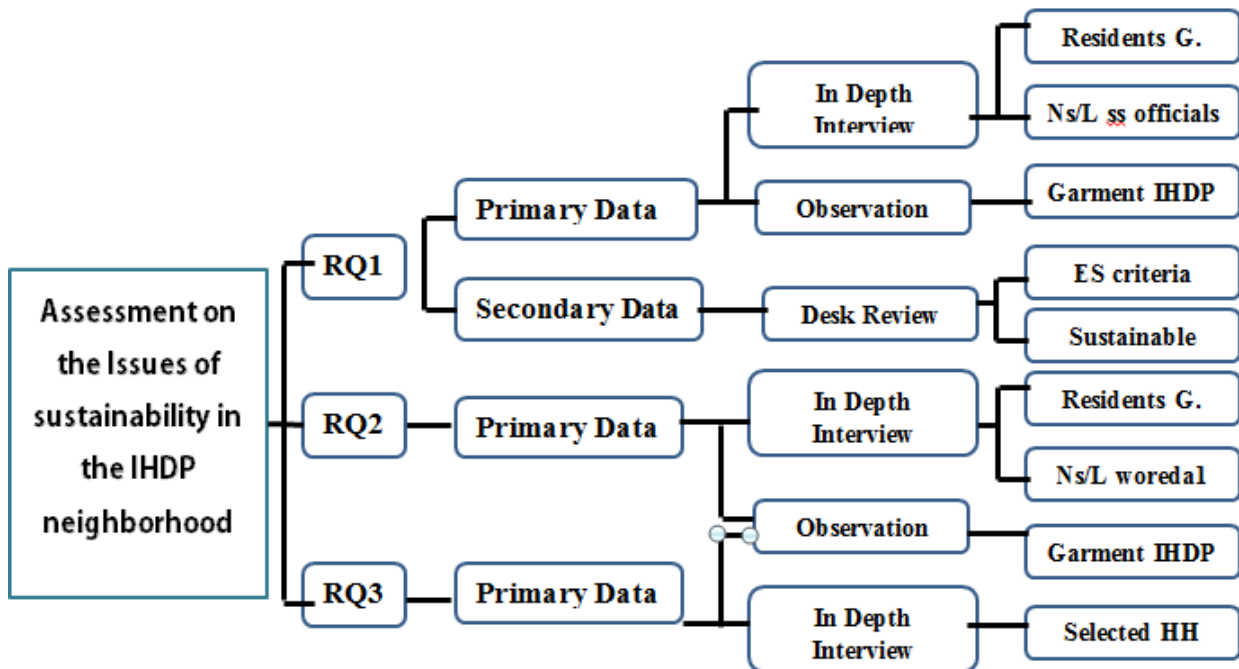


Figure 7: Summary of Research Methodology

3.6 Sampling Method

Convenience sampling with quota sampling method is used for determining the case study site and samples in this research. When population elements are selected for inclusion in the sample based on the ease of access, it can be called convenience sampling (Kothari, 2004). Among the IHDP developed buildings on the expansion site of the city the researcher choose the Mekanisa-kotari site based on the criteria of proximity of the site to self-location.

Quota sampling the interviewers is simply given quotas to be filled from the different strata, with some restrictions on how they are to be filled. (Kothari, 2004). On choosing of the interview samples the researcher use quota sampling technique of non-probability sampling used

for qualitative data by dividing the samples in the five compounds of the site. Three households from each compound were distributed to different level of floors in order to get full information which can be varied due to location of the sample households.



 <p>Figure 9: Arial map of Nifas silk Lafto s.s</p>	<p>First stage Sampling (Convenience sampling)</p> <ul style="list-style-type: none"> ✓ Selection of Mekanisa- kotari condominium based on researcher’s self-proximity.
 <p>Figure 12 : Site map of Mekanisa Kotari compound classification</p>	<p>Second Stage Sampling (Quota Sampling)</p> <ul style="list-style-type: none"> ✓ Selection of samples by distributing the samples in the different compounds of the site

Table 4: Sampling Method

3.7 Sample size

Sample size for qualitative research varies with different scholars. While some experts in qualitative research avoid the topic of “how many” interviews “are enough,” there is indeed variability in what is suggested as a minimum. An extremely large number of articles, book chapters, and books recommend guidance and suggest anywhere from 5 to 50 participants as adequate (Shari 2012).

Among the residents in Mekanisa-Kotari condominium the sample taken was fifteen households, five committee managers. five environmental protection and green area development office team leaders and five focus group of each compound committee members.

3.8 Data Analysis and presentation Techniques

Both qualitative and quantitative analysis method was used for the data obtained. The type of analysis used depending on the data type is narrative and descriptive analysis for qualitative and quantitative data respectively. Narrative analysis is used to analyze content from various sources, such as interviews of respondents, observations from the field, or surveys. It focuses on using the stories and experiences shared by people to answer the research questions (Bhatia, 2018). Scholars who conduct this type of analysis make diverse yet equally substantial and meaningful interpretations and conclusions by focusing on different elements (SAGE, 2017). Descriptive statistics is used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with simple graphic analysis, they form the basis of virtually every quantitative analysis of data (Trochim, 2006). These summaries may either form part of a more extensive statistical analysis, which is the basis of the initial description of the data, or they may be sufficient in and of themselves for a particular investigation (Amber, 2018).

In this research, the various data obtained and analyzed are presented in the form of text, pictures, maps, tables, charts and graphs. Processed data helps in obtaining information from it; as the raw data is non-comprehensive in nature. Presenting the data includes the pictorial

representation of the data by using graphs, charts, maps and other methods. These methods help in adding the visual aspect to data which makes it much more comfortable and quicker to understand (Tank, 2019).

In qualitative work there is no clear boundary between data collection and analysis (Denzin & Lincoln, 2007). The data analysis will start by preparing and organizing the data collected after reviewing according to the criteria's listed in the frame work of this thesis, the data gathered by different formats like maps , photographs ,interview answers, researchers site observation and drawing files will be presented graphically by graphs, tables and narration in order to answer the research questions. Finally comparison and analysis will be made based on the framework for environmental assessment of a building for summarizing and conclusion purpose.

CHAPTER FOUR

CONTEXTUAL BACKGROUND AND DATA PRESENTATION

4.1 Contextual Background

4.1.1 General background of the national and urban context of the study

Ethiopia is a country located in the eastern part of Africa, with a population about 114,427,730 million as of April 2020 data; according to Worldometer Ethiopia is the second most populous country in Africa With urban population of 21.3% in 2020 and rapidly urbanizing. In the space of fifteen years the population more than doubled from 57 million in 1995 to 114.9 million in 2020. The population is very young with 40 per cent under 15 years of age at 2019.



Figure 9: Ethiopia location in Africa

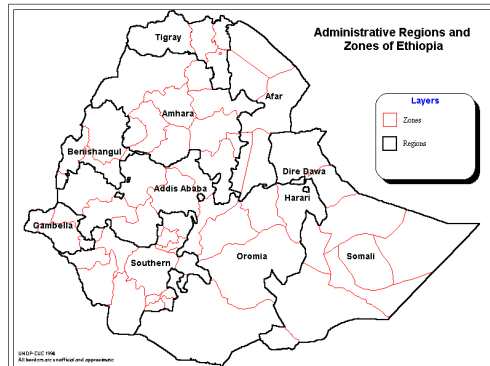


Figure 8: Map of Ethiopia

It's been some years since Ethiopia has been growing in a double digit number but still facing the problem of high population, housing crisis and urban poverty. According to Habitat for humanity journal in 2017, 80% of the population in Addis Ababa still living in slums, and

urbanization at a rate of 8% per annum, which needs either replacement or significant upgrading. The combination of high population and urban growth rates, coupled with a high prevalence of urban poverty, has placed enormous strain on Ethiopian cities, especially when it comes to adequate and affordable housing. Almost 50 % of city slum dwellers live below the poverty line and their hardships are enormous (Mekonnen, 2015).

Addis Ababa, the capital city, is relatively young having been founded in 1886 and has a population of approximately 4.7 million based on world population review of 2020. In the past ten years Addis Ababa has risen from a city of self-built single-story homes, to a city of skyscrapers.

4.1.2 History of housing in Ethiopia

Addis Ababa has seen its fair share in the evolution of housing since the liberation of the Italian regime in 1941. The population continued to grow at a faster rate afterwards, with the response of a subdivision of existing lots and residential buildings to expand the supply of affordable rental dwellings (Index Mundi, 2015). The housing built was as a response to the demand for housing for the urban poor. As a result the houses were poorly built, substandard, did not have proper foundations and basic facilities such as private toilets, kitchens or connections to water lines (Balcha, 2014). According to UN-HABITAT 2011 history of land before 1975 was that land and housing in Ethiopia were controlled by a selected few individuals and groups owning more than 70% of the land, on which 80% of the peasants were tenants. Low-income households had little option but to rent housing. In 1975, after the ‘Derg’, overthrow of Emperor Haile Selassie all urban land and ‘extra houses’ were nationalized in an effort to force a fairer distribution of wealth across the country. Thus two new typologies in the housing sector were established: Government-owned rental units (Kiray betoch) and Kebele Housing. During this time approximately 60% of housing in Addis Ababa was rental accommodation. The low rental rates resulted in little to no investment in housing which led to a further deterioration of housing quality. The housing conditions were poorest in the center of Addis Ababa.

Since the overthrow of the ‘Derg’ by the Ethiopian People’s Revolutionary Democratic Force (EPRDF) in 1991, Ethiopia has been undergoing market-orientated reforms, structural adjustment policies, decentralization of governing structures, and a programmer of agricultural development-led industrialization. Ethiopia come up with a land lease policy no. 80/1993 which enables people to possess land so as to build houses for residential as well as for rental purposes. The land lease policy incorporate the Government’s practice of maintaining public ownership of land, was also implemented at this time but it assumed that the housing market alone would meet the demand for affordable housing of the low-income population. Despite large subsidies and land provided at highly subsidized rates, the private sector has failed to deliver affordable housing at the large scale required. The practice of low-cost government owned rental housing continues to be the dominant low-income housing strategy. But this housing stock is of a very low quality, is poorly maintained, and needs either replacement or significant upgrading.

4.1.3 The Integrated Housing Development Program (IHDP)

The Integrated Housing Development Program (IHDP) is a government-led and financed housing provision program for low-and middle-income families in Ethiopia. At the start of the program, the Mayor created a committee composed of the Bureau Heads of the Addis Ababa City Administration and representatives from GTZ and MH Engineering, an Ethiopian design and engineering consulting firm. Later, the Housing Development Project Office assumed full management of the program and a Board of Governors containing all members of the former steering committee, except the GTZ representative, was created. (UN-HABITAT, 2011)

The pilot project consisted of 750 residential units along with office and commercial units. GTZ managed the project on behalf of the city government and the project was extremely successful in terms of cost and time. When the government suggested building upwards of 40,000 houses every year, GTZ declined to continue their direct involvement with project design and implementation, instead taking an advisory role. To achieve such ambitious targets, GTZ recommended that the government create a new office specifically for housing development, which they did in 2005 by establishing the Addis Ababa Housing Development Project Office (HDPO).

Condominium ownership in Ethiopia actually brought a big relief for those demanding houses as there are acute shortages of housing facilities in the country (Yirga, 2012) that is why in 2014 when the government started registration for future homes more than 900,000 home seekers applied. It isn't that public housing is a perfect solution but it is the only solution available for the middle and low income groups of the society. so improving these projects will yield a positive effect on the future of the country. Specially because according to the UN estimates the urban dwelling population of Ethiopia is set to triple from 19% in 2010 up to 2040 with an annual growth of approximately 3.5 %.

The Integrated Housing Development Program the prominent current government approach to solving the low-income housing challenge is the IHDP, initiated by the Ministry of Works and Urban Development (MWUD) in 2005. The Program is a continuation of the 'Addis Ababa Grand Housing Program' which supported the endeavors of the Ethiopian Government in their implementation of the 'Plan for Accelerated and Sustained Development to End Poverty' (PASDEP).

The IHDP aims to:

- a) Increase housing supply for the low-income population
- b) Recognize existing urban slum areas and mitigate their expansion in the future
- c) Increase job opportunities for micro and small enterprises and unskilled laborers, which will in turn provide income for their families to afford their own housing
- d) Improve wealth creation and wealth distribution for the nation

Housing shortage in Addis Ababa is one of the major concerns for the government. Current shortage is estimated to be 1.2 Million units, increasing by 100,000 units each year (MUDH, 2017). There are many problems and inefficiency which is investigated by researchers

and that the government of Ethiopia is working on to improve but also the need for housing is still unsatisfied.

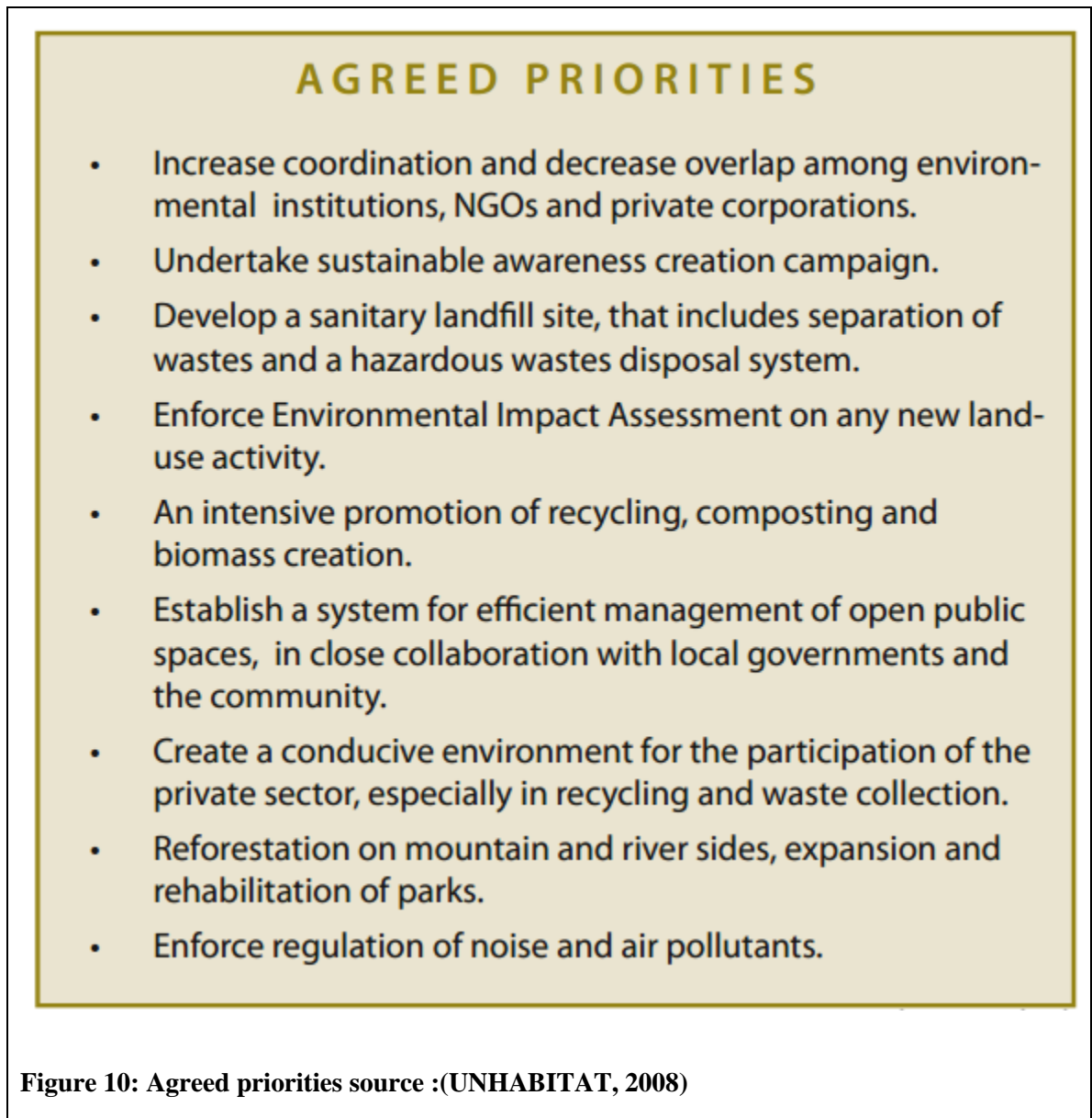
4.1.4 Environmental Sustainability in Ethiopia

The Environment Protection Authority was created in 1994. The Institute of Biodiversity and the Ethiopian Wildlife Conservation Authority have also been strengthened with more power and mandate in conservation of biodiversity and sustainable use. The Environmental Policy of Ethiopia was approved on April 2, 1997 by the Council of Ministers. The Environmental Policy of Ethiopia has embraced the concept of sustainable development. As its goal, the Environment Policy of Ethiopia states “to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human-made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs.”

Ethiopia aims to achieve middle-income country status by 2025 while developing a green economy. This is the vision set in Ethiopia’s Growth and Transformation Plan (GTP) 2010/11-2014/15 and the main agenda of the GTP is the eradication of poverty. (“Roles of Agroforestry on Climate Resilient Green Economy of Ethiopia: Review,” 2019)

Over the last two decades, the Ethiopian government has put in place a number of policies, strategies and laws that are designed to support sustainable development and also signed and/or ratified many of the international conventions and protocols.

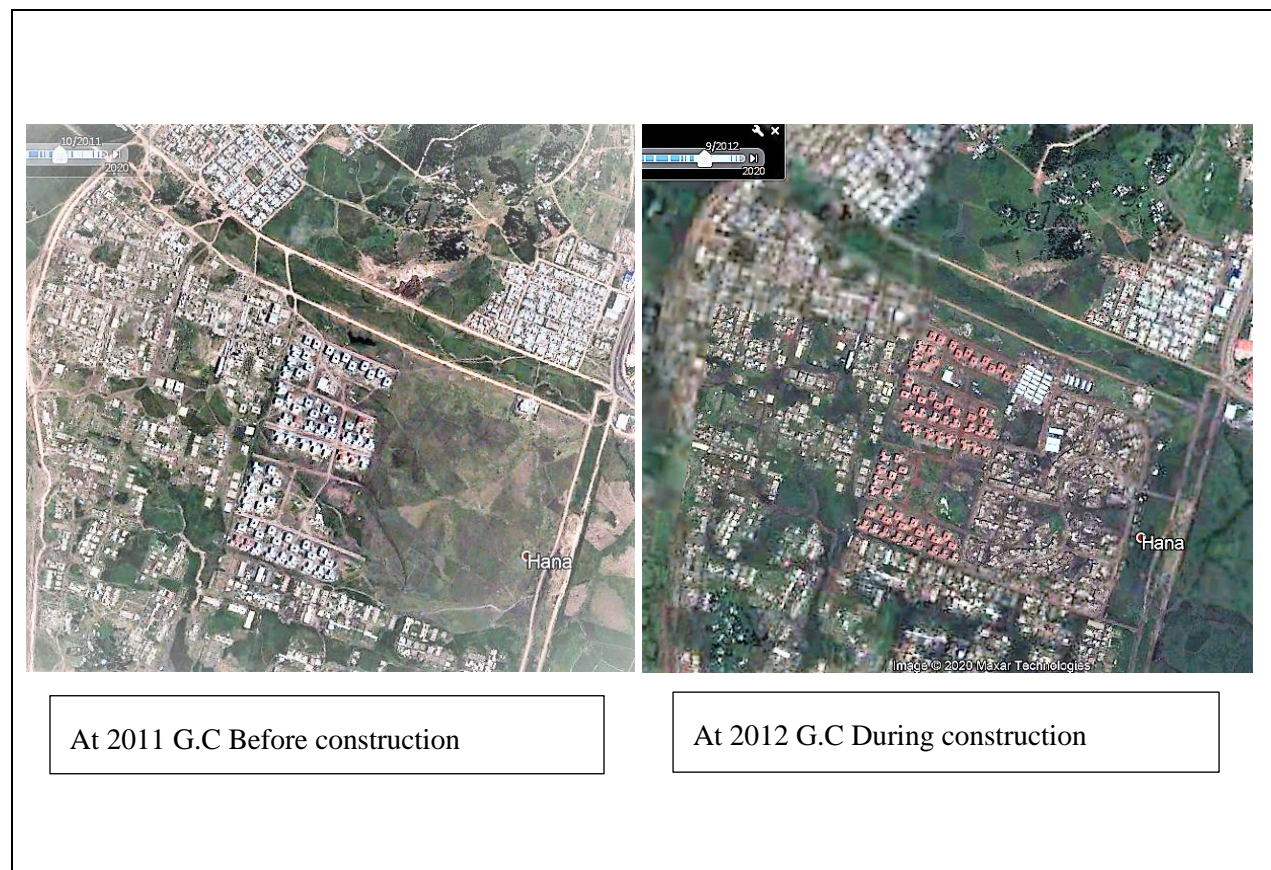
The United Nations Human Settlements Program states the following as agreed priorities among the concerned government bodies including the federal environmental protection authority and the Addis Ababa environmental protection authority and NGOs such as clean and green initiatives (UN-HABITAT, 2008):

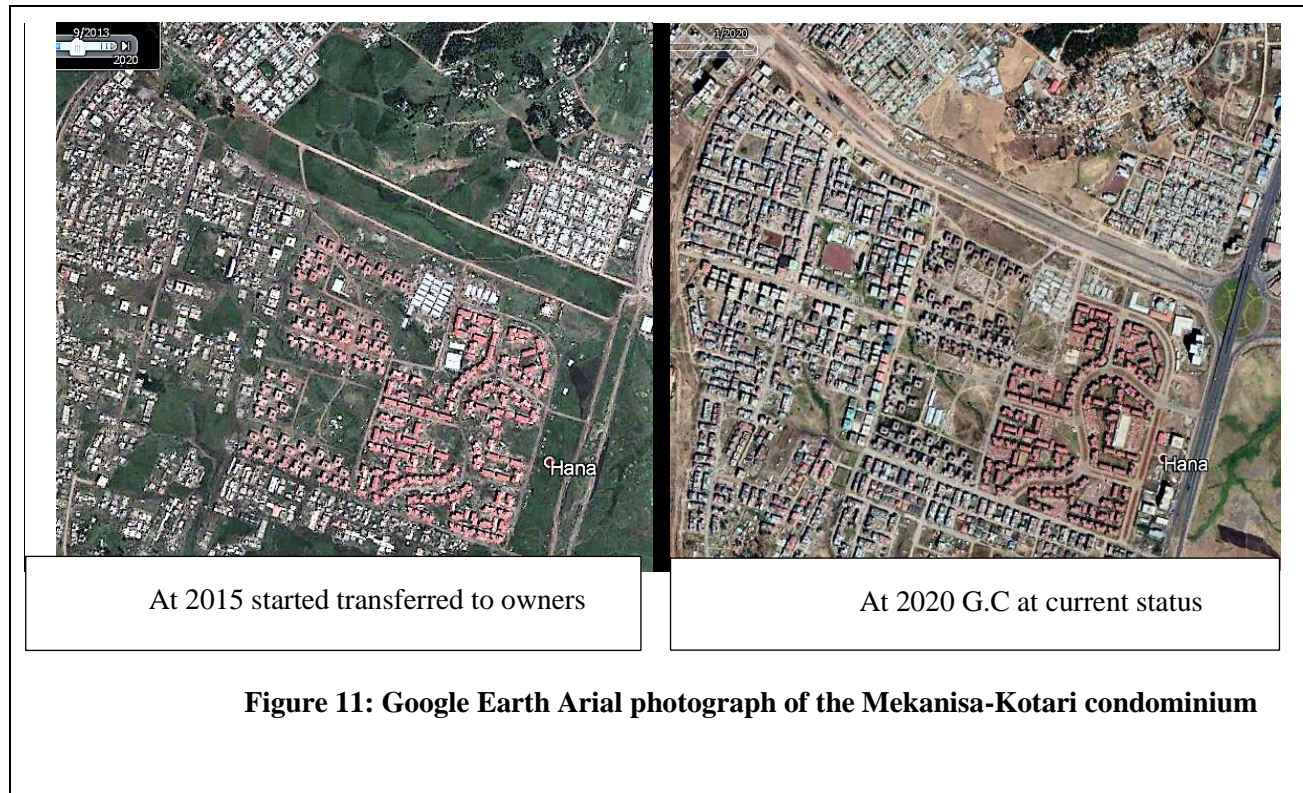


This is in addition to the condominium housing project itself which is meant to solve the housing problem in general and if implemented with the stipulated degree environmental situation could improve. Preparation and Submission of different Project and Program Proposals at national level was prepared to address environmental issues in Ethiopia.

4.2 Description of the neighborhood

Mekanisa Kotari condominium is one of the sites developed by the IHDP in 2013G.c the site was constructed by Addis Ababa Housing Development project office (AAHDPO) under the Gulele project office as an expansion site. The houses were transferred to the owners by the randomized lottery of the project starting from 2015 at different times. The buildings are G+4 in height and this expansion sites brought up more typology options and acquired a greater land space which was used for mass production of 101 building blocks with 2889 housing units, the typology which are found in the Mekanisa-Kotari condominium are A1, L1 and L2 which have a wider variety of areas depending on the typology of the housing unit.





The five compound associates are presented as follows:

- Compound 1 is the smallest one called Addis Brhan with 11 blocks from Block 1 to 11 which have 313 housing units,
- Compound 2 is called Addis Hiwot with 25 blocks from block 12 to 36 having 714 housing units,
- Compound 3 is called Shalom with 20 blocks from block 37to 56 having 567 housing units,
- Compound 4 is called Selam containing the highest number of buildings of all the association with 26 buildings from block 57 to 82 having 750 housing units and
- Compound 5 is called Sefere Genet with 19 buildings from block 83 to 101. In general there are 3 types of condominium buildings based on their design which are called L1, L2 and A1.



Figure 12: Site map of Mekanisa Kotari compound classification

The 5 compounds of Mekanisa –Kotari condominium have their own association and administration rules, these associations have chief and deputy managers and secretary which administrate the overall activities on the site such as hiring, directing and controlling the securities and gardeners of the compound, providing a parking service for households, developing the site, collecting monthly contributions, regulating conflicts, regulating residents

and manage all the relationships with the Woreda and sub city offices. The compounds differ in their physical situations depending on the initiation of the residents.



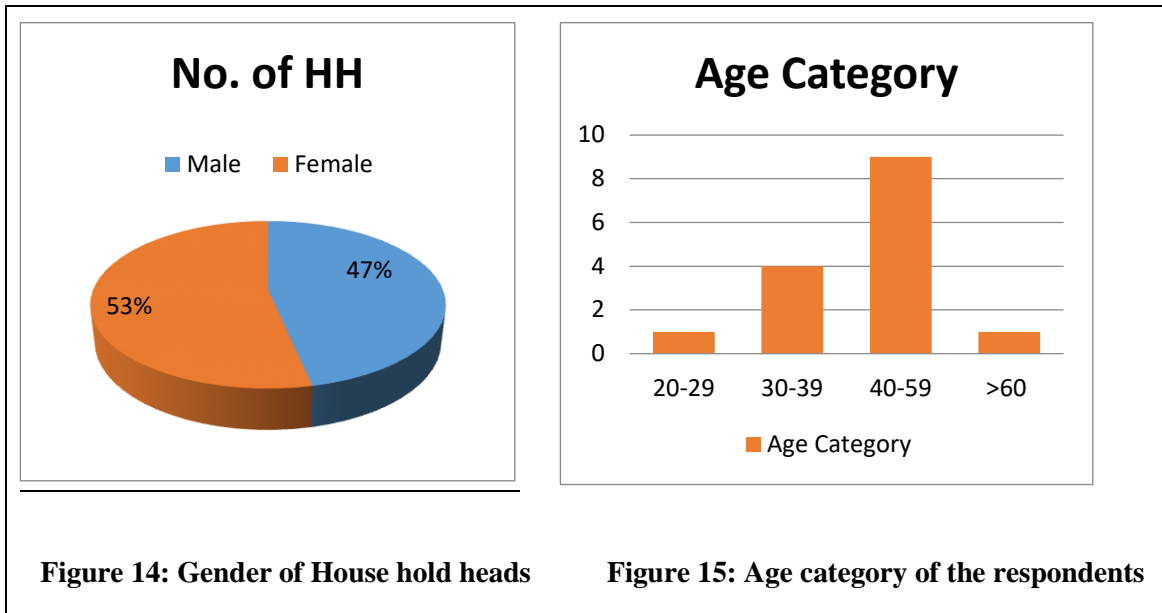
Figure 13: Photograph of Mekanisa-Kotari condominium

4.3. DATA PRESENTATION AND INTERPRETATION

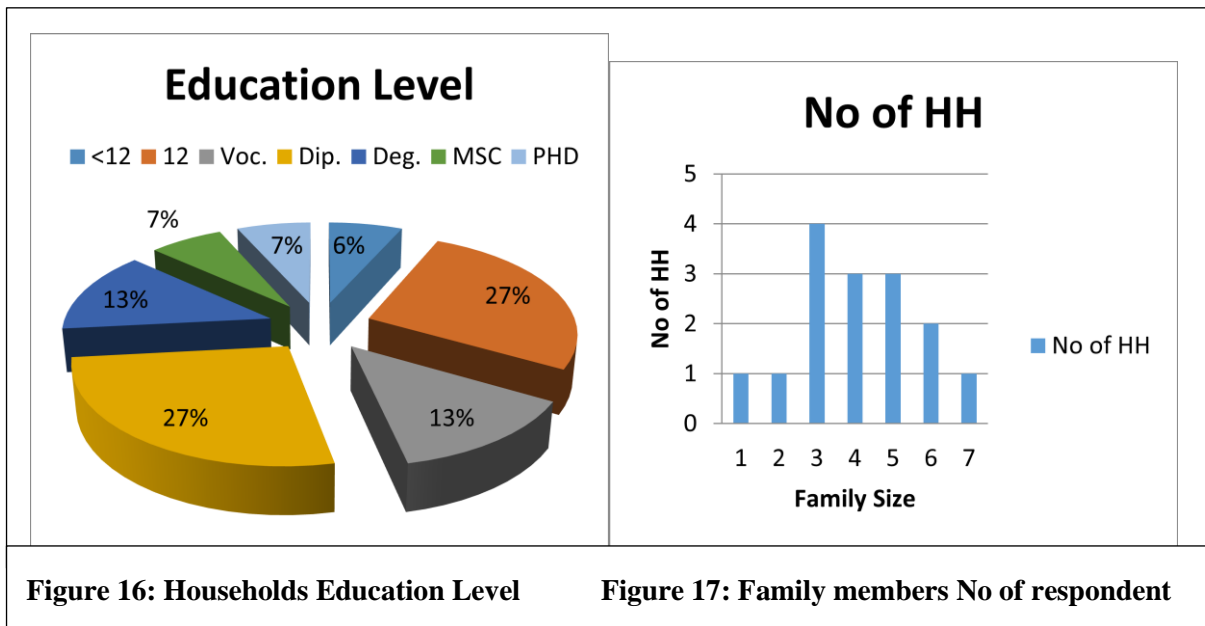
For this study of environmental sustainability of the IHDP developed building interviews were taken from the residents, administrators of the five committees, the Environmental protection office in the sub city and woreda level, Housing Agency of woreda 1 and centralized water treatment plant of the site. For the 15 interviews taken from the residents three households were chosen from each condominium compound of the Mekanisa kotari site which is on different floor level from ground floor up to fourth floor.

4.3.1 HOUSEHOLDS PERSONAL INFORMATION

Fifteen interviews were taken from willing households, the demographic characteristics like sex ratio, age, educational level, number of families, tenure status and length of stay in the building was assessed. Among the households interviewed 53% were female respondents and 47% were male, as the data recorded by the committee of the sites female home owners were also greater than male home owners. In the age category one respondent is in the youth category (20-29), four respondents are in young adults (30-39), nine respondents are in middle age adults (40-59) and one respondent is in the old adults category (> 60).



Education is a way which increase understanding level and widening peoples perspective therefor educational level was also assessed in the data gathering process, the education level was classified into below Grade 12, Grade 12 complete, Vocational, Diploma, Degree, Masters and PHD level which is presented below in percentile.



As of the data majority of the head of households are middle age adults (40-59), the diploma holder and the former 12 complete households have an equal majority share preceding the vocational on the education level and the three family members widely held in the respondents.

Females are also majority of the house owners according to the registered data of the condominium committee.

4.3.2 GENERAL HOUSE INFORMATION

The majority of the housing units are used for dwelling purpose due to the design of the buildings which leads the ground floor for commercial purpose and the other four floors for residence. The tenure status of the residents and the number of years they have stayed in the house will also have an impact in the response of the residents among the fifteen interviewees seven of them are renters and eight of them are owners of the house they live in.

In the type of housing unit we have a one unit studio, five 1 bedroom types, five 2 bedroom type and three of them were 3bedroom type and one unit is a commercial unit.

Since the Mekanisa kotari condominium project constructed under Gulele sub city in 2013 to 2015 by Gulele sub city and was distributed through the lottery to the winners in 2015; so the longest household living in the building is only for six years.

4.3.3 ENVIRONMENTAL ASPECTS

LOCATION AND TRANSPORTATION

In the Mekanisa-Kotari condominium there are two approaches of transports, the one is the three wheeler vehicle usually known as Bajaj which works from the main road to the end of the condominium compounds, while the other is the public transport system which starts from the main road to different part of the city. The modes of transport that the residents use are classified as shown in the graph.

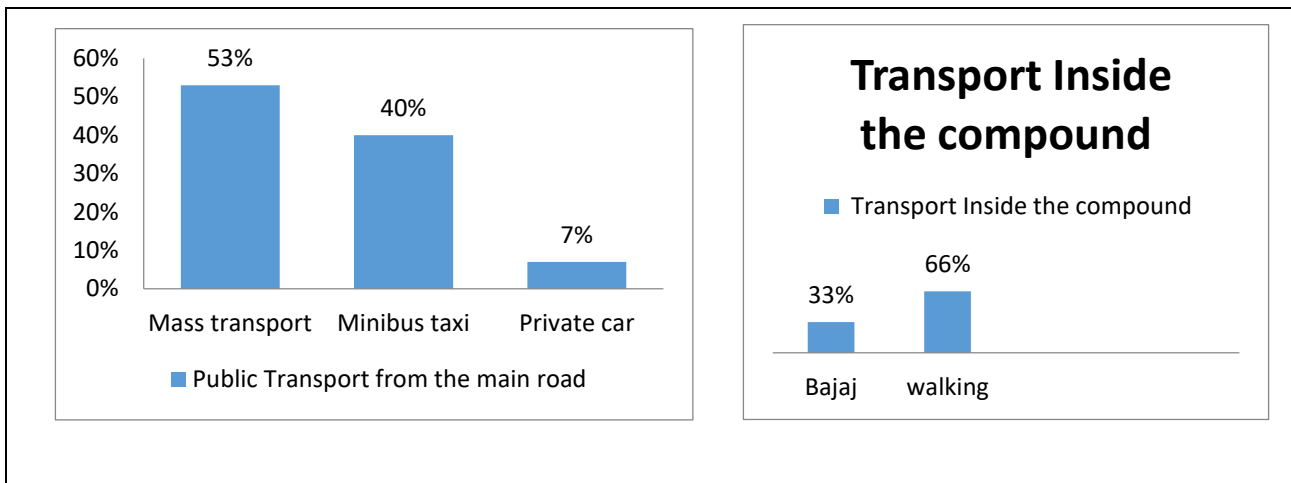


Figure 18: Choice of transport modes

In the mass transport system there is only the city bus called Anbesa bus there are no other city bus like Sheger bus or a rail way passing garment area. In the location of the site 93% of the respondents are satisfied with the site location which is near to different public services and places to move but one respondent 7% is not satisfied and suggested that the mass transport access should be inside the compound.

SITE MANAGEMENT POLICY

There is a site management policy in the neighborhood which is developed by the committees and approved by the woreda's housing agency office. The site management policy focuses more on the structural organization of the committee members and rules and regulations for residents of the condominium building. 100 % of the respondents know that there is a site management policy but 60 % of them suggest that the committee did not implement the policy.

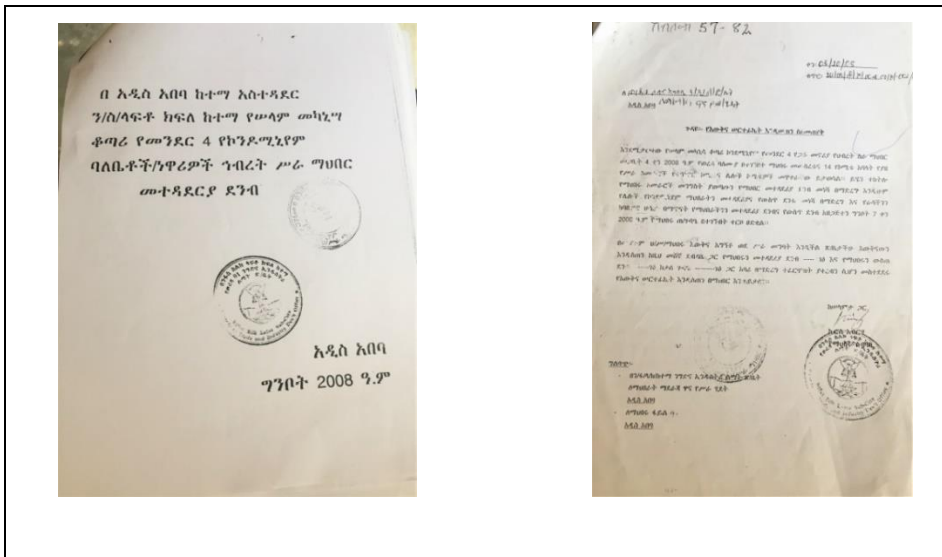


Figure 19: Picture of the association’s Regulation

ENVIRONMENTAL PROTECTION ACTIVITY

The Nifas silk sub city environmental protection office is assigned to work in four categories such as Green area, energy, construction minerals, and pollution which further divided to water pollution, Air pollution, Land or soil pollution, noise pollution and ray radiation. Among these activities the residents of the Mekanisa Kotari condominium have seen only two of the activities. The percentage of the respondents is presented below. Among the respondents 53% of them only know the sound pollution activities.

The condominium site environmental activities are under the Ns/L sub city woreda 1. According to the woreda’s officials they are currently working effectively in green area development due to the general government’s vision of the Green legacy program. In the direction of pollution, the woreda and sub city’s works mostly depending on complaints from residents other than there site visit schedule once in a month.

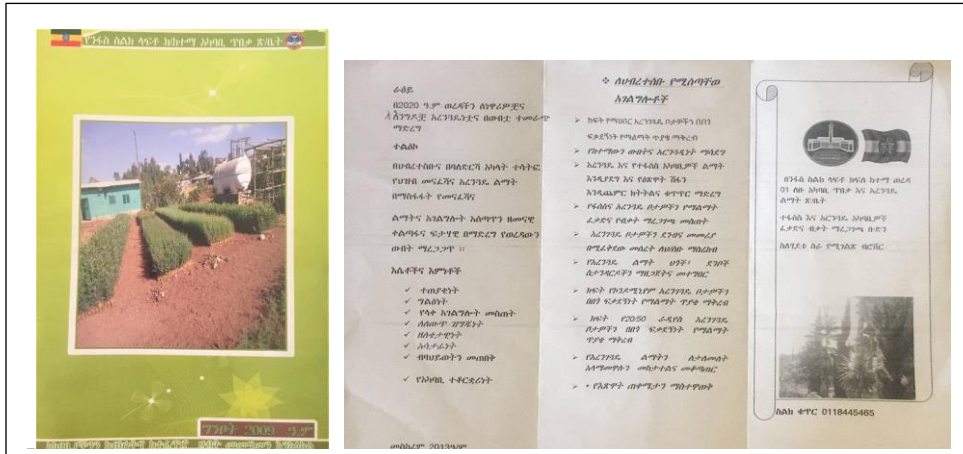


Figure 20: Environmental Protection Office brochures

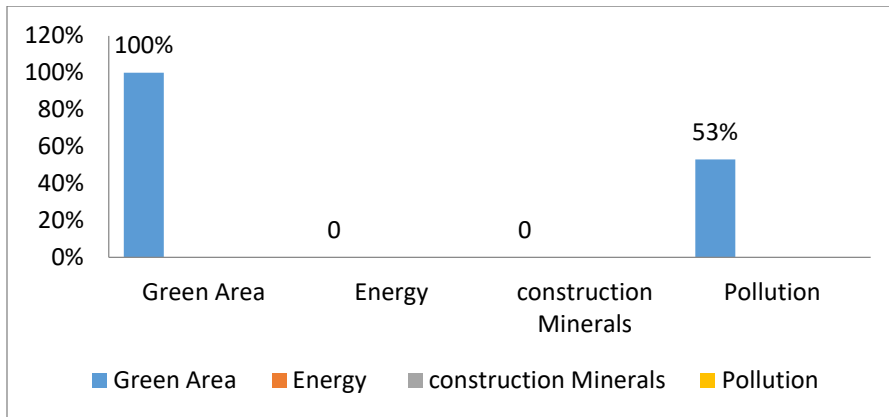


Figure 21: EPA Identified & known by the residents

Even though it is found in there directive there is no identified activities or awareness creation in energy efficiency, in the use of renewable energy source and protecting construction minerals for the residents by the authorities.

GREEN AREA

The condominium residents and the committee administrators are working vastly on the green areas of the compound they also get a technical help and provision of plants from the worda’s green area development office. 100% of the respondents are aware of the work and contented of the development.



Figure 22: Green area of the site

The other type of greenery found in the site is individual's vegetation by container at the corridors, stairs, windows and balcony in the buildings. This trend of the households should be encouraged and adapted widely in order to regain the greenery's lost in the site clearance of the green land development of the site.



Figure 23: Individuals greenery

WATER EFFICIENCY

In the assessment of the water efficiency the residences use of water, rain water collection and waste water management was asked. 80% of the respondents don't control their use of water by their monthly fee which reflects their spending of water and the corresponding approximate payment to identify the gap if it doesn't align with their use, 53% of them have encountered leaks on bathroom or kitchen pipes which contribute to large amount loss of water, 93% do not turn off water between uses such as brushing teeth, washing hand and faces and washing utensils which double the amount of water needed they do not even recognizes until they was asked for the question, 67% of the residents confirm that they have dual flush toilet which is considered to be one of low flow toilet than the usual one, 80% of them recycle water specially on using the waste water from washing clothes for toilet flushes and 93% of them do not collect rain water because they have no suitable space for the purpose.

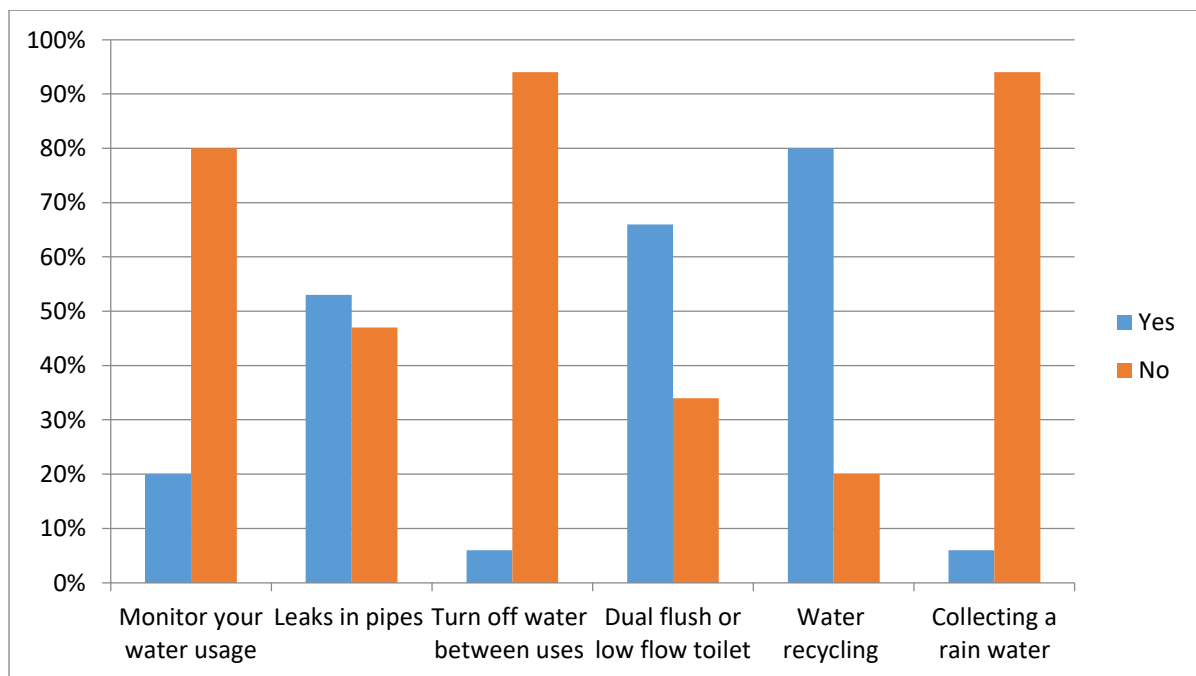


Figure 24: Water efficiency components assessed

ENERGY

86% of the residents use electricity as a primary source of energy for lighting and cooking but they use charcoal and cylinder gas when there is no light the other 14% uses petroleum gas and charcoal as a primary source for cooking but uses electricity for lighting and other purposes as electricity in our country is based on hydropower it is a renewable energy but the charcoal and fuel are a use of non-renewable energy which impacts the environment and should be minimized and controlled. In addition to the residents home use there is no renewable source of energy in the site or the buildings to promote efficiency use of energy.

RECYCLED MATERIAL

According to the households respond there is no recycling materials collection by separating the solid wastes into recyclable and non-recyclable wastes but all the households recycle some materials like plastic bottles ,paint container for planting vegetation and glass bottles for home uses.

LIQUID AND SOLID WASTE DISPOSAL SYSTEM

The liquid waste or sewer system of the IHDP buildings goes to a central waste treatment plant which is located adjacent to the site at 8055'58.66"N, 38043'59.14"E and 2220.7m which is called Membrane Bio Reactor (MBR), a containerized system that refines waste electromagnetically. No chemical is added on the process other than to clean the parts of the MBR it only use filters and pressure for the refining process.



Figure 25: The waste treatment plant location on Google earth map



Figure 26: Photo of waste treatment center

The solid waste disposal system is controlled by the woreda's solid waste secretary office which collects the solid waste of the Mekanisa Kotari condominium residents twice a week inside the compound but the residents who is not home during the day will take the waste to the site's collection points which are located in three places around the site.



Figure 28: Solid waste disposal Locations



Figure 27: Solid waste collection and deposit

INDOOR ENVIRONMENTAL QUALITY

In the quality of a building's environment in relation to the health and wellbeing of those who reside in the space within it can be determined by many factors, including natural lighting, air quality, noise, thermal comfort, quality view and damp conditions.

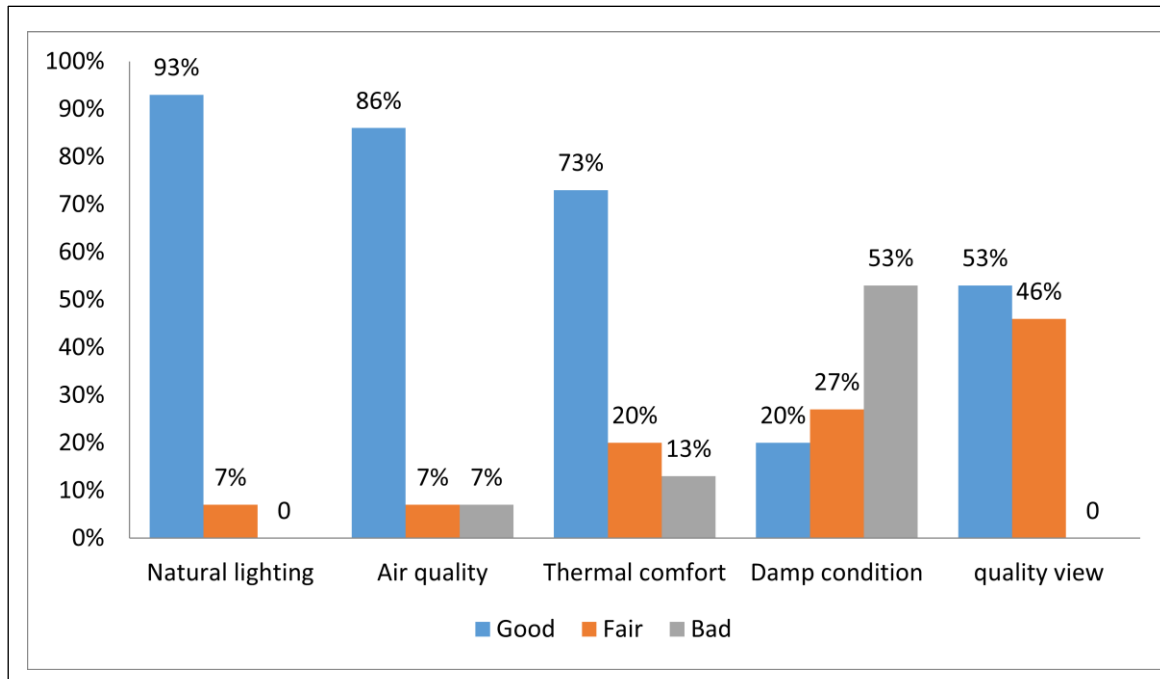


Figure 29: Indoor Environmental quality graph

Among the fifteen respondents fourteen of them agreed they have a good natural light in their rooms beside the one who responded that they don't get a direct sun light due to the orientation of the house, thirteen of the respondent are happy of the air quality of their house and the surrounding area and one respondent complain of odor comes from the waste water treatment and the solid waste disposal points which are located on the way to the main road, eleven of the respondents suggests that they have a good thermal comfort and the rooms are well ventilated while two respondents states that there is bad thermal comfort in some rooms due to a harsh sun entering the rooms during the afternoon time.

Dampness condition of the building parts are classified into two the ground and the upper floor houses. Respondents which reside in the upper floor face damp conditions which came from the upper floor leaks mostly in wet areas and the ground floor residents dampness that occur due to the poor finishing of the site work creating an open space between the wall and the finished floor around the building



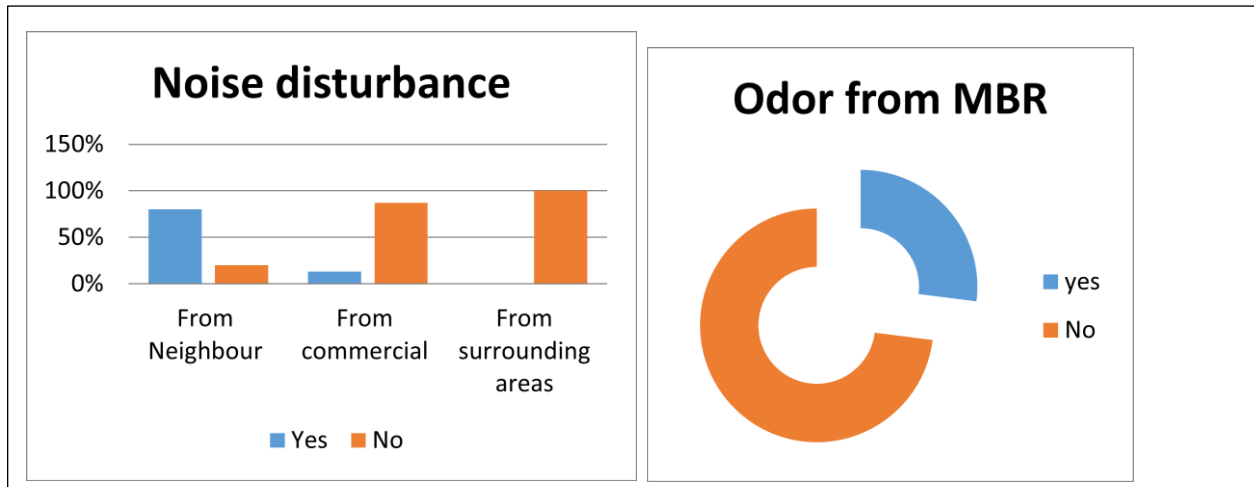
Figure 30: Dampness cause in the building

Considering the positive view from the building eight of the respondents are satisfied with the view they get from there house specially to the green areas of the site while seven of them criticize the design of the face to face doors with the neighbors.

POLLUTION

According to the residents and the committee administration the pollutions that occurred in the site is air pollution or odor which comes from the waste water treatment center but some suggests that the smell is seasonal when they face problem on the drainage system and the smell that comes only reach the compounds adjacent to the treatment center.

The other type of pollution is noise pollution that is recognized by the respondents and it comes from the neighbors in sides of the house and who are right above on the top floor and also from the commercial units in the ground floor on the buildings facing the local roads in between the five compounds.



Some residents reported noise and air pollution percentage red from the hollow concrete block manufacturing places beside the site. The manufacturers originally occupied the space during the construction of the IHDP site to supply the HCB for the construction of the buildings but they still are on the area and the dust from the resources used disturb the residents near to the location.



Figure 32: HCB manufacturing site

DETERIORATION

The residents were asked if any deterioration occurred and they have mentioned in the parts of the building both inside and outside their house. The inside parts such as the partitions walls, the fittings of shower and kitchen and cracking on the slabs which occurred by leakage from the upper floors. On the outside of their house or the communal parts such as the stair case floor finish, wall finish and gutters.

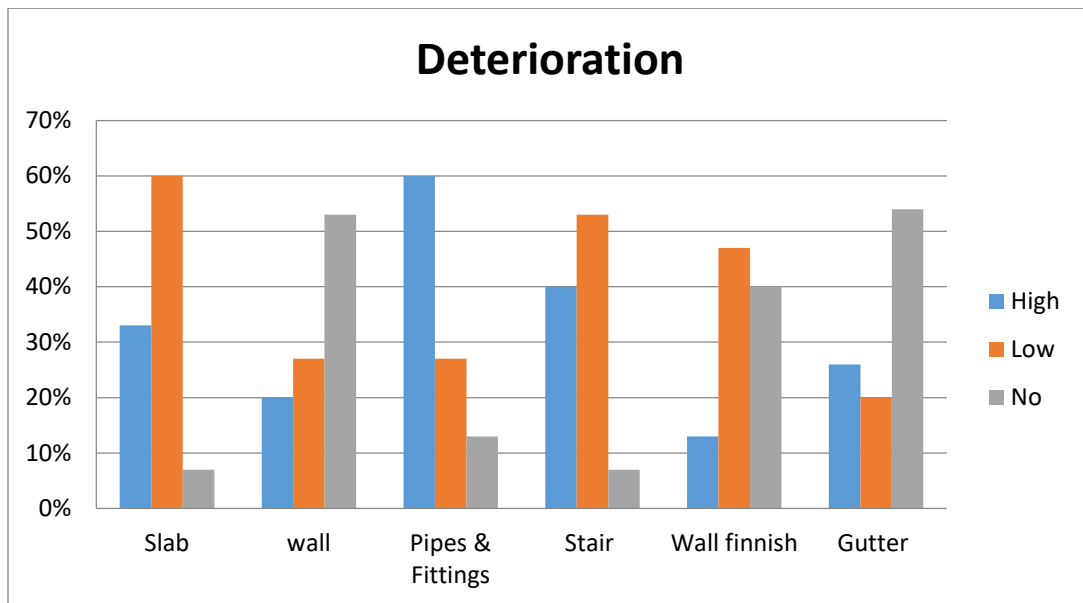


Figure 33: Deterioration assessed in the parts of the building

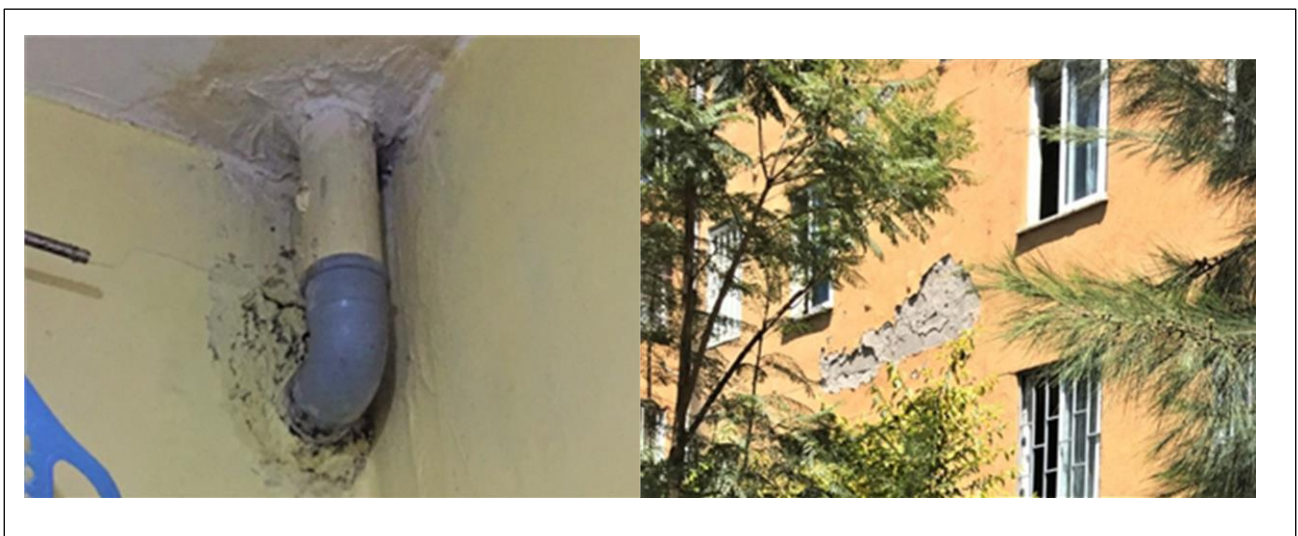




Figure 34: Physical deterioration of the building parts

ADAPTABILITY AND FLEXIBILITY

The capacity of a building to undergo modifications and accept changes of function with limited structural involvements was one of the things involved. In the assessment the respondent's attitude on their satisfaction on the area and design of the house and the actions they take on the houses were asked separately.

60% of the respondent are satisfied with the area and design of the house and didn't take any modifications while 40% of them are satisfied but still take some modification by covering the balcony as an additional room.

On the other hand among the respondents who are not satisfied by the design and area of the house 53% of them made modifications to the design of house by adjusting the rooms which was possible due to the use of agro-stone material on partition walls.

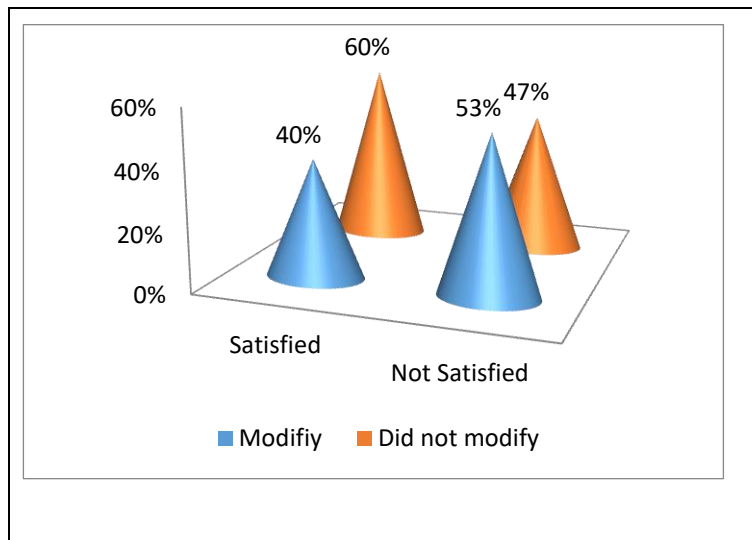


Figure 35: Adaptability and Flexibility chart

INNOVATIONS

According to the LEED criteria Innovation is one of the green building components which encourage the creation of something new that improves performance in the site. Agrostone panel is an alternative low-cost eco-friendly building material which mainly uses agricultural/industrial wastes and/or natural minerals as raw materials.(Taffese 2012) Among the IHDP sites the Mekanisa-Kotari condominium site also uses of Agrostone panel which is environmentally friendly material for the production of partition walls which can be considered as innovative action by AAHDPO however respondents have not seen further innovation in the site of the neighborhood after they start living in.

QUALITY

According to the assessment taken from the respondents on their opinion of the building quality 93% of the respondents are not satisfied with the quality of the building based on the above issue raised and with their own personal measurement.

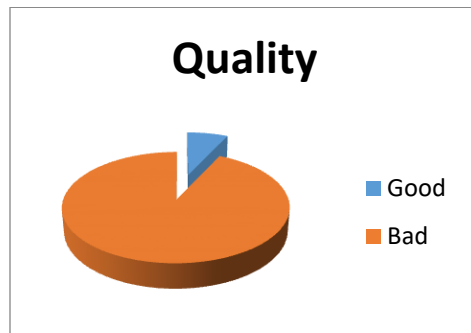


Figure 36: Opinion of residents on the quality of the building

OPERATION AND MAINTENANCE

Building components such as plumbing, electrical and water supply systems, and roofs may require maintenance. Residents were asked if the building is suitable for Operation, maintenance, repair and replacement of building components and equipment.

53% of the respondents reflect that the building is not suitable for operation since it involves willingness of the whole households in the building while 47% of them agreed that the building is suitable for operation as long as it is in the individual household.

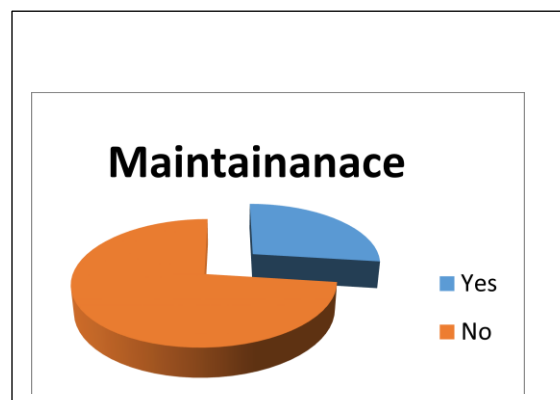
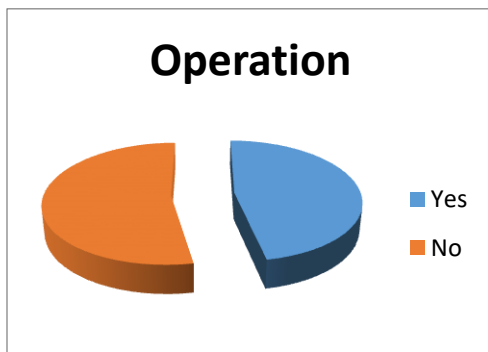


Figure 37: Residents opinion in the operation and maintenance of the building

In the suitability for maintenance 73% suggests that it is not suitable for maintenance because of the connected line of plumbing, electrical and water supply system from the top to bottom and also due to the joint responsibility of the residents in the communal spaces so that it require a lot of process to maintain adjust or change some things in the house. Some households who are near the ground floor took there on measure for maintenance because the proper way needs a lot of time and procedure.



Figure 38: Individual's measure for plumbing maintenance and maintained stair case



Figure 39: Drainage line needing maintenance

CHAPTER FIVE

RESULT & DISCUSSION

5.1 RESULT

5.1.1 THE SITE AND HOUSE HOLDS

The Mekanisa kotari site is one of the IHDP developed site. Building as this expansion area site has strengths in being bigger in scale for accommodation of more units relative to infill area projects. The inclusion of the private sector in the design and planning process and provision of more time to the preparation of LDP's NHD's and typology designs has positive contribution for the development of suitable housing areas.

The households in the Mekanisa-Kotari condominium are mostly displaced households from the inner city redevelopment areas like Tekle-haimanot and Sengatera and some of them are lottery winners by the Addis Ababa Housing Agency (AAHA) and others are teachers who got a chance of owning the IHDP houses.

The site is near to the main round about and relatively near to the city center compared to other expansion condominium sites. It also has a variety of destination starting from the roundabout which makes transportation a lot easier. The public transportation available are public minibus, taxis and mass transportation system that is provided by Addis Ababa Anbesa Bus which is very suitable in a day times and a little bit crowded in rush hours. Nevertheless the residents need an additional public transport facility since the site is expanding faster and is accommodating a lot of households.

The site promotes walking from the last point of the public transport to the compounds of the condominium even if the three-wheels small cars (Bajajs) are available most residents choose to walk due unless it is very sunny or they have lot of loads, The site is also suitable for a bicycle riding since it is all roads outside of the compound are paved with coble stone but due to the

bajaj transports and private cars moves a lot around the site the bicycle riders choose to ride in the playground inside the condominium compounds.

The site management policy of the association mainly focuses on how to administer the compound including monthly fees and other payments, about parking ,security ,cleaning the surroundings and the rights and obligation of the users both the renters and owners of the building.

5.1.2 ENVIRONMENTAL PROTECTION ACTIVITIES

The environmental activities performed on the Mekanisa –Kotari condominium is assigned for the Nifas-silk Lafto woreda 1 Environmental protection & Green area development office. The office is mandated for four types of environmental protection activities such as Green area development, energy, construction minerals and pollution of water, air, land or soil, noise and ray radiation.

The woreda’s green area development project office was promoted to its current name project office in 2012. The Office’s mandates were enacted into law by the City Government of Addis Ababa (Regulation NO.84/2016). However the office does not have a given strategy or rules to implement the works. According to the team leader they are working in closer interaction with Mekanisa-kotari condominium committees by providing different type of seedlings and making them to plant in a designed manner, supervision and support and helping to get water meters for the green area and they have visitation period two times in a month.

The other active office under the EPO is the environmental pollution and climate change office which regulates the pollution types listed above based on the given standard. The office also gives approval for some commercial activities in the site but mostly works to resolve complaints from the residents. Most reports come for a sound pollution problems due to loud music noises form bars & restaurants, metal and wood workshops in the site. The office checks both in the night and day standards. In general, the project office need to carry out awareness

creation and regular site visit in all dimensions of environmental protections which is also mentioned in the regulations

5.1.3 INDOOR ENVIRONMENTAL QUALITY

When natural lighting was assessed from the components of IEQ, an adequate natural light existed in all rooms of the condominium unit unless they use or cover the space provided for balcony. However some buildings get a diffused light in some rooms instead of direct sunlight due to the orientation of the building.

The air quality of the rooms is very good. There is a wind circulating through the rooms and ventilates it, due to the reach green environment in and the surrounding site. It is sometimes too much in the upper floors when the windows are open. In relation to the air quality even if some rooms get the harsh sun, the thermal comfort of the units are good due to the well ventilated rooms.

The dampness condition in the building specially in the ground floor is worse during the rainy season compared to the dry season. The exterior walls are getting separated from the floor surrounding them. It give a way to the accommodation of storm water in between. The dampness in the upper floors is occurred from the leaks of wet areas and poor management of water in the next and upper unit houses.

The buildings in the Mekanisa-Kotari site have a good quality view to the surrounding green areas which satisfies the residents.

5.1.4 OUTDOOR ENVIRONMENTAL QUALITY

In the air pollution assessment of outdoor environmental quality a complain about an odor originated from the liquid waste treatment center. But it is insignificant during the site visit and the sub city's environmental protection office assessment who is assigned to check on pollutions of industries although the center's plant operator suggests that there may be

insignificant smell coming out, if there is absence of both electricity and a fuel for the generator which will be a long time coincidence.

The solid waste disposal points which is used as a transfer station take a little time and make the residents uncomfortable who pass along the area however the smell from the site doesn't get into the buildings.

In the direction of sound pollution in the site there are no huge factories producing large amount of sounds to pollute the site despite the fact that there are industry areas around Haile garment and also the industries do not have other recognizable pollutants like carbon dioxide emission or smoke.

The IHDP building uses a recycled material called Agro stone for partition walls; it is a good start of using recycled material in public housing since it is environmentally friendly material regardless of its poor resistance to water. The residents do not have a trend to recycle wastes but they reuse plastic and glass bottle which is a part of recycling too.

The other major component of outdoor environmental quality is access to open spaces which is widely developing part of the site. All the five compound of Mekanisa Kotari condominium have a good and well-kept green area which is accessible to all residents and also provide a fresh air, quality view and used as a buffer zone between the building blocks.

5.1.5 THE IHDP BUILDING

One of the physical conditions of the building assessed in this study is the building material condition. The slabs of the building are damp particularly in wet areas of the units and the area around them. It's because of the leak of the bathroom and kitchen accessories or due to ignorant use of water in the house. The wet condition makes the slabs very sensitive to pass a little amount of water to the other floor. In relation to this the walls near these wet areas are also moist and cracked. In some areas the outside of the building wall finishes are falling down.

The floors of the remaining parts of the building are in a fair conditions and also great if they have a floor finish on top. The window and door parts of the building are in good condition which in some places the sliding of the windows couldn't function due to the dust blocked the rails. The stair of the building is cracking in most building which force some of the residents to maintain it with a new granite floor finish because of the threat faced for the elders and children of the community.

The damp condition in the building, the falling wall finishes which expose the hollow concrete block unprotected, the breakage of the gutters and sewerage pipes and the cracking of the floor finishes contribute to a faster deterioration of the building.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

The aim of the assessment of environmental sustainability of the IHDP building in the case of Mekanisa-kotari site is to help on decision making process as it affects the human health & comfort, and development of new technology.

The mass housing provision called the IHDP to solve the housing problem in the process of the country's fast urbanization which has been implemented since 2006 for fourteen years is assessed in this study for the environmental sustainability of its buildings in the case study site. In order to sum up the main points and arguments that the research is executed on, research questions will be discussed as follows.

A. What is the building practice and activities of the IHDP buildings of Mekanisa-Kotari condominium?

The building practice of Mekanisa-kotari condominium with regard to developing sustainable sites, increasing water and energy efficiency, reducing waste and emission and using environmentally friendly building material are poor as presented in the analysis part. Since buildings are responsible for a lot of the world's energy waste and overall energy use the site management policies which focus on sustainable building practices should be prepared by government or housing agency and implemented by the end users of the building.

Using environmentally friendly building material such as the Agrostone panel for the partition walls which reduces the construction time, cost and uses agricultural waste materials based on the study is a great advancement and should be developed and also the use of environmentally friendly material should be applied in different parts of the building.

B. Which characteristics of IHDP contribute to sustainable development?

The characteristics of the IHDP building that is contributing to environmental sustainable development is the quality of indoor environment such as natural light, thermal comfort the good views, and air quality which reduce the use of energy to heat and ventilate the unit, The green area developed in the site which minimize pollution, habitat creation and environmental improvement, the adaptability and flexibility of the building due to the non-load bearing agro stone partition walls respond to changes at a lower cost which will be utilized more efficiently, and stay in service longer. The liquid waste treatment center is a good environmental sustainability practice of the site that minimizes or eliminates the pollution of rivers by filtering and clarifying the waste water before releasing into the natural stream or municipal drains.

C. What are the observed positive and negative environmental impacts of the IHDP buildings at the Mekanisa-kotari site?

One of the environmental impacts of the IHDP building assessed according to the component of green buildings is the dampness condition which can cause damage to a building. The unwanted moisture enables the growth of microbes such as molds, fungi and bacteria which cause health issues and may eventually lead to sick building syndrome. It also makes superficial damage to an internal & external wall Plaster and paint deteriorate.

As the site is a green filed development the prime farmland was considered for the building's location. Natural habitat should have been conserved and even maximized as part of the building design and construction however the effort of restoring green space and natural habitat has contributed substantially to keep the natural environment balanced.

The deterioration of the building parts in the superstructure are discussed in the analysis and finding part. The causes of the deteriorations are not clearly identified but moisture is one of the visible reasons and other defects on improper fittings and poor material qualities are the reasons which need a proper maintenance. Even though reinforced concrete is a low maintenance

building material with a useful life over 60 years, maintenance of the building is very important thing to protect the building from various deterioration factors.

The households who reuse waste water from washing clothes and rainwater harvesting in very few residents in the ground floor are performed depending on the scarcity of tap water nevertheless conserving water inside the housing unit should be intentional. since usable water is scarce resource rainwater harvesting, grey water reuse systems, fixing leaks and installing low-flow fixtures should be a trend.

D. To what extent are the IHDP buildings environmentally sustainable?

Environmental sustainability of a building can be summarized in to Effective protection of the environment and Cautious use of natural resource. Effective protection of the environment on the site are characterized by minimizing polluted emission from the liquid waste, good construction practice by using environmentally friendly material, and creating healthy indoor environments.

While there is a lot to do on use of natural resource such as on the use of renewable and recyclable resources to reduce energy consumption and water and waste minimization must be carefully considered.

6.1.1 Summary

Balancing all the three dimension of sustainability is an ideal since this study focuses only on the environmental sustainability and the high relationship to the social and economic sustainability it can't be categorized to some level. However due to the short period of the Mekanisa-kotari condominium building use compared to the planed useful time of the building it is in a poor environmental sustainability stage. A serious consideration must be given and the roles of actors to improve the buildings sustainability should be clearly identified since the residents and committee's on this site are not aware of what to do and who should be involved

while some impacts are happening. In general the buildings should be environmentally responsive and resource-efficient throughout the building's life-cycle.

6.2 Recommendations

The Mekanisa-Kotari condominium Buildings of the case study area as part of sustainable development of the city have been assessed from environmental sustainability dimension. Since buildings are infrastructure built to last for several decades, new construction is a significant investment that needs to be properly planned with a long-term vision of how it will benefit and do not harm to future generations. It is for this reason why understanding and planning for the future environmental impacts are so important for sustainable development.

As the study is intended to assess the environmental sustainability of the IHDP building some characteristics like green area development, liquid waste disposal, the indoor environmental quality which includes natural lighting, air quality, thermal comfort, quality view and the adaptability and flexibility of the building align with environmentally sustainable building characteristics and other building practices such as water efficiency, recycled material, solid waste disposal, dampness condition, durability and operation & maintenance of the building are negatively impacting the environment as indicated in the conclusion part.

The purpose of this study as mentioned at the start of the paper is that sustainability assessments are to gather and report information for decision making. The study has been performed at the use and operation stage of the building, during the assessment there are implication that leads to different stage of the building process which needs recommendation as follows.

➤ Recommendation on policy

There should be a policy or regulation at a national level to promote sustainable and environmentally friendly buildings or to force on attaining at least minimum sustainable building design requirement although there should be an environmental assessment tool in the country

which Ethiopia don't have currently to evaluate the building performances. Government should also prepare incentives for environmental performance of a building and should find a funding option for green/ sustainable building.

➤ **Recommendation on programing and planning**

In the programing and planning stage of a grand housing program like the IHDP, a department to meet the criteria on environmentally sustainable building should be established. Selection of design teams should incorporate an interested and experienced design team in a sustainable design.

➤ **Recommendation on design stage**

Environmental impact assessment of a project should be performed on the design stage in order to know all the pressures of a project in the environment starting from the selection of the site which affects biodiversity and environment specially the sites of a Greenfield development like Mekanisa-kotari condominium site.

Mixed use developments which enhance walking to different amenities should also be considered in order to minimize the air pollution caused by automobile smokes. Building orientations must be used for passive solar design, optimize wind and improve indoor environmental quality naturally.

Infrastructure design to support walking and alternative transports like bicycle should be considered by providing a bicycle parking spaces and green corridors and walk ways for walking purpose.

➤ **Recommendation on use and operation**

Developing previous surfaces and green spaces such as roof garden and trellises for minimization of urban heat island effects is advised. Rather than the use of potable water for the

green area development it is recommended to develop storm water management system for the site.

Developing on site renewable energy will also help to promote efficient energy use which can be used for site and parking lighting and different energy use of the communal spaces.

➤ **General Recommendation**

Sustainable building refers to both a structure and the application of processes that are environmentally responsible and resource efficient throughout a building's life cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. These responsibilities should be performed deliberately and consciously.

This study of environmental sustainability assessment is very significant as it is associated with people health and wellbeing which affects their day to day live and work in general leads to impacting the countries productivity.

The limitation of this study is its focus on the one dimension of sustainability which is environmental sustainability in order to make an entire sustainability assessment to know the efficiency and effectiveness of the case study site as well as the IHDP developed buildings, the economic and social dimension of the site must also be studied by other researchers.

In summary, sustainable development commits us to considering the long term. It encourages a continuing reflection on the implications of human activity towards environmental sustainability. It provides a new perspective from which to see the world. It is a perspective that forces many professions to work as a team. Environmental Sustainable practices need to be integrated into all construction activities for the future of the earth.

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APPENDIX A : KEY INFORMANTS

Interviewed House holds						
No	Name	Gender	Age	Ownership type	Type of housing unit	Floor Level
1	Ato Esamel Eliyas	M	57	Owner	1 BedRoom	G
2	w/ro Tsehay Biruk	F	48	Owner	1 BedRoom	+3
3	w/rit Hana Wubshet	F	38	Owner	2 BedRoom	+2
4	W/ro Belaynesh Kifle	F	55	Rent	3 BedRoom	G
5	Ato Tesfaneh wolde	M	59	Owner	2 BedRoom	+1
6	W/ro Marsh mulatu	F	28	Rent	1 BedRoom	+4
7	W/ro Fikirte Getachew	F	37	Owner	1 BedRoom	+1
8	Ato alemayehu Sisay	M	55	Rent	3 BedRoom	+2
9	Tewelde Mekonin	M	30	Rent	Studio	G
10	Ato Markos Gidabo	M	65	Owner	2 BedRoom	G
11	Ato Alemseged Belachew	M	42	Owner	2 BedRoom	+3
12	W/ro Mtke Nigatu	F	48	Owner	3 BedRoom	+4
13	W/ro Weynua G/silase	F	50	Rent	1 BedRoom	+2
14	W/ro Mekdes Dereje	F	34	Rent	2 BedRoom	+3
15	Ato Abdi Jemal	M	40	Rent	3 BedRoom	G
Commercial unit						
No	Name	Gender	Age	Ownership type	Business type	Business Name
1	Ato Sisay	M	58	Rent	Cafe	SisFam Cafe
Interviewed Committee members						
No	Name	Gender	Name of the Compound	Compound No.	Position	Experience in the position
1	Biniyam Esayas	M	Sefere Genet	5	G, service	4 Yrs
2	Bethelhem Mekonin	F	Selam	4	Secretary	1.6 Yrs
3	Debebe Woyesa	M	Shalom	3	Manager	3 Yrs
4	Hana Wubshet	F	Addis Brihan	1	Manager	1Yrs
5	Tadele Mogesse	M	Addis Hiwot	2	Supervisor	4Yrs

Interviewed Nifas Silk-Lafto Sub city and Woreda Officials				
	Name	Gender	Level	Position
1	Negash Alemayehu	M	Sub city	Environmental protection & Green area Development supervision and control team Leader
2	Seblewengel Tefera	F	Woreda	Government Houses Administration Officer
3	Kabtish Dejene	F	Woreda	Environmental Protection & Green area dev. Team leader
4	Jenber Belay	M	Woreda	Environmental pollution & climate change Team Leader
5	Mulusew	M	Sub city	Nifas silik-Lafto Housing agency

APPENDIX B : HOUSEHOLD INTERVIEW

ADDIS ABABA UNIVERSITY

EiABC

Interview Guide for Household

The main purpose of this interview is to gather information from the residents of Mekanisa-Kotari condominium building on the Environmental sustainability of the buildings. You have been selected to answer the questions as a part of the participant of the study.

Therefore, your cooperation to answer the questions, share your experiences and opinions is very important for the study.

Thank you!

PART ONE

PERSONAL INFORMATION

1. Sex: _____ Age: _____ . Educational Background: _____
2. Ownership type? Owner Rent
3. For how long have you been living in this condominium house?
4. How many family members live here?
5. What do you use the house for? Residence Commercial Mixed
6. Type of the housing unit? Studio 1 bed room 2 bed room 3Bed Room
7. Area of the house in m² _____
8. Do you take a walk to reach your house from work?
9. What type of transport do you use the most to travel to places?
10. Is there any mass transportation? Is it enough?
11. Is the site suitable for pedestrian movement and bicycles?
12. Is there a site management policy or rules?
13. Is there any environmental protection activity in your area?
14. Is the site clean and well-maintained?
15. Have you faced flooding both in site and home level while living in this unit of the
condominium building?
16. Do you monitor your water usage?
17. Is there Leaks in pipes and fittings inside the building?
18. Do you turn off water in between uses such us brushing, washing face & hands and washing
things?

19. Do you use Dual flush or low flow toilet?
20. Do you recycle water? How?
21. Do you collect and use rain water?
22. What do you use the most as a source of energy or for cooking?
23. Is there any action you take to conserve energy and resources? If yes what are they
24. Is there central sewer system? If yes where?
25. Do you recycle materials? Which ones?
26. Is the waste disposal system functional?
27. Do you think there is enough natural light in your house?
28. Do you think there is enough air and ventilation in your house?
29. Is there dampness or moisture in the house? If yes, Where? When? And how do you control it?
30. Do you hear too much noise from neighbor? If yes are there any sound proofing methods you use?
31. Is there a thermal comfort in the building?
32. Do you think you have quality views to the surrounding areas?
33. Is there a shortage of space? Were there any modifications you made to the house? And why?
34. Do you think the building you live in are durable?
35. Are the building components Fire proof?
36. Has the building materials deteriorated?
37. Is the building suitable for operation and maintenance?
38. Were there any demands that are specific to the Mekanisa-Kotari condominium? Are they

fulfilled? What are they?

39. Are there any exceptional or innovative things on Mekanisa-Kotari condominium?
40. Is there any pressure on environment?
41. Do you think that the building is environmentally sustainable?
42. What should be added or eliminated in order to make the design or building more comfortable for you?
43. Any suggestion or a comment that is not raised by the questions which you want to discuss?

Thank you again!!!

APPENDIX C : CONDOMINIUM COMPOUND INTERVIEW

ADDIS ABABA UNIVERSITY

EiABC

Condominium compound committee Interview Guide

The main purpose of this interview is to gather information from condominium committee on the Environmental sustainability of Mekanisa-Kotari condominium buildings. You have been selected to answer the questions as a part of the participant of the study.

Therefore, your cooperation to answer the questions, share your experiences and opinions is very important for the study.

Thank you!

1. Sex _____ Educational level _____ Position _____
2. How long do you stay in the position
3. What is the name of this corporate?
4. How many buildings are there in this compound of Mekanisa-kotari condominium?
5. How many households living in the area?
6. How many types of building based on the design are there in this compound? What are they?
7. When was the lottery of the residents announced?
8. When was it handed to the residents?
9. Is there any site development and improving plan?
10. Is there any site management policy given to the committee or residents to follow?
11. Is there any gray water recycling system on the site?
12. Do you recycle materials in the site? What type?
13. Is there any actions or training you take to conserve energy and resources? If yes what are they?
14. Is the waste disposal system functional?
15. What are the building materials used?
16. Is there any reported or threat of structural failure?
17. Were there any training given on how to use the buildings?
18. Is there any prepared document to control the quality of the existing buildings?
19. Do you think the residents are satisfied with the current building design? If yes, how is the level of standard evaluated? Is there any bench mark?
20. Are there any demands that are specific to this Mekanisa-Kotari condominium compound?
21. Are there any environmental protection activities in the area? What types?
22. Do you have any controlling mechanisms or periodical site visit?
23. Is there any challenge in managing, administering and controlling the condominium buildings in this compound?
24. Any suggestion or comments?

I thank you again!

APPENDIX D : ENVIRONMENTAL PROTECTION OFFICE INTERVIEW

ADDIS ABABA UNIVERSITY

EiABC

Interview Guide of Environmental protection office

The main purpose of this interview is to gather information from the environmental protection office of the **Nifas-silk Lafto sub city** and **Woreda** on the environmental sustainability of condominium buildings. You have been selected to answer the questions as a part of the participant of the study.

Therefore, your cooperation to answer the questions, share your experiences and opinions is very important for the study.

Thank you!

1. Name _____ Sex _____ position _____
2. Are there any environmental sustainability activities in Addis Ababa and at Mekanisa – Kotari condominium neighborhood? If yes, what types of activities?
3. When was it started? How?
4. What are the environmental protection activities on the site?
5. Is there any proclamation, agreement or policy to follow? If yes what are they?
6. Who are the actors of the environmental protection activities on the site?
7. What is the process? What are the actions you are taking?
8. explain the waste sewage disposal system
9. Is there any gray water recycling system on the site?
10. Is there any action you take to conserve energy and resources? If yes what are they?
11. Does the project use any renewable energy? For what purpose?
12. Is there any reported or threat of any environmental problem?

13. Were there any training given on how to use the buildings and surrounding in order to protect the environment?
14. Was there an attempt to do research on former condominium buildings on environmental pressure and energy and efficiency issues?
15. Do you have any controlling mechanisms or periodical project site visit?
16. Is there any prepared document to control the quality of the environment for the condominium site?
17. What are the future plans to minimize different environmental pressure?
18. Do you think the building is environmentally sustainable? How?
19. Any suggestion or comments?

I thank you again!

ANNEX 1: Publishable manuscript

Thesis Paper

ASSESSMENT ON ENVIRONMENTAL SUSTAINABILITY OF THE IHDP DEVELOPED BUILDINGS, IN THE CASE OF MEKANISA-KOTARI CONDOMINIUM HOUSING

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Abstract: Ethiopia is a second most populous land locked country found in east Africa. With the fast growing economy, urbanization and population the countries need to housing increased rapidly. Due to the increase urban population a high need of standard housing arisen which force the government to introduce a new program called Integrated Housing development program (IHDP) since 2006 providing housing opportunities for the mass population which are low and middle income families while fulfilling other objectives related to housing. The mass housing provision of the IHDP developed building must be assessed for sustainability in order to insure the effectiveness of the building in the long run that is why this study of assessment on environmental sustainability of the IHDP developed building is executed in order to examine and measure the environmental sustainability of the Mekanisa-kotari condominium site. The research takes a case study method performed in Mekanisa-kotari condominium with a quota sampling technique based on sustainable/Green/ building components compiled from international standards chosen for this research due to the lack of the countries own sustainable assessment tools. According to the data analysis the sites green area development, non-polluted air, good environmental quality on natural lighting, air quality, thermal comfort and quality view are the components which have a positive experience among the residents and which should be enhanced and supported by professionals and government the other components such as water efficiency, use of recycled material, solid waste disposal system, dampness conditions of the building, durability of the building parts and the operation & maintenance are impacting the environmental sustainability of the site and needs a quick interventions starting from policy, programing and planning, design and also use & operation of the buildings. Finally the study recommends some solutions to implement based on the assessed data on the current use and operation stage of the building.

Keywords: Sustainability; Environmental sustainability; IHDP; Assessment

1. INTRODUCTION

Rapid urbanization means increased use of resources and non-renewable energy and an increased built area. A high rate of rural urban migration accounts for about 40 percent of the growth. Coupled with rapid natural population growth, Addis Ababa has become one of the fastest growing cities on the continent, and faces multiple challenges, including environmental deterioration (HABITAT, 2008)

Taking in account the extent of housing problem, launching a massive housing development program is taken as one of the major intervention sectors in Ethiopia to reduce the poverty level of cities. This housing development program is not meant only to supply housing, rather it is envisioned to improve the wild urban poverty. The “Brundtland Commission” report, *Our Common Future*. Famously defines sustainable development as: ***development that meets the needs of the present without compromising the ability of future generations to meet their own needs*** (McManus, 2014).

Modern buildings in cities have high levels of energy consumption. Thus, unplanned and unsustainable urban development will lead to severe environmental pressures. Sustainability assessment is being increasingly viewed as an important tool to aid in the shift towards sustainability. The aim of sustainability assessment is to ensure that “plans and activities make an optimal contribution to sustainable development” (Verheem, R., 2002) Therefore the IHDP buildings which are seen as part of the urbanization process of the city to solve the city’s housing problem; on the way, to improve the urban environment must be assessed for sustainability.

This research is conducted in one of the sites of the integrated housing development program which is around Haile Garment called Mekanisa kotari condominium neighborhood. therefore the principal objective of this research is to examine and measure the Environmental sustainability of the IHDP Mekanisa-Kotari condominium buildings by Studying the Building practice and activities , analyzing the factors that affect the environmental sustainability and evaluating the impact.

2. MATERIALS AND METHODS

The case study method is used to understand the behavioral conditions through the actor's perspective and in order to answer questions of the research and to gain an in depth view of the topic the open ended questions will help the researcher to follow up on a particular issue, clarify concepts or check the reliability of data. By including both quantitative and qualitative data, case study helps explain both the process and outcome of a phenomenon case study method selects a small geographical area or a very limited number of individuals as the subjects of study and conducts an in depth study of issues.

Deep interview at the case study area is conducted on different levels of respondents starting from the Nifas silk-Lafto sub city and Ns/L sub city Woreda 1 government official to the end user of the building in order to get deep and elaborated answers. The Interviews are two types structured and non-structured type of interview depending on the area of the study and the research questions, Observation is also performed by the researcher and focus group discussions with committees and Other data collection methods such as images and photographs, drawings of CAD files, maps and Baseline maps will be collected from the Nifas silk-Lafto sub city, Woreda 1 and the

different government officials who are part of the project and have information to provide.

The data, after collection, has to be processed and analyzed in accordance with the outline laid down for the purpose at the time of developing the research plan. This is essential for a scientific study and for ensuring that we have all relevant data for making expected comparisons and analysis. Technically speaking, processing implies editing, coding, classification and tabulation of collected data so that they are amenable to analysis. Analysis of data in a general way involves a number of closely related operations which are performed with the purpose of summarizing the collected data and organizing these in such a manner that they answer the research question.

The data analysis will start by preparing and organizing the data collected after reviewing according to the criteria's listed in the frame work of this thesis, the data gathered by different formats like maps , photographs ,interview answers, researchers site observation and drawing files will be presented graphically by graphs, tables and narration in order to answer the research questions. Finally comparison and analysis will be made based on the framework for environmental assessment of a building for summarizing and conclusion purpose.

3. RESULTS

THE SITE AND HOUSE HOLDS

The Mekanisa kotari site is one of the IHDP developed building as an expansion site Expansion area sites like Mekanisa –Kotari have strengths in being bigger in scale for accommodation of more units relative to infill area projects. The inclusion of the private sector in the design and planning

process and provision of more time to preparation of LDP's NHD's and typology designs was a positive remark for a wider area of the housing typologies which differ from the former site of the IHDP buildings.

The households in the Mekanisa-Kotari condominium are mostly displaced households from the inner city redevelopment areas like teklehaimanot and sengatera and some of them are lottery winners by the Addis Ababa Housing agency (AAHA) and others are teachers who got a chance of owning the IHDP houses.

The site is near to the main round about and relatively near to the city center from other expansion sites it also has a variety of destination starting from the roundabout which makes transportation a lot easier. The public transportation available are public minibus, taxis and mass transportation system that is provided by Addis Ababa Anbesa Bus which is very suitable in a day times and a little bit crowded in rush hours. Nevertheless the residents need an additional public transport facility since the site is expanding faster and is getting accommodating a lot of households.

The site promotes walking from the last point of the public transport to the compounds of the condominium even if the three-wheels Bajaj's are available most residents choose to walk due to the higher fee of the bajaj unless it is very sunny or they have lot of loads, The site is also suitable for a bicycle riding since it is all coble stone paved but due to the bajaj transports and private cars moves a lot around the site the bicycle riders choose to ride in the playground inside the condominium compounds.

The site management policy of the association mainly focuses on how to administer the compound including monthly fees and other payments,

about parking ,security ,cleaning the surroundings and the rights and obligation of the users both the renters and owners of the building.

ENVIRONMENTAL PROTECTION ACTIVITIES

The environmental activities performed on the Mekanisa –kotari condominium is assigned for the Nifas-silk Lafto woreda 1 Environmental protection & Green area development office. The office is mandated for four types of environmental activities such as Green area development, Energy, Construction minerals and pollution of water, Air, Land or soil, Noise and Ray radiation.

The woreda’s green area development project office was promoted to a project office in 2012. The Office’s mandates were enacted into law by the City Government of Addis Ababa (Regulation NO.84/2016). However the Office does not have a given strategy or rules to implement the works. According to the team leader they are working in closer interaction with Mekanisa-kotari condominium committees by providing different type of vegetation’s and making them to plant in a design, supervision and support and helping to get water meters for the green area and they have visitation period two times in a month.

The other active office under the Environmental Protection office is the Environmental pollution and climate change office which regulates the pollution types listed above based on the given standard. The office also gives approval for some commercial activities in the site but mostly works to resolve complaints from the residents. Most reports come for a sound pollution problems due to loud music noises form Bars & Restaurants, Metal and wood workshops in the site. The office checks both in the night and day standards. In general the project office need to carry out awareness creation

and regular site visit in all dimensions of environmental protections which is also mentioned in the regulations

INDOOR ENVIRONMENTAL QUALITY

When natural lighting was assessed from the components of IEQ, an adequate natural light existed in all rooms of the condominium unit unless they use or cover the space provided for balcony. However some buildings get a diffused light in some rooms instead of direct sunlight due to the orientation of the building.

The air quality of the rooms is very good since there is a wind circulating through the rooms and ventilates which is due to the reach green environment in and surrounding the site sometimes it is too much in the upper floors when the windows are open. In relation to the air quality even if some rooms get the harsh sun the thermal comfort of the units are good due to the well ventilated rooms.

The dampness condition in the building specially in the ground floor is worse during the rainy season compared to the dry season due to exterior walls getting separated from the floor surrounding them which give a way to the accommodation of storm water in between and the dampness in the upper floors are occurred from the leaks of wet areas and poor management of water in the next and upper unit houses.

The buildings in the Mekanisa-Kotari site have a good quality view to the surrounding green areas which satisfies the residents.

OUTDOOR ENVIRONMENTAL QUALITY

In the air pollution assessment of outdoor environmental quality a complain about an odor originated from the Liquid waste treatment center is

disproved during the site visit and the sub city's environmental protection office assessment who is assigned to check on pollutions of industries although the center's plant operator suggests that there may be insignificant smell coming out, if there is absence of both electricity and a fuel for the generator which will be a long time coincidence.

The solid waste disposal points where they gather the wastes till they take it to other destination take a little time and make the residents uncomfortable who pass along the area however the smell doesn't get into the buildings.

In the direction of sound pollution in the site there are no huge factories producing large amount of sounds to pollute the site despite the fact that there are industry areas around hail garment and also the industries do not have other recognizable pollutants like carbon dioxide emission or smoke.

The IHDP building uses a recycled material called Agro stone for partition walls; it is a good start of using recycled material in public housing since it is environmentally friendly material regardless of its poor resistance to water. The residents do not have a trend to recycle wastes but they reuse plastic and glass bottle which is a part of recycling too.

The other major component of outdoor environmental quality is access to open spaces which is widely developing part of the site, all the five compound of Mekanisa Kotari condominium have a good and well-kept green area which is accessible to all residents and also provide a fresh air, quality view and used as a buffer zone between the building blocks.

THE IHDP BUILDING

One of the physical conditions of the building determined is the building material condition. The slabs of the building are damp particularly in wet areas of the units and also the area around them due to the leak of the bathroom and kitchen accessories or due to ignorant use of water in the house which makes it very sensitive to pass a little amount of water to the other floor in relation to this the walls near this wet areas are also moist and cracked in some areas which is showing off in the outside of the building and leads the wall finish to fall down.

The floors of the building are in a fair conditions and also great if they have a floor finish on top. The window and door parts of the building are in good condition which in some places the sliding of the windows couldn't function due to the dust blocking the slide. The stair of the building is cracking in most building which force some of the residents to maintain it with a new granite floor finish because of the threat faced for the elders and children of the community.

The damp condition in the building, the falling wall finishes which expose the hollow concrete block unprotected, the breakage of the gutters and sewerage pipes and the cracking of the floor finishes contribute to a faster deterioration of the building.

4. ANALYSIS AND DISCUSSION

The aim of the assessment of environmental sustainability of the IHDP building in the case of Mekanisa-kotari site is to help on decision making of the process as it affects the human health & comfort, the advancement of socio-economic status of the community and development of new technology.

The mass housing provision called the IHDP to solve the housing problem in the process of the country's fast urbanization which has been implemented since 2006 for fourteen years is assessed in this study for the environmental sustainability of its buildings in the case study site.

The building practice of Mekanisa-kotari condominium with regard to developing sustainable sites, increasing water and energy efficiency, reducing waste and emission and using environmentally friendly building material is poor as discussed in the analysis. Since buildings are responsible for a lot of the world's energy waste and overall energy use the site management policies which focus on sustainable building practices should be prepared by government or housing agency and implemented by the users of the building.

The start of using environmentally friendly building material such as the Agrostone panel for the partition walls which reduces the construction time, cost and uses agricultural waste materials based on the study is a great advancement and should be developed and also the use of environmentally friendly material should be applied in different parts of the building.

The characteristics of the IHDP building that is contributing to environmental sustainable development is the quality of indoor environment such as natural light, thermal comfort the good views, and air quality which reduce the use of energy to heat and ventilate the unit, The green area developed in the site which minimize pollution, habitat creation and environmental improvement, the adaptability and flexibility of the building due to the non-load bearing agro stone partition walls respond to changes at a lower cost which will be utilized more efficiently, and stay in service longer and The liquid waste treatment center is a huge environmental sustainability practice of the site that eliminates the pollution of rivers by filtering and

clarifying the waste water before releasing. One of the environmental impacts of the IHDP building assessed according to the component of green buildings are the dampness condition arising can cause damage to a building. The unwanted moisture enables to growth of microbes such as molds, fungi and bacteria which cause health issues and may eventually lead to sick building syndrome. It also make superficial damage to an internal & external wall Plaster and paint deteriorate.

As the site is a green land development the prime farmland was considered for the building's location. Natural habitat should have been conserved and even maximized as part of the building design and construction however the effort of restoring green space and natural habitat should be maximized in order to keep the natural environment balanced.

The deterioration of the building parts in the superstructure are discussed in the analysis and finding part. The causes of the deteriorations are not clearly identified but moisture is one of the visible reasons and other defects on improper fittings and poor material qualities are the reasons which need a proper maintenance. Even though reinforced concrete is a low maintenance building material with a useful life over 60 years, maintenance of the building is very important thing to protect the building from various deterioration factors.

The households who reuse waste water from washing clothes and rainwater harvesting in very few residents in the ground floor are performed depending on the scarcity of tap water nevertheless conserving water inside the housing unit should be intentional. since usable water is scarce resource rainwater harvesting, grey water reuse systems, fixing leaks and installing low-flow fixtures should be a trend. Environmental sustainability of a building can be summarized in to Effective protection of the environment and

Cautious use of natural resource. Effective protection of the environment on the site are characterized by minimizing polluted emission from the liquid waste, good construction practice by using environmentally friendly material, and creating healthy indoor environments.

While there is a lot to do on Cautious use of natural resource such as on the use of renewable and recyclable resources to reduce energy consumption and water and waste minimization must be carefully considered.

5. CONCLUSION AND RECOMMENDATION

The Mekanisa-Kotari condominium Buildings of the case study area as part of sustainable development of the city have been assessed from environmental sustainability dimension. Since buildings are infrastructure built to last for several decades, new construction is a significant investment that needs to be properly planned with a long-term vision of how it will benefit and not harm future generations. It is for this reason why understanding and planning for the future environmental impacts are so important for sustainable development.

As the study is intended to assess the environmental sustainability of the IHDP building some characteristics like green area development, liquid waste disposal, the indoor environmental quality which includes natural lighting, air quality, thermal comfort, quality view and the adaptability and flexibility of the building align with environmentally sustainable building characteristics and other building practices such as water efficiency, recycled material, solid waste disposal, dampness condition, durability and operation & maintenance of the building are negatively impacting the environment as indicated in the conclusion part.

The purpose of this study as mentioned at the start of the paper is that sustainability assessments are to gather and report information for decision making. The study has been performed at the use and operation stage of the building, during the assessment there are implication that leads to different stage of the building process which needs recommendation as follows.

Balancing all the three dimension of sustainability is an ideal since this study focuses only on the environmental sustainability and the high relationship to the social and economic sustainability it can't be categorized to some level. However due to the short period of the Mekanisa-kotari condominium building use compared to the planed useful time of the building it is in a poor environmental sustainability stage. A serious consideration must be given and the roles of actors to improve the buildings sustainability should be clearly identified since the residents and committee's on this site are not aware of what to do and who should be involved while some impacts are happening. In general the buildings should be environmentally responsible and resource-efficient throughout the building's life-cycle.

Sustainable building refers to both a structure and the application of processes that are environmentally responsible and resource efficient throughout a building's life cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. These responsibilities should be performed deliberately and consciously.

This study of environmental sustainability assessment is very significant as it is associated with people health and wellbeing which affects their day to day live and work in general leads to impacting the countries productivity.

The limitation of this study is its focus on the one dimension of sustainability which is environmental sustainability in order to make an entire

sustainability assessment to know the efficiency and effectiveness of the case study site as well as the IHDP developed buildings, the economic and social dimension of the site must also be studied by other researchers.

In summary, sustainable development commits us to considering the long term. It encourages a continuing reflection on the implications of human activity towards environmental sustainability. It provides a new perspective from which to see the world. It is a perspective that forces many professions to work as a team. Environmental Sustainable practices need to be integrated into all construction activities for the future of the earth.

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