
**ST. MARY'S UNIVERSITY**

**SCHOOL OF GRADUATE STUDIES**

# DETERMINANTS OF ENVIRONMENTAL SUSTAINABILITY OF CONDOMINIUM HOUSING PROJECTS IN ADDIS ABABA

**BY**

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**MAY 2019**

**ADDIS ABABA, ETHIOPIA**

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**A THESIS SUBMITTED TO ST.MARY'S UNIVERSITY SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF PROJECT MANAGEMENT**

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**APPROVED BY BOARD OF EXAMINERS**

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## LIST OF ABBREVIATIONS/ACRONYMS

CBs Condominium Buildings

CHPs The Condominium Housing Projects

EPA Environmental Protection Authority/ Agency

ES Environmental Sustainabilityy/ Environmentally Sustainable

ESBs Environmentally Sustainable Buildings

ESB Environmentally Sustainable Building

ESD Environmentally Sustainable Design

EPBM Environmentally Sustainable Building Materials

LEED Leadership in Energy and Environmental Design

## Abstract

*The growth rate of Addis Ababa's population has resulted in a chronic housing problem expressed in the growing slums, unsanitary living conditions and a degraded environment. The condominium housing project launched by the government in addressing this problem, even though it stands to save the city of worse environmental deterioration, has used the open and green spaces of the city; and being solely directed to solve the housing backlog, may lack environmental sustainability initiatives. The purpose of this study therefore was to investigate the perceived reasons for influencing environmental sustainability of condominium housing projects in Addis Ababa. Addis Ababa, where the study was conducted, is the largest city in Ethiopia with a great influx of people and high demand for housing. As such, environmental challenges resulting from Condominium housing projects are many. To accomplish its purpose, three sites – the Bole Gerji, the Gofa Mebrathaile and the Milifoni– were selected as case study samples. The study was a descriptive research as it investigated the perceived reasons for influencing environmental sustainability of condominium housing projects Therefore, a cross-sectional descriptive survey design was used. Qualitative and quantitative research methods were used for the collection and analysis of data. Methods of collecting data included questionnaires, interview schedules and observation. The data collected was analyzed by a mixed method of data analysis comprising both qualitative and quantitative methods. Recommendations were made and some conclusions were drawn from the results of the study. The questions asked design to discover how aware of environmental issues such as global warming and climate change the dwellers were. The results show that though dwellers are educated and aware of the issues of global warming and climate change, they have not taken the most optimal environmental sustainable measures they could. i.e., the long-term impacts of the measures taken to meet their immediate needs. The results from the site observations show that most open spaces are not used according to the original design; that the design was lacking in areas that could contribute positively to good indoor air quality and to the health and comfort of the dwellers; and that the materials used in construction are not durable. After the sites were delivered to the dwellers, in general, it can be said that successful environmental sustainability concepts undertaken by them are limited to greening their immediate surroundings.*

# CHAPTER ONE

# Introduction

## 1.1. Background of the Study

An ever growing awareness of the massive changes that our human societies are causing to our environments and planet Earth, increasingly calls for a fundamental change in our lifestyles. Governments, non-governmental organizations and concerned individuals call for sustainable living and seek ways to transition from our current lifestyle to a more sustainable way (Emaculate et.al, 2010).

Efforts to promote the application and utility of energy since the beginning of the 20th century have resulted in the invention of many types of energy-consuming active equipment and household appliances. Due to growing awareness of the vulnerability of the Earth's ecological environment, environmentalists have promoted energy-conserving passive design since the late 20th century. In the wake of the greenhouse effect and global energy crisis, the dawn of the 21st century has forced the world to confront the contradiction between energy-conserving sustainable passive design and energy consuming active design meeting the need for comfort. This has resulted in the new paradigm of intelligent energy use (Emaculate, et al, 2010).

Environment issue is an important aspect of sustainability. Now, we are facing the challenge of natural resource shortages, landscape and biodiversity depletion, and global climate change. There is a consensus that the construction industry has a considerable impact on the environment. It consumes both renewable and non-renewable natural resources and generates waste and emissions during construction and management of the buildings. In short, it has impact on the environment during the whole life time of building.

Ethiopia is undergoing a transformation. The East African state is prioritizing a wealth of construction projects in order to stimulate its economy. Construction is a huge part of Ethiopia’s economic recovery. The building sector has seen double digit growth, expanding by 37% annually, and is ushering in a new phase of development for the country. As the sector is growing rapidly, preserving the environment poses a host of challenges (UN-HABITAT 2008).

This problem should be well taken into consideration when it comes to residential buildings because it’s the place where people spend much of their time and where their entire health,

comfort and well-being is all at stake. Integrated housing development program(condominium housing) was launched in 2004( 1996 in Ethiopian calendar) with a target of constructing 175,000 residential condominium units in Addis Ababa and the construction is still ongoing at large scale (UN-HABITAT 2008).

The comprehensive building project, under the integrated housing development program, is meant to solve the huge housing backlog in the city of Addis Ababa. It will also create job opportunities for a great number of men and women; the construction helps the country's economy. It is home ownership for those the units of the condominiums are delivered to, and is wealth. But considering the environmental sustainability of the condominium buildings and the project in general, and taking measures to that effect in designing, constructing and making selection of sites harmony with nature is needed in relieving the planet of environmentally unsustainable development (Yewoinishet, 2007).

Environmental sustainability requires that we devise ways of how we can build the needed housing and still conserve nature. This can be done in the way we use energy, the needed water and other resources; by relying more on renewable resources; and by observing limits in the exploitation of non-renewable resources, understanding the threat to nature and the environment. This is what nature needs from us at a time when our reliance on the environment is proving to have become unsustainable.

## 1.2. Statement of the problem

According to the study by UN-HABITAT demand for housing in urban areas has been on the rise at a faster rate than the number of houses available or under construction due to high rate of rural urban migration that accounts 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. because Rapid urbanization means increased use of resource and non-renewable energy an increased built area. (UN-HABITAT, 2008)

The chronic housing shortage that is expressed in growing slum, deteriorated urban environment and a large housing backlog and the need for affordable housing and lack of financing finally prompted the intervention of the government. And introduce condominium housing program

launched in 2004 by the then mayor of Addis Ababa Arkebe Oqubay. But, no education or even an effort has been seen to introduce environmental sustainability. Some of the problems; There was no regard for the environment during site selection. Land belongs to the government; as such the government provides land for condominium housing projects in order to cut construction costs. Building sites were randomly selected for the project on open spaces in inner city.(Emaculate, et al, 2010).

With regard to sanitation and waste disposal the condominium housing project didn't meet it's intended target of creating a cleaner environment fully due to the ever increasing population in Addis Ababa in search of better opportunities and services the drainage and sewer pipes are frequently busting and blocked because they are failing to cope with increasing pressure. Designers did not consider the size of the pipes in anticipation of the proportion of the number of condominium housing units built (Addisalem, 2009).

This study therefore sought to investigate the determinants of environmental sustainability of condominium houses in Addis Ababa. focusing on the selected sites in Addis Ababa. the study sought to fill in the research gap.

## 1.3. Research Questions

1. How do perceived socio-economic factor to influence environmental sustainability of condominium housing projects in Addis Ababa?

2. How do environmental awareness influence environmental sustainability of condominium housing projects in Addis Ababa?

3. How do mitigation measures influence environmental sustainability of condominium housing projects in Addis Ababa?

## 1.4. Objective

### 1.4.1. General objective

The study aim at investigating the determinants of environmental sustainability of condominium housing projects in Addis Ababa.

### 1.4.2. Specific objectives

- To Identify how socio-economic factor influence environmental sustainability of

condominium housing projects in Addis Ababa.

- To identify how environmental awareness influences environmental sustainability of condominium housing projects in Addis Ababa.
- Assess how mitigation measures influence environmental sustainability of condominium housing projects in Addis Ababa.

## 1.5. Significance of the Study

This study investigates the perceived reasons for influencing environmental sustainability of condominium housing projects in Addis Ababa. It is hoped that findings of this study, benefit and create more awareness among condominium Housing project developers, government, contractors, project managers and other organization dealing with environmental sustainability of integrating housing projects. It can also be a part of a case library study related to sustainable condominium housing as a reference material for similar studies in the future. For the public/reader, it can help create awareness about environmentally sustainable housing and shed some new insight on the benefits of sustainable construction and renovation, and promote willingness to achieve environmental sustainability. The thesis can assist responsible bodies to assess the strengths and weaknesses of the condominium housing construction process. And hopefully, it can inspire researchers for further study in the area.

## 1.6. Scope of the study

The concept of sustainable development has been analyzed in theory and application from different perspectives. Sustainable development is defined as a set of indicators in the multi-criteria analysis to include environmental, social and economic aspects, and it provides information dealing with economic, ecological and social components of sustainable development with analysis focusing on the aggregated indicators on air pollution variation, income, energy consumption and selected social indicators.

In this thesis, consideration was given to the environmental aspect of sustainability and its relation to socio economic factor because it is the fundamental idea that designers, consultants, contractors, government and the society as a whole need to put in mind in their way of moving towards achieving sustainability.

## 1.8. Organization of the Thesis

Structurally, the paper was composed of five chapters. The first chapter presents introduction. which includes background of the study, problem statement, research objective, research questions, significances of the study and the scope and limitations of the study. The second chapter reviews literature on the environmentally sustainable building concept. The third chapter states how the study was carried out and what methodology was used regarding each objective of the research. With this background, the report presents analysis and interpretation of the data gathered in the Fourth chapter. Finally, in the sixth chapter, the conclusion and important recommendations are provided.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1. Theoretical Literature

### 2.1.1. Sustainability Building Definition

A sustainable building is defined as a building with minimum negative impacts on the natural surroundings, materials and resources. This kind of building does not deny human needs because it considers human existence to be part of nature; rather, it is constructed in line with the idea that humanity can exist, multiply, build, and prosper with nature and the earth's natural processes without damaging the long term habitability of the planet (Press, 2006). In order for a building to be considered as a sustainable building, it must display certain characteristics and probably needs to be assessed under a rating framework.

Sustainable buildings reduce the destruction of natural areas, habitats, and biodiversity, air pollution, water pollution, solid waste and they lower operating, maintenance, and environmental costs. The use of natural resources is minimized because renewable energy sources are used instead of non-renewable natural resources. This kind of building minimizes negative outdoor environmental impacts such as greenhouse gases, global warming and acid rain as well as maximizing the quality of the indoor environment and thermal comfort. A sustainable building also generates better long-term economic value and greater human satisfaction and productivity (Garzone 2006).

As the product of construction industry, building is an essential thing for every people's life especially residential building, which can not only provide a shelter for people to live in, but also recently, is treated as a work place, such as SOHO small office home office, which means work at home (Kilbert 2012).

When it is adapted to sustainable development of residential buildings, the definition can be translated as "design of sustainable residences has to satisfy the needs of the present without compromising the ability of future generations to meet their needs of having a good living condition."

The definition of sustainable development set in 1987 plays an important role. By using the

adapted definition, the sustainable development of residential building can be guided to a positive direction. Moreover, the number of residential building is large and special for living, which is the corner stone of people's happiness. And the sustainable residences will definitely push the whole sustainable development forward and the whole society to a higher and comfortable living condition

### 2.1.2. Housing and The Environment

Buildings are the source of half the world's green house gas emissions making them the largest contributor even more than manufacturing and transportation. Such emissions would increase by 37% by 2030 if actions in making them sustainable are not taken (Yudelson, (2007)

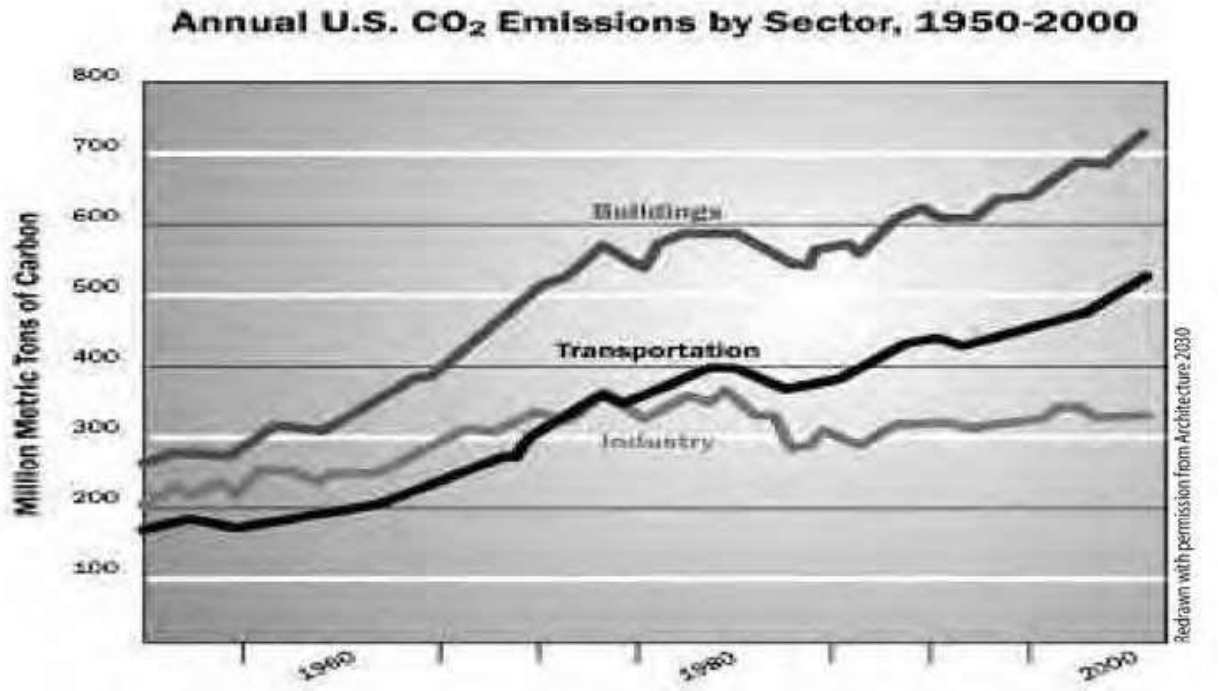


Figure 2.1. Greenhouse gas emission of buildings, transportation and industry (Source: Yudelson Jerry 2007).

The challenges of the urban environment posed by housing are more pronounced in the developing world. Rapid urbanization, and with it, the large slum areas, deteriorates the urban environment through unplanned and therefore, unsustainable settlements. Such settlements are characterized by poor water, air and soil quality and lack of access to sanitation, creating a troubled urban environment (Emaculate et.al, 2010).

### 2.1.3. Environmentally Sustainable Design

Sustainable design is one that could bring about a low to none nonrenewable energy use and that conserves resources. In general, ES strategies during construction ensure the health of both the occupants and the environment during the use of the buildings. A high performance building is one that saves at least 50% of the energy use of a standard building. Reducing energy consumption requires utilizing natural site advantages and choices in envelope which will impact cooling and heating and how much we can exploit energy options, such as sunlight or wind (Yudelson, 2007).

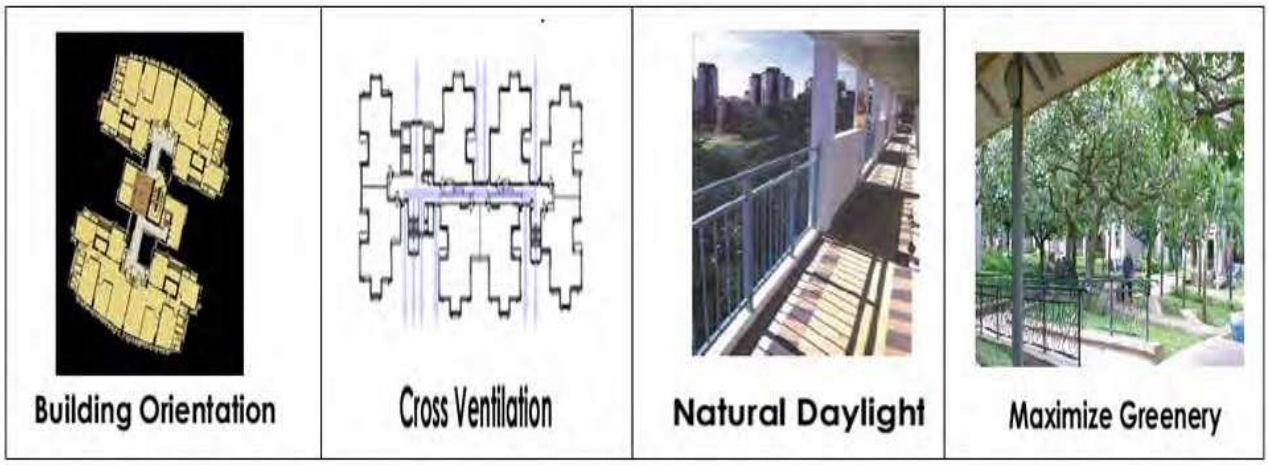


Figure 2.2: Utilizing natural solutions. (Source: Dr Johnny Wong Liang Heng)

A ventilation system based on the natural movements of air in reducing cooling and heating loads and to ensure indoor air quality, has three components:- air inlets air outlet points and an outlet at roof level. (Towers, 2005)

Other factors that should be considered in sustainable design are maximum use of natural light and green areas. Green areas is discussed below in case of natural light the building's long axis should be oriented east to west, as this allows maximum sun lighting both from north and south- facing windows (Yudelson, 2007).

### 2.1.4. Sustainable Renovation

Renovation (also called remodeling) is the process of improving a structure. We understand the word' renovation' is generally used to cover remodeling, modernization, restoration, retrofitting and rehabilitation, each of which is a method for renovation.

According to Latour (1999), renovation design has two emphases: immutable and mobile.

Immutable refers to the old, respecting the history and culture of the building, and mobile refers to the new, satisfying the modern requirements. They are equal items, putting onto each side of a balance. And for renovation of residential buildings, people occupying the residences need to be carefully thought.

Renovation refers to reuse of an existing construction (including structure and components etc.) on the site, integrate its structure, and possibly upgrade it or extend it. It is now relatively common in the field of heritage structures as they are seen to have cultural value. While in many other existing building with little historic or cultural values, renovation is also possible to improve their quality.

Renovation may fill the gap between simple housing maintenance and demolition because it provides opportunities for establishing closed loops for the usage of buildings. It is an important tool for usage of buildings shifting from 'cradle-to-grave' to cradle-to-cradle, which means 'Renovation' can provide opportunity for buildings to be reborn through reusing some old components that are still reliable, and upgrade some elements that should 'retire'. In this case, renovation can be seen as the corner stone of the 'loop'; or in other word, 'renovation' play a key role for building reusing.

## 2.2. Problem in existing buildings

Although green buildings represent the next phase of buildings, the reality is that the vast majority of buildings are not green, and these buildings will continue to be used for many years to come. Improving the energy efficiency of existing buildings typically involves a process called retrofitting, which can mean anything from installing more energy-efficient fixtures to increasing the amount of insulation in a building. While greening existing buildings does not receive the attention that new green buildings do, it is certainly more important when looking at reducing the environmental impacts of buildings nationwide.

## 2.3. Impacts of conventional buildings

The environmental impacts of buildings are enormous. Conventional buildings use large amounts of energy, land, water, and raw materials for their construction and operation. They are responsible for large greenhouse gas (GHG) emissions as well as emissions of other harmful air pollutants. They also generate large amounts of construction and demolition (C&D) waste and have serious impacts on plants and wildlife. An analysis of these issues demonstrates the scope

of the problem. The most important impact of buildings and building products has been shown to be: Global warming, Resource depletion, Indoor air quality and Ecological toxicity.

Buildings and building materials have a large impact on the environment during their lifetime. There are different methods for calculating these environmental impacts and a lot of research has been done which gives quantitative data about them. For example, Junnila and Horvath (2003) did a research on a new high-end office building over 50 years of service life to find out its environmental impact. Furthermore, a lot of research compares different building materials to discover which are the most eco-friendly to use in building construction. Gustavsson and Sathre (2005) studied a wood and concrete framed building to find out which was the more environmentally friendly material based on their energy consumption and CO2 emissions for manufacturing, and their use. This research showed that wood is more eco-friendly than concrete. Further research was done by Vukotic et al. (2010) who compared two simple single storey structures to each other. The first building was a timber load-bearing paneled wall, and the second one was a steel frame building with concrete block work. The aim was to find out the embodied energy and carbon dioxide of the buildings over their lifetime, and to find out which stage of a building's life consumes the highest amount of embodied energy. The result showed that a timber framed building was more efficient, and the end of a building's life is its most important stage.

Therefore all this research shows that buildings have a large environmental impact during their life and it is our duty to decrease these environmental impacts to protect the world foe current and future generations. So many researchers have tried to find a way to decrease these environmental impacts, and sustainable development is a solution.

## 2.4. People in different fields involvements

The application of the measures aimed towards achieving sustainable construction requires close cooperation among various professionals, policy-makers and other stakeholders (Bakens, 2003).

- Government is an important player for sustainable construction because they are the rule-makers and can create the institutional environment for sustainable renovation. The positive policies issued by government can incent sustainable projects develop or vice versa.

- Client is the one who starts and plans a construction process, pays for it, make the final decision and chooses the designers, consultants, contractors and suppliers. Their attitude and ideas will

determine the direction of the whole project.

- Designers and consultants not only refers to architects, but also engineers and other specialists. Other specialists include building archaeologists or restorers for historical investigations, social experts and even professional photographers. They should form a trans-disciplinary team and have close cooperation with each other.

- Contractors have responsibility to create good site environment, reduce impact to surrounding environment and increase the productivity of site work through advanced managerial method. Suppliers, as the partner of contractors, should well cooperate with contractor, such as transport material to site in time and keep quality of material in a high level. Moreover, suppliers have to remember that they also have a responsibility to lower the emission and impact of materials during their transportation.

- Users should be well communicated so that they can understand the benefit of renovation before any renovation process is initiated. Cooperation relationship should be setup during the design process between designers and occupiers, in order to have a better understanding of the existing building. Pearce (2006) stated that residents' opinion sometimes is better than scientificresearch. After renovation, occupiers should be given enough information to use new installed equipment in a right way to realize sustainability.

## 2.5. Components of Environmental sustainable buildings

Green buildings are known to have 5 major distinguishing characteristics using LEED method of certification those are ES site development, promote efficient use of water resources, conservation of energy and renewable energy use, conserve building materials and reduce construction waste, and protect and enhance indoor environmental quality (Yudelson, 2007). US EPA adds to those listed above recycling and optimization of operational and maintenance practices under components of ESBs. (EPA, 2011). In general based on the environmental threats and the need to conserve resources and protect natural surrounding the following are agreed up on components of ESBs and they are discussed one by one:

**Optimize site potential**

Environmental sustainability of a building begins with site selection. There are several issues/aspects that should be taken into consideration when selecting a site. These include

using a previously used and developed site rather than clearing a new site; exploiting potentials in using renewable and clean energy options; and exploiting naturally cooling, heating and ventilation options. These are factors that should be considered during site selection (Yudelson, 2007).

Other than the more important environmental significance in reduced carbon emission and in saving the non renewable resources such as fossil fuels that could have been used, energy sources that are clean, such as hydroelectric power, solar power, wind power and bio fuel have a long term benefit in being more sustainable. According to Smith, the combustion of fossil fuels and deforestation since the industrial revolution has increased the carbon dioxide concentration in the atmosphere by 26%. Therefore, incorporating the use of renewable sources of energy into the design of a building will lead to energy efficiency and a better environment (Smith, 2005).

**Energy efficiency and renewable energy**

Other than the more important environmental significance in reduced carbon emission and in saving the non renewable resources such as fossil fuels that could have been used, energy sources that are clean, such as hydroelectric power, solar power, wind power and bio fuel have a long term benefit in being more sustainable. According to Smith, the combustion of fossil fuels and deforestation since the industrial revolution has increased the carbon dioxide concentration in the atmosphere by 26%. Therefore, incorporating the use of renewable sources of energy into the design of a building will lead to energy efficiency and a better environment (Smith, 2005).

Renewable and non renewable energy Renewable resources of energy are those that can be grown or harvested at a rate that exceeds the rate of human consumption. Using these materials is, by definition, sustainable. The wind and the sun are good examples of sources of renewable energy. Currently, non- renewable energy usage is largely and primarily the burning of fossil fuels as a source of energy. This energy is exhaustive and is being exploited at a rate that exceeds its regeneration. Such energy sources are also a prime source of greenhouse gas emissions (Jin Kim and Rigdon, 1998)

**Water efficiency**

Another aspect of ESBs is that they are water efficient. As water is a scarce resource, efforts for its conservation are one way of identifying ESBs. Water efficiency also means reduction of the

carbon emission that could have been had in the production of the water and also reduced demand for chemicals used to treat potable water. Other measures regarding water efficiency is recycling the used water in the building and using rain water. Measures meant to lessen use of the water using systems that greatly reduce water use could also lead to conservation of the resource (Towers, 2005). Treating waste water and recycling it reusing brings to use the waste water buildings generate other than being disposed off threatening environmental pollution. Gray water a waste water other than from toilet and food wastes (Wudneh, 2009) is treatable at site or could be reused for different purposes such as cleaning, irrigation, floor washing, car washing, gardening, and for construction after treatment.

Gray water:- "…Water used for washing can be collected from sinks, washing machines, basins, baths and showers. It is then passed through a simple filter to remove any large solid particles, and collected in a tank. Grey water is very suitable for flushing toilets and can be used for other purposes such as watering plants…." (Towers, 2005)

**Environmentally preferable building materials**

Another component of ESBs is the use of environmentally preferable building materials (EPBMs), which are characterized by relatively low carbon emissions during production of the materials. Globally, building construction consumes 40% of raw stone, gravel, and sand each year and 25% of the virgin wood raw materials (Lauren E. Abraham, et. al, 1996 p. 25), indicating how much significant reduction in the carbon emissions during production and transportation of these materials would mean to the environment. The principle of life cycle design encourages recycling materials and reusing materials during demolition/deconstruction. This guarantees reduced carbon emissions and therefore a better environment (Jin Kim and Rigdon, 1998).

**Recycling**

Recycling means "resorting to using materials that could have been disposed of"; in other words, it is conservation of resources and avoiding the carbon emissions that we could have had during extraction and production. To ensure overall reduced carbon emissions and resource conservation the use of recycled materials for construction brings to use materials that could have been disposed off at the same time saving energy and resources. Waste recycling is one

way of bringing to use the waste that buildings commonly generate with the same effect of resource and energy conservation (Towers, 2005)

Recycling building materials:- The use of recyclable materials is one way for reduced carbon emission of buildings avoiding the carbon that would have been emitted during the extraction of resources and also during the production. The use of recyclable building materials brings to another use demolished buildings lowering the overall carbon emission of buildings. (Jin Kim and Rigdon, 1998)

**Waste reduction**

Another quality of ESBs is that during construction materials are used efficiently so that waste is reduced. This is done by using less packaging, using recycled materials and reusing building materials and construction debris on the construction site. These not only reduce waste, but also decrease the need for landfills and conserve resources. A further strategy in reducing waste during the construction of an ESB is using prefabricated materials (Lauren E Abraham, et. al, 1996).

**Indoor air quality**

The design and the construction process and building materials used affect the indoor air quality. But other than that the building envelope, ventilation systems, maintenance and occupants are controlling factors that ensure better indoor air quality (Lauren E. Abraham, et. al, 1996).

**Optimization of operational and maintenances practices**

The operation and maintenance cost of a building throughout its life span far exceeds its initial construction and design (Lauren E Abraham, et. al, 1996). ES of the building can only be preserved if operation and maintenance practices in making them sustainable are considered. This requires training of building occupants; using clean products so that no toxic material will be involved that will cause damage to the environment, indoor air quality, conservation of resources, and reusing and recycling.

## 2.6. Green Areas

Trees bring different benefits at relatively low cost both in mitigating the UHI effect and other

environmental consequences. Trees cool the city, lower energy cost; reduce the amount of flooding, erosion, and pollution. And as a result trees and plants in general are the most effective means to combat UHI effect. (Abof, et al, 2010) The evaporation from the plants has a cooling effect and they serve as a shade protecting the urban surface from absorbing heat. (Abof, et al, 2010).

Green areas provide a natural solution to greenhouse gas emissions and in dealing with global warming. More vegetation means we will be more prepared in absorbing carbon; but housing projects have an impact of destroying the natural environment, emphasizing therefore, the importance of green areas such as space provided for greening, vertical greening and green roofs.

### 2.6.1. Vertical Greening

Vertical greening is the process of replacing a green area that has been lost when erecting buildings. The vegetation on and greening of a side of a building at the façade of each floor, is one way this can be accomplished (Dr Johnny Wong Liang Heng, presentation) and can be used in several ways: as windbreaks, to absorb carbon dioxide and to generate oxygen. If appropriately integrated into the building structure, it could play a significant role in improving the comfort of the occupants (U.S. Army corps of engineers, et, al, 2007). Still, using simple structures buildings could be used for some greening and if it become a culture to save the urban environment from falling into a completely built area. Vegetation plays a role in moderating temperature and its effect can be seen both in the building and in the surrounding area to reduce the urban heat island effect There are three ways for structural design of vertical greening: Climbing plants with adventitious roots, Trellis system and Modular system. In case of climbing plants with adventitious roots the choice of vegetation is limited to those which can support themselves on the wall. In trellis system plants climb by twining on the curtail effect created through cables attached to the wall. The growing plants and irrigation system as part of the building is supported by the wall through the design of the building devised for the purpose in the modular system (Cheetham, et al, 2012).

### 2.6.2. Green Roofs

Turning the roofs of buildings into greening of open space for vegetation could do its part in offsetting the impact the building left on the natural environment that is other than avoiding the heat absorbing effect the building may have. The two types of vegetated roofs are extensive (six

inches or shallower) and intensive (more than 6 inches) (U.S. Army corps of engineers, et, al, 2007).

## 2.7. Empirical Literature

**The Level at which Environmental Awareness Influences Environmental Sustainability of condominium housing projects in Addis Ababa**

Environmental awareness flows from environmental education. A landmark for environmental education at the international level was the International Conference on Education organized by UNESCO and UNEP at Tbilisi in former USSR in 1977. Goals of environmental awareness were defined as: creating environmental awareness, impart general knowledge for basic understanding of environment, acquiring environmental friendly attitudes and values and creating new patterns of behavior towards the environment. Agenda 21, Chapter 36 which is devoted to environmental education states that "education is critical for promoting sustainable development and improving the capacity of people to address environment and development issues".

With environmental education comes information which provides data sources crucial for measuring the environmental performance of real estate portfolios. Information can help developers in terms of proper choice of place for building condominium housing projects, using building materials that are environmentally friendly and adopting ways of making condominium houses environmentally sustainable like usage of renewable resources, recycling of water and waste, planting of trees around the premises and many more (Hoerisch, 2002).

**The Influence of Socio-Economic Factors on Environmental Sustainability of condominium housing projects in Addis Ababa**

Socio-economic factors - also widely spoken of as socio-economic status (SES) - denote relationship between economic activity and social life. Basically, SES has three indicators namely financial resources or income, employment or occupation and level of education (Loomis, 2000). These indicators can determine environmental sustainability of condominium housing projects as follows:

A simple economic theory states that there is a correlation between production and consumption. Production and consumption are related to financial resources or income. The relationship is that

the more the income, the more likelihood the production and consumption. In order to preserve the environment, there is need to strive for sustainability in consumption and production patterns as these can reduce the use of natural resources and carbon dioxide emissions and in the long run achieve low carbon lifestyles and green economies. As such, the global community has to adopt more sustainable consumption and production patterns in order to alleviate some of the environmental challenges that we face (Loomis, 2000).

To improve Addis Ababa's environmental performance, a better understanding of socio-economic and behavioral forces driving unsustainable production and consumption is required. Economic growth, as measured by per capita national income, affects environmental quality (Constatini & Martini, 2010). As economy expands, environmental damage increases. However, a number of variables vary monotonically with income and in different directions according to Shafik (1994); for example access to safe water, sanitation, clean energy like solar panels and sustainable building materials show improvement with economic growth whereas there is an indication that CO2 emissions and waste generation deteriorate. Evidently, the richest countries' carbon emissions and resource consumption are continuing to increase beyond sustainable levels whereas some developing countries appear to perform better than developed countries from the environmental point of view (Moran, et al., 2008).

As such, economic growth may not necessarily be beneficial to environmental quality. Income distribution rather than average levels of income maybe critical determinant of environmental degradation.

Afroz, Keisuke and Tuddin (2010), conducted a study to obtain information on waste generation, socio-economic characteristics and willingness of the households of residential estates towards separation of waste. From 402 respondents in Dhaka City, it was discovered that dominant factors that influenced waste generation of households included household size, income, concern about the environment and willingness to separate waste. In order to improve waste management and reduce the environmental degradation in condominium houses, these factors must be controlled.

One of the major contemporary problems of our time concerns the challenge encountered in making sure that natural resources are consumed and waste is produced at sustainable rates. In spite of the endorsement in 2000 of environmental sustainability as one of the Millennium

Development Goals to be achieved by 2015, global rates of consumption and waste production were estimated to be at least 25% higher than the capacity of the planet to provide to provide resources and absorb waste. This rate rose to 50% by 2007 (Emerson, et al., 2010). One way of achieving environmental sustainability is social change through societal transformation. Spending is usually connected with occupation. For instance, those with lucrative occupations would tend to produce more in terms of waste and buy high polluting expensive cars to match their status in society.

**The Influence of Mitigation Measures on Environmental Sustainability of Condominium Housing projects in Addis Ababa**

Condominium Housing projects come with negative impacts like displacement of existing land uses and destruction of environmentally critical areas. They can also be a danger to residents by introducing hazardous conditions like air, water and noise pollutions, excessive depletion of resources such as fuel or timber which reduces forest cover and many more. As such,mitigation measures are taken to ensure environmental sustainability of condominium houses. There are a number of mitigation measures that can be taken to ensure environmental sustainability of condominium houses. According to a study conducted by UN-Habitat (2012) concerning ecological housing in Setagaya-Ku Fukasawa in Tokyo, Japan, it was found that there were many environmentally sustainable estate houses in 2007 in Japan with high levels of thermal insulation, solar collector for heating and solar cells. There were also rain water collection equipments installed, wind turbines attached, heating and cooling methods applied and the design was made according to the local wind patterns to enable natural ventilation during hot and humid summers. It was also found that green cover was increased by preserving trees and installing green rooftops which acted as carbon sinks by offsetting carbon dioxide through the process of carbon sequestration. Some of the mitigation measures that can be taken to ensure environmental sustainability of condominium houses include: Reducing, Recycling and Re-Using of Waste is another mitigation measure that can enhance environmental sustainability of condominium houses. Waste is an item or substance which has no utility value to the holder of the item. It may include any matter whether liquid, solid, gaseous or radioactive discharged, emitted or deposed in the environment in such a volume likely to cause alteration of the environment (Environmental Management and Coordination Act, 1999).

## 2.8. Conceptual Framework

In order to enhance environmentally sustainable housing in Addis Ababa city, it is conceptualized that reasons such as environmental awareness, socio-economic and mitigation measures need to be re-looked with the aim of striking a balance. The result of this synthesis will be an increase in awareness of environmental conservation issues and mitigation measures when engaging in Condominium house projects, reduction of environmental degradation and an increase in sustainable real estate housing just to mention a few.

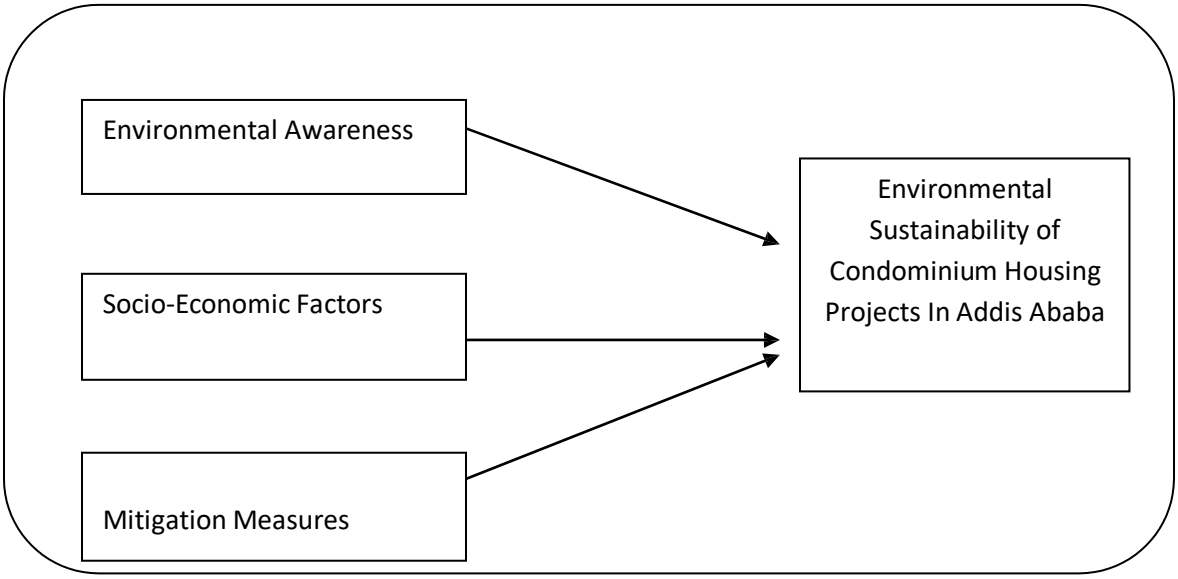


Figure 2.3 Conceptual Framework

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.1. Research Design

To conduct this study the researcher used descriptive research to investigate the perceived reason for influencing environmental sustainability condominium houses. As such, the study used a descriptive survey research design. There are different types of survey research designs; this study used a cross-sectional type of survey whereby different groups of people who differ in the variable of interest, but share other characteristics were asked questions about their experience on environmental issues.

## 3.2. Research Method

### 3.2.1., Sampling Techniques, Target Population and Sample Size

This study used non probability sampling technique because it is impossible to address all of the population because of time and resource constraint .From non –probability sampling the study used Purposive sampling technique, the reason for using these method is it can help to select the sample based on the objective of the study.

Three sites were purposively selected as case study sites. They are the Bole Gerji Site, the Milifoni Site and the Gofa mebrathaile site.

- The Bole Gerji site is selected for several reasons. Firstly, because it was the first site that offer services to the public. the site had been in use for roughly 15 years since inauguration at the time of the study.
- The Milifoni site located around Torhailoch, and A lot of trees surround this buildings given them aesthetic qualities. The first qualities observed from this building are: it was clean on the outside; it has sufficient amount of vegetative cover in the area and it is located in a very suitable area close to markets, schools, transport and cafés.
- The Gofa Mebrathaile site is selected for the following reasons. Because it is the latest of the sites and therefore any environmental sustainable building concepts considered and implemented by the government.

The size of the sample was selected as representatively as possible to minimize sampling error. A minimum sample size of 100 respondents will be taken. The minimum figure arrive at after

considering the finances available for data collection and the length of time available to collect data. Thirty dwellers from each site were selected using simple random sampling technique. The thirty dwellers chosen from each site considered to be a sufficient sample because it is assumed that most would have relatively similar views about the condominiums. The Remaining 10 respondents were contractors and government officials.

### 3.2.2. Sources, instruments and procedures of data collection

This study conducted both qualitative and quantitative data for investigation. The purpose of quantitative is to quantify the investigation situation by using statistical procedure. Whereas qualitative data described the phenomenon by using descriptive form.

To collect those qualitative and quantitative data the study used primary and secondary source of data, primary source of data was collected from interview, questionnaires, b/c the researcher can collect precisely the information they want, it is fresh and first-hand information use. The secondary source comprises the literature review, was collected by reviewing different research works and texts dealing with the environmental sustainable building concepts

In order to collect the required data the researcher used well-designed structure questionnaires. The design of the questionnaire is prepared in simple and clear language to collect meaningful data from the respondent. The questionnaire involves closed ended and open ended question. Beyond close and open end question the study used structured personal interview to collect data from the six site contractors and four government officials. The basic reason of using personal interview and questionnaire is to obtain detail information, to get explanation and it creates an opportunity to improve the quality of information.

### 3.2.3. Data Analysis Technique

The data was analyzed by using a mixed method of data analysis which involved both qualitative and quantitative data analyses. The first step in analyzing the data collected was to summarize the data using descriptive statistics which is quantitative analysis. This enabled the researcher to meaningfully describe distribution of scores or measurements using a few statistics. Since the study involved research questions and objectives qualitative method of data analysis was also used to achieve this. Qualitative analysis was used for all data that was not quantifiable. This was done in a systematic way in order to come to some useful conclusions and recommendations.

## 3.3. Validity of Data Collection Instruments

Validity is about how accurate the data obtained in a study represents the variables of the study. In order to ensure that the data gathered from the dwellers is concrete, meetings were conducted with the management committee of all three sites. Furthermore, in the interview, in order to verify that the dwellers understand the questions, they were given an opportunity to further explain if they answer 'yes' to questions.

# CHAPTER FOUR

# DATA ANALYSIS, PRESENTATION AND INTERPRETATION

## 4.1 Introduction

This chapter focused on presentation, interpretation and analysis of findings based on primary data collected from the respondents using questionnaires, interviews and observation guide. A critical analysis of each objective was done. From the data obtained, inferences and deductions were made in relation to the research objectives. The findings presented in this chapter have been discussed under thematic areas and sub-sections in line with the study objectives. The thematic areas include: study demographics, environmental awareness, socio-economic factors and mitigation measures in attaining environmental sustainability. The results are presented in form of tables.

## 4.2 Response Rate

In the study of the ES of the Addis Ababa CBs, 30 dwellers from each of the three sites – the Bole Gerji site, Milifoni site and Gofa Mebrathaile site – were selected to fill the questionnaires. four officials from government and six contractors were interviewed and all completed and returned all of the questionnaires.

## 4.3 Demographic Characteristics of the Respondents

Since data was collected from dwellers, contractors and government officials, it was necessary to present data first in terms of demographics of respondents.

Table 4.1 shows that out of those who participated in the study, 62 (68%) were female while 28 (31%) were male as shown in Table 4.1. The table shows that the distribution of gender is not evenly skewed. The gender of the respondents was noted because it has some relationship with a variable on environmental awareness.

Table 4.1: Gender Distribution of respondents

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 28 | 31% |
| Female | 62 | 68% |
| Total | 90 | 100% |

Regarding distribution of respondents by age, Table 4.2 shows that out of 90 dwellers, the age group of 18-25 had 8 respondents (9%); the age group of 26-35 had 39 respondents (43%), the age group of 36-45 had 29 respondents (32%) and the age group of 46-75 had 14 respondents (16%).

Table 4.2 Age Distribution of the respondents

| Age Group | Frequency | Percentage |
|---|---|---|
| 18-25 | 8 | 9% |
| 26-35 | 39 | 43% |
| 36-45 | 29 | 32% |
| 46-75 | 14 | 6% |
| Total | 90 | 100% |

Regarding distribution of respondents by level of education, Table 4.3 show that out of 90 dwellers, 9 (10%) respondent with only primary education; 14(16%) had completed secondary education, 19(21%) had completed college and 37 (41%) had completed university and 11 (12%) have above degree. The education levels were noted in relation to environmental awareness.

Table 4.3 Education Levels of respondents

| Education level | Frequency | Percentage |
|---|---|---|
| Primary Education | 9 | 10% |
| Secondary Education | 14 | 16% |
| Diploma | 19 | 21% |
| Degree | 37 | 41% |
| Above Degree | 11 | 12% |
| Total | 90 | 100% |

## 4.4. House ownership

Out of the respondents residing in the condos at the Bole Gerji site, 32% were renters, while the remaining 68% were owners of the units of the CBs. 39% of the dwellers interviewed at the Milifini site were renters, while the remaining 61% were owners of the units of the CBs. 46% of the dwellers interviewed at the Gofa Mebrathaile site were renters, while the remaining 54% were owners of the units of the CBs.

The results found at each site regarding ownership is that there are 30-43% of renters at each site. Both the dwellers and condominium management officials said the increasing number of renters is making organizing the dwellers for any effort that needs the cooperation of the dwellers difficult as the renters do not have an interest in efforts with long term effect.

Table 4.4 Average house ownership title

| Site | Bole Gerji | | Milifoni | | Gofa mebrathaile | | Average | |
|---|---|---|---|---|---|---|---|---|
| Unit | percentage | number | percentage | number | percentage | number | percentage | number |
| Renters | 32% | 10 | 39% | 12 | 46% | 14 | 39% | 12 |
| Owners | 68% | 20 | 61% | 21 | 54% | 16 | 61% | 18 |

From the ninety dwellers interviewed, 35 of them are renters and the remaining 55 are owners. This shows that on average 39% of the dwellers interviewed at all three sites are renters and 61% are owners.

## 4.5. Environmental Awareness and Environmental Sustainability of condominium housing projects

### 4.5.1 Sources of Information

Regarding the definition of environmental sustainability, most respondents gave the correct definition according to this study. The study further set to establish the sources of information on environmental sustainability.

Table 4.5 shows the sources from which dwellers got information about environmental sustainability. Out of the outlined methods used for disseminating information pertaining to environmental sustainability, 35 (39%) of the respondents heard it from television, 6 (7%) of the respondents heard it from newspapers/magazines, 22 (24%) of the respondents heard it or learned from school , 13 (14%) of the respondents heard it from radio, 8 (9%) of the respondents heard it from internet and 6 (7%) of the respondents heard it from friends. This means that television remains the most effective instrument of disseminating information about environmental sustainability. The results also show that the internet and tradition method of disseminating information (neighbor to neighbor) still

remain ineffective means of disseminating information concerning environmental sustainability of condominium housing.

Table 4.5 Where dwellers got Information

| Source | TVs | Radio | Friends | Internet | News Papers | School |
|---|---|---|---|---|---|---|
| Frequency | 35 | 13 | 6 | 8 | 6 | 22 |
| % Index | 39% | 14% | 7% | 9% | 7% | 24% |

### 4.5.2 Awareness of Types of Solid Waste and environmental sustainability

The study sought to establish if respondents were aware of the difference between biodegradable and non-biodegradable solid waste (garbage). Interestingly, all respondents said that they were aware of the two types of substances. The study then probed on whether the respondents separate these two when disposing them. Table 4.6 shows responses from different respondents. The results showed that 67 (74%) of the respondents do not separate solid waste into biodegradable and non-biodegradable waste, 8 (9%) separate their garbage and 15 (17%) were not respond. The results show that most of the respondents do no separate domestic solid waste into biodegradable and non-biodegradable in spite of the awareness.

Table 4.6 Separation of Biodegradable and Non-biodegradable Solid Waste by dwellers

| Do you do separation? | Frequency | Percentage |
|---|---|---|
| Yes | 8 | 9% |
| No | 67 | 74% |
| I don't know | 15 | 17% |

The study further probed the reasons why the majority of the respondents do not separate their solid waste into biodegradable and non-biodegradable substances. The reasons that were given are presented in Table 4.7. The results show that 29 (32%) of the respondents cited lack of separate bins to discriminate biodegradable and non-biodegradable substances when disposing, 27 (30%) said that they leave it to the waste collectors to separate the two, 29 (32%) said they have never thought about it, 5 (6%) said they do not bother to do so.

The results therefore indicate that there is need to encourage and sensitise people to change their attitudes on the importance of separating the two types of solid waste.

Table 4.7 Reasons for not separating Solid Waste

| Reason | Separate bins not provided | Leave to waste collector | Never thought about it | Don't bother to do so |
|---|---|---|---|---|
| Frequency | 29 | 27 | 29 | 5 |
| % Index | 32% | 30% | 32% | 6% |

The aforementioned analysis on environmental awareness shows categorically that a lot is known about environmental awareness. However, the analysis has shown that in spite of the awareness, very little is being done to enhance environmental sustainability in gated communities as depicted in the way residents dispose their waste. Moreover, other avenues for disseminating information pertaining to environmental sustainability like internet, school and radio are yet to be exploited.

## 4.6 Socio-Economic conditions and Environmental Sustainability of condominium housing projects

The study considered socio-economic factors that may enhance environmental sustainability of the condominium housing projects. Measures such, occupation, types of domestic solid waste produced were considered.

In order to keep the surroundings of condominium clean, there is need to raise funds. Many condominium levy monthly service charges. Data from dwellers shows that all respondents pay monthly service charges ranging from 100 to 200. The study probed on how satisfied the dwellers were with the monthly service charge. Table 4.8 presents the findings on a likert scale. From the findings, it shows that most respondents are either dissatisfied with the monthly service charge. This implies likelihood of affecting the maintenance of the condominiums and consequently affecting the environmental sustainability of the condominiums. This calls for sustainable ways of generating income.

Table 4.8 Attitude towards Monthly Service Charge b dwellers

| Attitude | Extremely Dissatisfied | Dissatisfied | Neutral | Satisfied | Extremely satisfied |
|---|---|---|---|---|---|
| Frequency | 24 | 31 | 16 | 17 | 2 |
| % Index | 27% | 34% | 18% | 19% | 2% |

## 4.7 Condominium Buildings and change in air temperature

Table 4.9: Dwellers view on the environmental sustainability of the condominium housing project.

| Questions presented | Bole gerji | | Gofa Mebrathaile | | Milifoni | | Average | |
|---|---|---|---|---|---|---|---|---|
| Units | % | NO | % | NO | % | NO | % | NO |
| Do you think there is climate change in Addis Ababa | 100% | 30 | 73% | 22 | 100% | 30 | 100% | 30 |
| Do you think buildings contribute to climate change? | 60% | 18 | 43% | 13 | 30% | 9 | 43% | 13 |
| Do you think the city is doing enough to reduce the environmental consequences | 53% | 16 | 43% | 13 | 40% | 21 | 70% | 14 |

From the 90 dwellers interviewed, 82 believed that there is climate change in Addis Ababa. Furthermore, 40 of them believed the buildings contributed to this effect and 50 believed the government was not doing enough to reduce the environmental consequences.

## 4.8 Dwellers perceptions on building materials and measures

Table 4.10 shows ES measures by dwellers

| sites | **Bole Gerji** | | **Gofa Mebrat Haile** | | **Milifoni** | | **Average** | |
|---|---|---|---|---|---|---|---|---|
| Units | % | NO | % | NO | % | NO | % | NO |
| Water conservation mechanisms | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| | | | | | | | | |
| Store rainwater | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Clean and renewable energy | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Plantation | 50% | 15 | 27% | 8 | 63 % | 19 | 46% | 14 |
| Recycling | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |

From the 90 dwellers interviewed, 37 of the interviewees engaged in plantation of some kind. The comments the dwellers gave on materials used during the construction of the CBs were divided into three parts: building materials used for the construction of the condominiums, sewage line defects and comments given on accessories and fixtures.

Table 4.11 Comments on building materials

| sites | **Bole Gerji** | | **Gofa Mebrathaile** | | **Milifoni** | | **Average** | |
|---|---|---|---|---|---|---|---|---|
| Units | % | NO | % | NO | % | NO | % | NO |
| Material deterioration | 43% | 13 | 37% | 11 | 37% | 11 | 39% | 35 |
| Sewage line defects | 53% | 16 | 13% | 4 | 23% | 7 | 30% | 27 |
| Low quality accessories | 70% | 21 | 77% | 23 | 70% | 21 | 72% | 65 |

From the 90 dwellers interviewed, 35 of them believed the building materials were deteriorating, 27 of them reported sewage line defects and 65 of them believed the condominium project used low quality accessories and fixtures.

## 4.9. Results from qualitative Data Analysis

**Results from the Bole Gerji condominium site**

The Bole Gerji condominium site has a green view but dwellers say it is the result of their personal effort and that it is not organized. The Bole Gerji CBs were built on farmland.

Dwellers of the site give reasons for any inaction regarding ES:

The condominium life has made communication among the dwellers difficult and the increasing number of renters, whom it was claimed, does not consider the site as their own and so lack the motivation to get involved in improvements with a long term effect. With more than 350 cars at this site, the management of the site addressed the need for parking space in several ways. Firstly, only 350 are allowed on the site. Secondly, each car is allocated a parking area around a playing field in the site with their plate number. Thirdly, by building a curbstone around the field, cars are discouraged from parking on the grass field and this has saved open areas for a play ground and greening. Furthermore, late comers that do not have a reserved parking space can park at the gate.

**Results from the Gofa Mebrathaile condominium site**

The Gofa Mebrathaile is the site with smaller green spaces. The entire site is covered with cobble stone, asphalts with nothing spared for greening or a children's playground. This was done to attract renters with cars to the site, which is attractive because of its proximity to the city centre.

**Results from the Milifoni site**

From the three sites studied, the Milifoni site is the one with more open and green spaces than the other sites. Open spaces in the compound have been changed into places where the dwellers dry washed clothes. All of the blocks at the Milifoni condominium have rooms reserved for commercial use at their ground floors. Most have been changed to cafes and shops. It has an internal asphalt road and built pedestrian ways. A large forest was cleared to build it.

From the interview with the contractors and government officials, they highlighted that they never considered building it to be environmentally friendly, the concept didn't even exist at that time. Even now, there is a general awareness of environmental pollution and increasing the comfort of building occupants but no major progress is seen in the way this conventional buildings are being built in both of the cases.

It gets worse, the buildings sewerage system is so poor that sewage leaks into the occupants' house, polluting their home causing major health problems. The problem is being addressed to the responsible party, but no measures have been taken to eradicate that problem. Not only are

any considerations given to renovate the building, but any measures have not been taken to right the malfunctioning components of the building. From this result, it can be seen how far we need to go not only to satisfy the need to build environmentally sustainable condominium houses, but to satisfy the fundamental needs of the occupants.

In order to satisfy the needs of minimizing the resource input as well as waste and maximizing the comfort of life, sustainable building is required. Countries like Ethiopia should strive to make efficient use of resources in every sector of the economy. Climate is a hot global topic and building environmentally sustainable housings is indispensable. McAllister and Fuerst (2008) suggest that developers, occupiers, and owners may obtain a verity of benefits that are associated with sustainable building. According to McAllister, other benefits are also important driving force for sustainable renovation.

Through minimizing the energy consumption and resource input, lower operating, maintenance and construction costs can be gained. Increasing living comfort can add value to the property. Space is more valuable, providing potential for higher rental growth or improving marketability. It reduces healthy risk caused by dust, noise, smell, resonance, smoke, excessive heat or cold, radiation or moisture, avoiding extra expense for sickness such as compensation costs. Since many people choose to work at home, a comfortable living environment, giving people a good mood, can increase people's productivity, which results in the economic benefits. Preservation of cultural and historical elements has educational and social effects, rising public awareness. Social equity, which increasing the comfort of life, also contributes to the social stabilization.

**A. Land Use and site selection**

Many millions of acres of land in this country have buildings constructed on them. Although buildings themselves use large amounts of land, this is not the primary issue. Rather, it is the poor siting of buildings that leads to large amounts of land (and other resources) being consumed. Poor design has cost the country for the unwise utilization of large amount of land. For example, buildings that are not built in existing residential or commercial areas require the construction of new roads, sewer lines, utility poles, and other infrastructure to reach them, which can lead to, among other things, habitat destruction. In addition, many buildings are not reachable by public transportation and thus require the construction of parking lots or garages (Yudelson, (2007).

Most significantly, buildings that are built outside the mainstream of existing urban or suburban areas often contribute to the problem of sprawl. Although sprawl can have many definitions, generally speaking, sprawl is the spreading of a city or, more typically, its suburbs (in disorderly fashion) to previously undeveloped or lightly developed areas.

Green buildings can address the problems of sprawl. Finding or determining an appropriate site is normally the first step in the design process of a green building. Ideally, the site for a green building should be strategically located so it is close to mass transit and fits into the master plan of the city to reduce car dependency and sprawl. The building's site should encourage pedestrian and bicycle use with accessible paths and sidewalks. If possible, sites that currently have existing buildings on them should be used, given that they are often in existing commercial or residential areas.

After a site is chosen, the development process should minimize land disturbance and erosion. The site can be graded to accommodate runoff and prevent damage to the surrounding ecosystem. Geotextiles and silt fences can be used during construction to prevent erosion. Light, shade, wind, and water should be considered when designing the building's envelope, windows, and utilities to take full advantage of the conditions of the site. Landscape elements should include native plants as alternatives to conventional grass lawns, which often depend on irrigation and pesticides. Native plants are adapted to the natural hydrology, climate, and geography of the region and have evolved in relation to other local plants. This allows native plants to provide habitat for local species. Also, native plants normally require less watering, fertilizers, and pesticides. All three of the case study sites, the Bole Gerji, the Milifoni and the Gofa Mebrathaile, were built by clearing a green area. The Bole Gerji was once farmland; the Milifoni site and Gofa Mebrathaile was a forest.

**B. Energy Efficiency and Renewable Energy**

One component of ESBs is the quality of being energy efficient and of using renewable energy such as hydroelectric power, solar energy, wind power and bio fuel. All three of the condominium sites are powered by hydroelectric power. No other source of renewable energy is used. However, since moving to the site, dwellers report that their spending on utilities, electricity being one, have increased but they can use and utilize solar energy instead.

### C. Water Efficiency

Another feature ESBs possess is water efficiency, meaning that the quantity of water used is reduced, that water is recycled, reused and stored and that rain water is collected. But in all selected sites, rain water is not stored and not any type of water recycle process or used again.

### D. Environmentally Preferable Building Materials EPBMs

Another feature of ESBs, are those that have low carbon emissions during their production. One way of including them in the construction of a building is by using precast materials. Precast materials were used in the construction for all the condominiums at all three sites.

A complaint that building materials, particularly fixtures and accessories, were not of proper quality was common at the three condominiums studied and among the dwellers. Dwellers of the Gofa Mebrathaile condominium site say it is less costly to use the more expensive products and saves the time and other costs that using cheap and low quality products bring.

### E. Recycling

Recycling is another way to make buildings ES, beginning from the construction. It involves reusing building materials and utilizing everyday waste such as dry waste in order to put a check on pollution and as also a way in using the opportunity for resource conservation. It was found that the material used to partition the units, has some recycled components. However, the dwellers at all three sites do not see waste as something useful and so do not make efforts to recycle it.

### F. Indoor Air Quality

This quality of ESBs states that the building materials used affect indoor air quality. Ventilation systems and maintenance are factors that control this aspect. At all three sites, it was noted the number of windows were not enough to allow for sufficient natural lighting or air. Furthermore, at all three sites, bad odors, a lot of which came from leakages of pipes in bathrooms and toilets and pipes that passed through their houses, were complained about, indicating that the pipes were not properly bonded together. These pipes are also reported to sometimes explode. At the Gofa mebrathaile site in particular, other than toilet pipes, the water treatment facility was a major source of bad odor.

This odor was the result of a combination of factors such as unavailability of water at the time they needed it, particularly at Gofa Mebrathaile site and Bole Gerji site, and leakages from the sewage and pipe lines that passed through their house, maintenance of which is a common task for the condominium's management. These sewage lines at times explode, and it is a common occurrence. But the dwellers don't mention lack of ventilation. They say their houses get enough air.

**G. Optimization of Operational And Maintenances Practices**

ES of the building can only be preserved if operation and maintenance practices in making them sustainable are considered. The main issue under this feature of ESBs is that occupants of the building should be given trainings that will help they themselves to carry out maintenance that is environmentally friendly. At the three sites, no dweller reported that they had been given trainings. However, fixing leakages of pipes, which should be carried out by condominium management officials are carried out by the dwellers themselves.

No training was provided or environmental sustainability is being considered in the communities up keep and use of the condominium sites. The Gofa Mebrathaile raises financial constraints as a reason for the failure to make efforts organized at the site level and at the same time remind that with the exception of the land allocated for parking, play ground and greening the rest belongs to the government.

**H. Green Areas**

Under this feature of ESD, the importance is in having a natural solution to dealing with greenhouse gases emission and in dealing with to global warming which can be accomplished by having green areas because they will absorb the carbon. The Bole Gerji site has a field that is protected from being used as a parking area for cars by a curb. At the Gofa mebrat haile site, green spaces are limited to the fronts of units, while the majority of the site has been covered with cobble stone. At the Milifoni site, there are many green areas.

**I. Vertical Greening**

Vertical greening is the process of replacing a green area that has been lost when erecting buildings. This feature of ESD can be implemented by greening the side of a building.

The Bole Gerji condominium site addressed the need for parking space allocating a parking area around a square in the site for specific cars and now car owners can also use the reserved space for cars around the square in addition to the pavements in the site. The Milifoni site and the Bole Gerji sites were found to be greener than the Gofa Mebrathaile site. There were efforts for greening at the Bole Gerji site when the units of the site were first passed to the dwellers, but the dwellers say that they themselves are the ones that have taken the responsibility for greening the immediate surroundings of their units. The Milifoni site gets its green view from the greenery that surrounds the site.

**Environmental laws of the country and the Condominium sites**

The environmental impact assessment proclamation provides the possibility to force projects to provide an impact assessment report so that the environmental protection authority may permit, deny or make suggestions based on the report presented. But lack of directives to enforce the proclamation has hindered the growth of ES in construction that could have come with a legal backing. Besides, it would have created a commitment on the side of the government to take necessary measures. The pollution control proclamation which provides standards to be established regarding disposal and which also gives the environmental protection authority an oversight over municipality waste disposal systems is also not being exploited. The law was a potential to create efforts for a cleaner environment. The provisions of the proclamation allows going to the extent of coordinating dwellers for waste disposal, which is considerate of the environment, and includes facilitating ways for recycling the waste. Even if the proclamation is primarily meant to enforce proper handling and disposal of hazardous waste, the definition of which to be determined by another directive, the odor the waste at Gofa Mebrathaile creates, for example, is the nuisance the proclamation is there to avoid.

**Resource Utilization**

Resource utilization at the sites, as was found, has increased significantly. At Gofa Mebrathaile site, they are now using 76% more of the resources of electricity and water than before they moved to the condominiums. The Bole Gerji site did not show much change, only an increase. At Milifoni the dwellers are now using 66%. But, as was indicated earlier, no inhabitant in the selected condominium sites has any kind of resource conservation mechanism, and none of them use clean and renewable energy (other than hydroelectric power), either as a source of electricity

or to heat water, the more customary usage. The reasons that the inhabitants gave were that it is expensive and not accessible and that they were not familiar with it. Lack of communication among the dwellers was also raised. The installation/commencement of these renewable sources of energy could be in the interest of all the dwellers. To store rain water, the dwellers answered that such a facility needed to have been thought about at the beginning, during the construction.

# CHAPTER FIVE

# Conclusion and Recommendations

## 5.1 Conclusion

The study was meant to investigate the determinants of environmental sustainability of condominium housing projects in Addis Ababa. The area of study was Addis Ababa city. The study had three objectives which were environmental awareness, socio- economic factors and mitigation measures.

The study concludes that the economic factors are perceived to be the major barriers as regards the adoption of technologies that influence environmental sustainability of condominium houses. There was further revelation by the study that those selected sites that have not adopted technologies that influence environmental sustainability of condominium houses are inhibited by cost of procuring and installation. Although the cost of procuring and installation of the technologies is exorbitant yet it is cheaper to use the technologies in the long run once they are installed; for example, a lot of respondents from selected sites stated that the procurement and installation of solar energy is expensive and as such they option to use hydro-electric power and generators which are very expensive in the long run from the view of cost. Also, the impact of generators on the environment is huge due to greenhouse gases that generators produce.

The level of environmental awareness in most of the selected sites is good, yet there is lack of good will to implement what the dwellers know about environmental awareness. This is clearly exemplified by the fact that most dwellers are aware of the difference between biodegradable and non-biodegradable solid waste, yet almost none of them separate these two substances. And also

There are some noteworthy efforts (whether deliberate or otherwise) towards environmentally sustainability at some of the sites studied. In the construction stage for all the condominiums, precast materials were used. Another noteworthy measure of the studied sites, is the decision to limit the number of cars that enter the site and the protection of the field from becoming a parking lot with a curbstone, at the Bole Gerji site.

After reviewing literature on what ESBs are, and after comparing the results of the interview,

questionnaires and observation of the three Addis Ababa condominium building sites with these concepts, it can be concluded that to a large extent efforts towards environmental sustainability at the sites are confined to limited attempts by the stakeholders. Therefore, to a large extent they are not environmentally sustainable buildings.

## 5.2 Recommendations

The following are some recommendations to make future condominium buildings environmentally sustainable including creating the awareness of what ES is; by involving experts in ES and making them part of the practical construction process; and by sites imitating ES measures carried out by other sites.

The huge scale of the condominium housing project, which is of significant interest to nationals, is an opportunity for environmental sustainability to also be introduced. While informing the public of the progress made in the buildings, the government can also take the time to present some environmental sustainability concepts to the dwellers. Then, similarly, when the units are being handed over to the owners, they could be made to agree to standards concerning the environmental sustainability of the sites.

Moreover, involving specialists in environmental sustainability in the early stages of the construction of the buildings is another way to incorporate special environmental sustainability features in the buildings. Features such as green roofs and vertical greening could be incorporated in the buildings if experts in environmental sustainability are involved. It would also lead to the establishment of a framework for any efforts to be made and also encourage an establishment of influential standards that are considerate of the environmental sustainability realities of the country. Not only can the features of ESBs presented in the literature review be adapted to the condominium buildings, any ES efforts that were and are observed at any site, can be introduced to other sites. This would be another effective way to get dwellers to implement such measures.

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# Appendix

**Appendix A**

**Questionnaire for Dwellers**

Please answer the following questions as honestly as possible. There is no need to indicate your name anywhere. Write or tick in the box as appropriate.

**Schedule A**

1. Gender: Male ☐ Female ☐

2. Age: 18-25 ☐ 26-35 ☐ 36-45 ☐ 46-80 ☐

3. level of education

a) primary school ☐ b) Secondary education ☐

c) Diploma ☐ d) Degree ☐ E) Above Degree ☐

4. Occupation: Employed ☐ Business ☐

Student ☐ Unemployed ☐

5. Ownership title

a. Owner ☐ b. Renter ☐

**Schedule B**

1. Have you ever heard about environmental sustainability?

☐ Yes (Please answer question 2)

☐ No (please skip question 2 and go directly to question 3).

- ❖ If yes, what is your understanding of environmental sustainability? _____

2. Where do/did you learn about environmental sustainability? (tick where appropriate)

a) Radio ☐ b) Newspaper/magazine ☐ c) Television ☐

d) Internet ☐ e) School ☐ f) Friends/neighbors ☐

3. Are you aware of decomposable (biodegradable) and non-decomposable (non-biodegradable) type of garbage or substance?

☐ Yes ☐ No

- ❖ If yes, do you separate these two substances when disposing them?

☐ Yes ☐ No

- ❖ If no, why not?_____

4. What are the sources of solid waste (garbage) created in your house?

a) Food ☐ b) Plastic bags/papers ☐ c) Tin/cans ☐ d) Glass bottles ☐

5. How do you cook/boil water?

a. Using electricity ☐ b. Using gas ☐ c. Using charcoal/firewood ☐

e. Using paraffin/kerosene ☐ f. Other (specify)_____

6. What alternative energy do you use for lighting and other things when there is no

power?

a. Generator ☐ b. Solar Power ☐ c. Biogas ☐ d. Paraffin/Kerosene ☐

e. Battery ☐ f. Candles ☐

7. In your view, which activity consumes electricity most in your household?

a. Cooking ☐ b. Lighting ☐ c. Ironing ☐ d. Other (specify) _____

8. How much do you pay for monthly service charge? _____

- How satisfied are you with the monthly service charge?

  a. Extremely satisfied ☐ b. Satisfied ☐ c. Neutral ☐

  d. Dissatisfied ☐ e. Extremely dissatisfied ☐

9. How do you evaluate the city waste disposal system?

Good ☐ Bad ☐

10. Are there measures you take to reduce the environmental consequence of your actions?

Yes ☐ No ☐

- if yes what _____

11. Do you think the city is doing enough to reduce the undesirable environmental consequence of the condominium buildings?

Yes ☐ No ☐

- ❖ What are your reasons _____

12. Were you given trainings or guidelines on how you conserve energy and resources before you started living in the condominium buildings?

Yes ☐ No ☐

13. Do you think the city have put the environment in jeopardy with the construction of the condominium buildings?

Yes ☐ No ☐

14. Do you face shortage of water?

Yes ☐ No ☐

- ❖ If yes how do you manage them _____ _____

15. Do you face shortage of energy?

Yes ☐ No ☐

- ❖ If yes how do you manage them_____ _____

16. Do you think there is enough natural light in your house?

Yes ☐ No ☐

- ❖ If yes what do you think is the reason? _____

17. How much do you think the condominium housing contribute to the climate change and why

_____

18. What are you doing on your part to reduce energy use and for responsible resource utilization?

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**Appendix B:**

**Interview Questions for Contractors**

1. What is your view on environmentally sustainable construction?

2. What activities have you noticed to achieve environmental sustainability?

3. Are any measures taken by the government to promote environmental sustainability?

4. Why do you think environmental sustainable building concept is not popular in Ethiopia?

5. What measures do you think we need to take in order to educate the society and the building industry about the need to build green?

## DECLARATION

I, the undersigned, declare that this thesis is my original work, prepared under the guidance of Dr. Chalachew Getnet. All sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted either in part or in full to any higher learning institution for the purpose of earning any degree.

_____ _____

Name Signature

**St. Mary's University, Addis Ababa** **May, 2019**

**ENDORSEMENT**

This Thesis has been submitted to St. Mary's University, School of Graduate Studies for examination with my approval as a university advisor.

_____ _____

Advisor Signature

**St. Mary's University, Addis Ababa** **May, 2019**