



**ADDIS ABABA UNIVERSITY**  
**COLLEGE OF BUSINESS AND ECONOMICS**  
**SCHOOL OF COMMERCE**

**ASSESSMENT OF SUSTAINABILITY IN ETHIOPIAN**  
**BUILDING CONSTRUCTION FIRM: THE CASE OF LEVEL I**  
**RESIDENTIAL CONTRACTORS IN ADDIS ABABA**

**By**

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## DECLARATION

### Student

I, Amanuel Ashenafi, declare that the project work titled " Assessment of Sustainability in Ethiopian Construction Firm: The Case of Level I Residential Contractors in Addis Ababa " is the result of my own efforts, and that all sources of materials used in the study have been properly acknowledged. With the exception of the research advisor's advice and suggestions, I have developed this research entirely on my own. It is provided as part of a Master of Art in Project Management degree program.

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## **STATEMENT OF CERTIFICATION**

This is to confirm that Amanuel Ashenafi worked under my supervision on the project " Assessment of Sustainability in Ethiopian Construction Firm: The Case of Level I Residential Contractors in Addis Ababa " This work is original, and it is sufficient for submission as partial fulfillment for a Masters of Art in Project Management degree.

**ADVISOR**

**SIGNATURE**

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## **ABSTRACT**

*Building construction uses land, energy, water, and other natural resources, produce waste and releases hazardous gases causing ecological imbalance. Incorporating sustainable principles in the construction sector, the buildings can develop the capacity to curtail Green House Gas emissions and reduce the carbon footprint. The research provides assessments with in a geographical scope of major local (Ethiopian) construction firms which are highly involved and are very influential in providing the Countries economic value. The study used descriptive research design and qualitative research approach. The study uses a sampling technique known as Purposive sampling. Specifically, the Maximum variation sampling is used through the research. Four, level I, construction sites were selected, 28 questionnaires were distributed to key personnel, 7 to each built environment, direct observation and key personnel interviewing were key during the information gathering. Sustainable Building Assessment Residential 1.04 Tool is used to assess and analyze the sustainability of Built Environments, through the data collected and derive a report based on the data fed. Findings from the study revealed that built environments in Ethiopian construction firm provide partial capability to enable occupants to achieve Human Development Index and Ecological Footprint targets and live in a sustainable way. It is evident that much more work needs to be done in the areas of the built environments support to use sustainable products and services, support to the local economy, mains water usage minimization, waste minimization and energy usage efficiency, to improve the sustainability in the built environment. The study suggests that future researches to be performed considering other levels of building contractors in Addis Ababa and other parts of the country as well.*

***Key Words; Sustainable Built Environment, Sustainability, Sustainable Building Assessment Tool, Building Construction in Ethiopia, Level I contractors***

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## Table of Abbreviations

<b>No.</b>	<b>Abbreviation</b>	<b>Description</b>
2	AEC	Architecture, Engineering and Construction
3	BIM	Building Information Modeling
4	BRE	Building Research Establishment
5	BREEAM	Building Research Establishment Environmental assessment method
6	CASBEE	Comprehensive Assessment System for Building Environmental Efficiency
7	CGRE	Climate Resilience Green Economy
11	GHG	Green House Gas
12	HDI	Human Development Index
14	IBS	Industrialized Building system
15	IPT	Technological Research Institute Sao Paulo
16	ISO	International Organization For Standardization
	KPI	Key Performance Indicators
17	LCA	Life Cycle Analysis
18	LEED	Leadership in Energy and Environmental Design
21	PMBOK	Project Management Body of Knowledge
22	PRINCE	Projects IN Controlled Environment
25	SBAT	Sustainable Building Assessment Tool
29	UNEP	United Nations Environmental Programme

# **CHAPTER ONE**

## **1. INTRODUCTION**

### **1.1 BACKGROUND OF THE STUDY**

According to the Brundtland Report (1987), sustainability is meeting our own needs without compromising the ability of future generations to meet their own needs. In ecology, the word sustainability characterizes the ability of biological systems to remain healthy, diverse, and productive over time.

Incorporating sustainable principles in the construction sector, the buildings can develop the capacity to curtail GHG emissions and reduce the carbon footprint. Buildings not only have negative impacts in their pre-construction and construction phase but also during the operation and maintenance (post construction) phase (Jain et al., 2013).

Having described sustainability, it is important to understand how this relates to developing and developed countries. Developed countries may have achieved certain aspects of ‘a state of social sustainability’, such as reasonable health and safety within their populations. It therefore could be argued that social sustainable development objectives could have a lower priority to economic and environmental sustainable development objectives in these developed countries. Developing countries on the other hand are unlikely to have achieved many aspects described for a state of social sustainability. Addressing social sustainable development objectives is therefore likely to be a priority in developing countries. These differences in states mean that there are often differing priorities in developing and developed countries. In sustainable development it is therefore important to understand the local context and priorities. The assessment framework must acknowledge and respond to the context in which it is used (Gibberd, 2005).

In developing countries the availability of conventional construction materials will fall considerably short of their demand, despite improved productivity, and several alternatives for them are being developed. Research and development institutions in India have developed a number of technologies for production of new building materials that are cost-effective and ecofriendly with special attention to utilization of industrial and agricultural waste. However, most of these technologies are still in the experimental or demonstration stage. The development of new

materials and technologies needs also to take into account the fact that the majority of the population is associated with very limited investment capacity. Furthermore, efforts must not only be concentrated on sourcing new and environmentally friendly construction materials, but attention must also be given to innovative recycling and re-use. This would require, as part of the strategy, a practice of producing buildings and materials with a longer life-span, and which are easy to recycle and can be disposed of at minimal environmental cost. Thus, the adverse impacts of construction activities and products on the physical environment would only be effectively minimized through efficient use of natural resources, especially non-renewable resources (Vij et al. 2010).

Inside the climate mitigation market, the construction sector is assessed to offer a wide scope of opportunities for new cost-effective services and products that improve sustainability in the built environment (McKinsey & Co., 2009).

As the intensive construction in Ethiopia today becomes more complex, the impacts of the buildings in the environment, economy and society is also seen to be increasing in an exponential manner. Although, academicians have been playing an important role in universities by giving lectures on sustainability for young designers that will build the future, those lectures are mostly about the buildings yet to be built in the future. Even though the proposals the buildings of the capital are crucial in the country's struggle to achieve sustainability, there are no implications of remedial sustainable building features on the buildings of Addis Ababa.

The research provides assessments with in a geographical scope of major local (Ethiopian) construction firms which are highly involved and are very influential in providing the Countries economic value. A shift to more sustainable building is seen as an essential part of urban renewal focused on reduced environmental impacts..

## **1.2 STATEMENT OF THE PROBLEM**

Almost all researches that are done on this area of study have focused on the firms residing in developed nations. This research is motivated to bring the area of study to developing nations like Ethiopia and use the assessment tools to examine the firms standing point towards the attainment of sustainable construction. According to the Federal Democratic Republic of Ethiopia's water and energy authority, Climate Resilience Green Economy (CRGE) vision is for Ethiopia to become a

middle-income country by 2030, through rapid economic growth that is resilient to climate change and results in no increase in carbon emissions.

The Constitution of the Federal Democratic Republic of Ethiopia sets the overall environmental values to be preserved and protected under the Environmental Objective of 92(sub-articles 2&4). But, the uncontrolled rate of urban population growth in the country has damaged the environment by degrading the resources found on it. Additionally, the misuse of resources in rural and urban areas leads to different environmental degradation. Buildings, both in urban and rural, misuse the quality and quantity of sensitive resources. With the ongoing rapid construction dynamics, Addis Ababa is prone to such degradation. Nowadays, there are many improvements in constructing sustainable buildings. Many initiatives and experiments have been taken in order to make buildings to be built in the future sustainable and durable. This concept is poorly applied on the currently being built buildings in Ethiopia particularly in Addis Ababa (Taeka, 2016).

The buildings in the city are simply abandoned units that are functional only in the inside. But externally they do not compliment the environment or their aesthetics is somewhat alien when we look at them from nature's point of view. They do not merge into the environment or emerge from the environment. There is no anchoring natural element that connects the buildings to the ground they are built on. (Taeka, 2016).

The uncontrolled rate of urban population growth which increased the housing needs in the capital that exposed the city life to the environmental, economic and social impacts of construction has nudged the researcher to conduct this study which points out what is needed to be done to minimize those impacts and secure the future generations safety of living in a sustainable environment.

The purpose of this study is to assess the Sustainability within the construction industry of Ethiopia, and identify research gaps and potential new topics for research in relation to the management of sustainability in the local construction Industry, and to increase knowledge on the evaluation of sustainability in the construction sector. It analyses the research to pinpoint main focus areas and strengths, as well as identifying areas of weakness and research gaps, which are seen as potential topics for new research. The emphasis is on comprehensive projects of buildings with a holistic sustainability approach. What makes this study different from the others is because it is conducted using a specific tool (SBAT) to assess the Sustainability of the construction firm.

## **1.3 RESEARCH OBJECTIVES**

### **1.3.1 GENERAL OBJECTIVE OF THE STUDY**

The general objective of this study is to assess the Sustainability within the construction industry of Ethiopia.

### **1.3.2 SPECIFIC OBJECTIVES OF THE STUDY**

1. To investigate the applicability of the Sustainable Building Assessment Tool (SBAT) to construction building developments in Ethiopia.
2. To assess the Sustainability and generate findings on the building construction firm according to the Sustainable Building Assessment Tool (SBAT).
3. To point out all the areas of improvements to achieve the sustainable built environment.

## **1.4 BASIC RESEARCH QUESTIONS**

This study has three research questions that address the evaluation of sustainability in the local construction sector from the Sustainable Building Assessment Tool (SBAT) adoption perspective.

**RQ1;** How applicable are the environmental considerations inherent in the Sustainable Building assessment tool to building developments in Ethiopia?

**RQ2;** what are the performance scores of the firm and its implications according to the SBAT?

**RQ3;** how do built environments attain the sustainable built environment?

## **1.5 SIGNIFICANCE OF THE STUDY**

It is known that organizations can gain a competitive advantage only by managing effectively for today, while simultaneously creating safe living for tomorrow, and sustainability is one of the innovative strategies in major architecture, engineering, and construction (AEC) organizations. The purpose of this study is to assess the Sustainability within the construction industry of Ethiopia by their environmental, economic and societal performances which in turn points out necessary measures to be taken to improve the performances to attain sustainable built environment that adds value in providing necessary feedbacks to the organizations involved, the society, the country's economy and the ecology balance in general. The study, then identifies research gaps and potential new topics for research in relation to the management of sustainability in the local construction Industry, and to increase knowledge on the evaluation of sustainability in the construction sector.

It analyses the research to pinpoint main focus areas and strengths, as well as identifying areas of weakness and research gaps, which are seen as potential topics for new research. The emphasis is on comprehensive projects of buildings with a holistic sustainability approach. The analysis focuses on the management and process aspects in relation to planning, decision-making, conducting, and evaluating construction projects. The result is a proposal for a recommendation of cumulative measures in attaining sustainable built environment.

## **1.6 SCOPE OF THE STUDY**

The research provides assessments within a geographical scope of major local (Ethiopian) construction firms which are highly involved and are very influential in providing the Country's economic value. This is done by selecting four level I Construction firms, which are located in Addis Ababa and measuring their sustainability performance through SBAT method of assessment. A shift to more sustainable building is seen as an essential part of urban renewal focused on reduced environmental impacts.

## **1.7 ORGANIZATION OF THE STUDY**

This study is organized in five consequent chapters. The first chapter introduces the background of the study, statement of the problem, basic research questions, and objectives, significance, scope and limitation of the study. The second chapter discusses a review of literatures with descriptions of different researchers related to the topics. The third chapter deals with the research methodology, design, sources of data, target population, sampling technique and sample size, validity and reliability of instrument and research ethics throughout the data collection and analysis. The fourth chapter presents the data analysis, presentation and discussion through tables, by frequency and occurrences and visually by a spider web diagram. The fifth chapter, which is the final chapter of the study, is about the summary of major findings, conclusion and recommendations.

## 1.8 OPERATIONAL DEFINITION OF KEY TERMS

- i. **Sustainability** – sustainability is meeting our own needs without compromising the ability of future generations to meet their own needs (Brundtland Report, 1987). Sustainability in construction, as with all industries, is measured by assessing the performance of social, environmental and economic principles. These three pillars of sustainability are often informally referred to as “people”, “planet” and “profit”. The ultimate project will rank highly for all three, but balancing all three areas can be one of the greatest challenges in implementing sustainable construction.
- ii. **Building Construction** - is generally the construction of sheltered enclosures with walk-in access for the purpose of housing persons, machinery, equipment, or supplies. It includes all construction of such structures, the installation of utilities and the installation of equipment, both above and below grade level as well as incidental grading, utilities and paving. Additionally, such structures need not be "habitable" to be building construction.
- iii. **Sustainable Built Environment** - A sustainable built environment is circular, designed for longevity, flexibility, adaptability, assembly, disassembly, reuse and recoverability, and considers future climate risks. It uses low-carbon, low-impact, non-toxic materials and it recovers used resources (materials and products on-site or from other sites). It is powered by renewable energy, ensures sustainable water consumption and enhances the wellbeing and safety of people. Green spaces, natural biodiversity and nature-based solutions increase resilience, wellbeing and social connectivity. It prioritizes sustainable and shared mobility. The SBAT suggests in order for a built environment to be sustainable it should balance among all the elements within the pillars of environmental, economic and social aspects of assessments.

## **CHAPTER TWO**

### **2. REVIEW OF RELATED LITERATURE**

This chapter provides an overview of previous research on knowledge sharing and intranets. It introduces the framework for the case study that comprises the main focus of the research described in this thesis.

#### **2.1 THEORETICAL LITERATURE**

##### **2.1.1 CONSTRUCTION PROJECTS**

The building shelter consumes one sixth of world's fresh supply of water, one quarter of its wood harvest and two fifth of its fossil fuel and manufactured materials (Wines, 2010).

There are two well-known sources within the project management domain that provide widely accepted definitions of project management. The first is the widely-cited Guide to the Project Management Body of Knowledge (PMBOK Guide), which suggests that project management incorporates an assemblage and application of knowledge, skills, tools, and techniques, to produce the desired project outcomes (PMBOKGuide, 2017).

The second is the PRojects IN Controlled Environments (PRINCE2) methodology (Axelos, 2020). This proposes that project management includes the application of specific processes and principles to "...initiate, plan, execute and manage ..." the change process introduced by project activity. Both therefore offer frameworks that might be employed as strategic alignment strategies to achieve project outcomes and business goals. However, both are relatively silent regarding managing sustainability and environmental issues in projects. This suggests that there is a knowledge gap in this area (Brones et al., 2014).

The mission of a construction project is "to create a desired facility like a housing complex or a plant with predetermined performance objectives defined in terms of quality specifications, completion time, budgeted costs and other specified constraints. It is not a routine activity like the regular maintenance of buildings or roads" (Chitkara, 2014). Therefore, construction projects are usually high-value projects. To be performed, a construction project requires both spatial (plans, designs, layouts, and blueprints) and non-spatial (schedule, amount and quality of materials, specifications, etc.) information, which is separately maintained by different project team members

and stakeholders. Construction projects are classified into three categories—(a) building construction projects such as residential and commercial buildings, schools (b) infrastructure construction projects such as highways, and (c) industrial construction projects such as manufacturing plants. The research mostly focuses building construction projects together with the preceding definitions of project management to form the key reference points for this research. This shifted the focus of the examination onto the sustainability elements contained within the project management framework. Previous research suggests that efficient and effective construction activity has a significant impact on national economic growth.

### **2.1.2 SUSTAINABILITY**

The research team examined the literature relating to sustainability. The definition of sustainability appears to encompass several key areas and is typically viewed on a global stage, to incorporate concepts such as ethical issues, rules, and guidelines, which act as a guide for organizational decision-making (Marcelino-Sádaba et al., 2015).

According to ISO definition (ISO 15392, 2008) sustainability refers to a state in which the components of the environment and their functions are maintained for present and future generations. In the construction sector sustainability relates to how the attributes of the activities, products or services used in construction work, or the use of the construction works, contribute to the maintenance of ecosystem components and functions for future generations (ISO 15392, 2008). Sustainability and as a result sustainable development is commonly defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Report, 1987). The definition of sustainable development was revised in 2006 stating “a long-term vision for sustainability in which economic growth, social cohesion and environmental protection go hand in hand and are mutually supporting” (European Commission, 2021). Sustainability might also incorporate key components such as cleaner-production, pollution prevention, and controlling mechanisms as well as designs that support ecological elements, among them structures and building architecture. The broad spread and concomitant understandings of the concept of sustainability, give rise to new terms and concepts in response to the constantly emerging developments (Glavič et al., 2007).

### **2.1.3 INFLUENCES OF SUSTAINABLE CONSTRUCTION PROJECTS**

Some literature refers to Sustainable Construction as the formation and management of a healthy built environment through the sensible use of resources and ecological principles (Kibert, 2013). Sustainable Construction is an approach that addresses the sustainable needs of the built environment (Abidin, 2010). It is important to note that the terms high performance, green, and sustainable construction are used interchangeably in most studies. Other terms that are synonymous with sustainable construction are green building and sustainable building (Wang, et al., 2014). According to Du Plessis (2007), Sustainable Construction is an all-inclusive process with the aim of re-establishing and maintaining harmony between the built and natural environments and the creation of settlements that assert human dignity and encourage economic equity. This definition implies that SC takes a lifecycle perspective with emphasis on environmentally orientated design, operation and maintenance procedures.

Majadalani et al. (2007) established that the main purpose of Sustainable Construction is to provide structures of long-term value, affordability, quality and efficiency to clients and to enhance economic sustainability whilst reducing the negative environmental impacts. Aghimien et al. (2016) stated that Sustainable Construction is the delivery of construction projects that encourages the preservation of the natural habitat; promotes social wellbeing of the occupants; and provides reasonable economic stand for the investors. Bal et al. (2013) conclude that a construction project is said to be sustainable if it meets environmental challenges, responds to social and cultural demands, and delivers economic improvement.

Developed and developing countries alike all share a common concern and that is the current environmental situation (Asif et al., 2007). The world is currently facing the effects of global warming, ozone depletion, destruction of natural habitats and loss of biodiversity. Sustainability is the way to go to avert the situation and this can be and achieved through the adoption of a multi-disciplinary approach covering several features such as: energy saving, improved use of materials, reuse and recycling and emissions control.

According to Du Plessis (2007), sustainability movement can only be set into motion if awareness and knowledge are in place. Abidin (2010) described the implementation of Sustainable Construction as a process that starts with awareness coupled with interest which leads to gaining knowledge. Acceptance of the knowledge gained will lead to increased demand and this result in

implementation. New technologies and concepts have emerged with the aim of achieving sustainability in the construction industry (Kibert, 2013). Examples like Building Information Modelling (BIM) and high efficiency photovoltaic are impacting approaches to project design and collaboration. Other philosophical and scientific concepts have risen due to the paradigm shift towards sustainability. These concepts include bio mimicry, cradle to cradle design, construction ecology, design for the environment, ecological economics, ecological footprint, life-cycle assessment, life-cycle costing etc. Other technological methods to enhance sustainability in the construction industry are Industrialized Building System (IBS), Value Engineering (VE) and lean construction (Hussin et al., 2013). These innovations have been introduced and are still being improved upon through further research to bring about energy saving, improved use of materials and implementation of reuse and recycling of materials as a way of controlling emissions.

#### **2.1.4 ASSESSMENT OF SUSTAINABILITY OF BUILDINGS**

In 1990, the Building Research Establishment (BRE) in the United Kingdom (UK) developed the first functional method for assessing the environmental performance of buildings. The method was named Building Research Establishment Environmental Assessment Method (BREEAM) (Haapio A.; et al., 2008). This method contained prescriptive requirements that focused on the interior of the building, its immediate surroundings, and the environment (Silva V. G.; et al., 2003). Since then, many tens of methods were developed and are in use throughout the world. There are basically two approaches for the analysis of environmental performance by buildings (Haapio A.; et al., 2008). The first and most widely used approach builds awards points within a selected number of parameters, so called indicators, according to a scale ranging from an environmental “small impact” to a “huge impact” (Ali H. H.; et al., 2009). These indicators have weights, explicit or not, that recognize the main environmental problems. The second model utilizes methodology of Life Cycle Assessment (LCA), to indicate the best choice of design, materials of construction, and options for local utilities. Local utilities include energy supply, waste management, and types of transport (Ali H. H.; et al., 2009).

Very rapid urban growth rates have meant that now 40 % of the Africa’s population live in cities. A large proportion of this growth has been in informal settlements which accommodate over 60% of the urban population Sub Saharan African cities (Gibbered, 2017). Continued growth and climate change has meant that it is becoming increasingly important to address these informal

settlements and develop improved housing. The Sustainable Building Assessment Tool (SBAT) for housing has been developed for this context. The tool has a focus on developing countries and provides a way of assessing sustainability performance (Gibbered, 2017). The research paper uses this tool for the assessments of construction projects in Ethiopia.

Table 2.1 shows the weights used for the main categories of evaluation in the most important rating systems used to assess green buildings, namely, Leadership in Energy and Environmental Design (LEED), Technological Research Institute of Sao Paulo (IPT), Building Research Establishment Environmental Assessment Method (BREEAM), Comprehensive Assessment system for Building Environmental Efficiency (CASBEE), and Sustainable Building Assessment Tool (SBAT).

Table 2.1 Comparison between the most important green building rating systems in terms of the weights used in the main categories of evaluation

Assessment criteria (%)	Green building rating system				
	LEED	IPT	BREEM	CASBEE	SBTOOL
Energy Efficiency	21.7	20	8.3	9.6	4.0
Water Efficiency	7.3	20	4.5	9.1	4.0
Indoor environment quality	18.8	6.0	12.4	22.4	23
Waste and material management	18.8	20	9.8	21.1	12
Eco management	10.1	0.0	14.1	0.0	10

Source: (Gibbered, 2017)

## 2.2 EMPIRICAL REVIEW

The following findings of studies have been reviewed for this research is some of prior studies on cause and effects of delay in different parts of the world.

### 2.2.1 INTERNATIONAL STUDIES ON SUSTAINABLE BUILT ENVIRONMENTS

Oscar o. et al., (2007) brings together research on life cycle assessment (LCA) applied within the building sector. More than ever, the construction industry is concerned with improving the social, economic and environmental indicators of sustainability. The paper implies that by applying LCA, it is possible to optimize these aspects, from the extraction of raw materials to the final disposal of waste building materials. First the review details LCA concepts and focuses on the LCA methodology and tools employed in the built environment. Secondly, the paper outlines and discusses the differences between the LCA of building materials and components combinations versus the LCA of the full building life cycle. Finally, this work can be used by stakeholders as an

important reference on LCA including literatures on approaches and methodologies to preserve the environment and therefore achieve sustainable development in both developed and developing countries. When summarizing, it stated that the application of LCA is fundamental to sustainability and improvement in building and construction.

Uttam K. (2014) aimed to bolster the knowledge of promoting sustainability in the construction sector, with the specific aim of analyzing the ways in which policy instruments such as environmental impact assessment and green public procurement can be reinforced to improve the coordination between planning and the implementation of sustainability considerations. The study conceptualizes an inter-link between impact assessment and green public procurement, and identifies the opportunities to develop the inter-link. As his paper, it is appropriate to plan for green public procurement at the pre-decision phase of an environmental impact assessment. The inter-link can be strengthened by involving contractors in planning for green and sustainable public procurement.

Kajander, (2016) utilized a mixed-method research strategy. Both quantitative and qualitative data is collected and analyzed with qualitative and quantitative methods to provide a more comprehensive understanding of the research topic. The study analyzes sustainability in the construction sector by using empirical data from construction projects. The study found that construction companies can evaluate sustainability by by investigating their potential monetary benefits and made the following proposals: (i) Construction companies should evaluate sustainability together with clients and value networks to systematically manage the development and adoption of sustainability; and (ii) construction companies can demonstrate the monetary benefits of sustainability to shareholders with the event study method, and the benefits to clients and tenants with real option analysis. The paper presented and tested two new tools that construction companies can use to evaluate sustainability. Overall, the study contributed by examining the evaluation of sustainability in the construction sector. It does so by investigating the evaluation of sustainability in construction projects and in the context of business management. Moreover the study demonstrates new managerial tools for the evaluation of sustainability, i.e event study and real option analysis.

## **2.2.2 ETHIOPIAN STUDY ON SUSTAINABILITY ASSESSMENT**

Teklea (2015) mainly assessed the nature of the selected buildings in terms of building orientation and location, functional layouts, indoor environment quality, energy consumption, water consumption, waste management and building material and finds out how to adopt the green building theories and concepts to the sampled buildings. The study employed both descriptive and explanatory research method and also mixed type of quantitative and qualitative data collected from primary and secondary data. The study found that most of the sampled buildings had problems in their indoor environment quality, over consume energy, are indifferently laid out functionally and have disorganized waste management system compared to green buildings. Possible remedial solutions were given based on Environmental planning and Landscape design.

## **2.3 CONCEPTUAL FRAMEWORK**

A conceptual framework is an analytical tool with many variations and contexts. It is used to make conceptual distinctions and organize ideas. Concepts are presented through visual or graphical frameworks. According to the SBAT analysis tool, improving all the aspects of Environmental, Economic and Social aspects of construction firms will lead to a reasonable result in the Sustainable Built Environment.

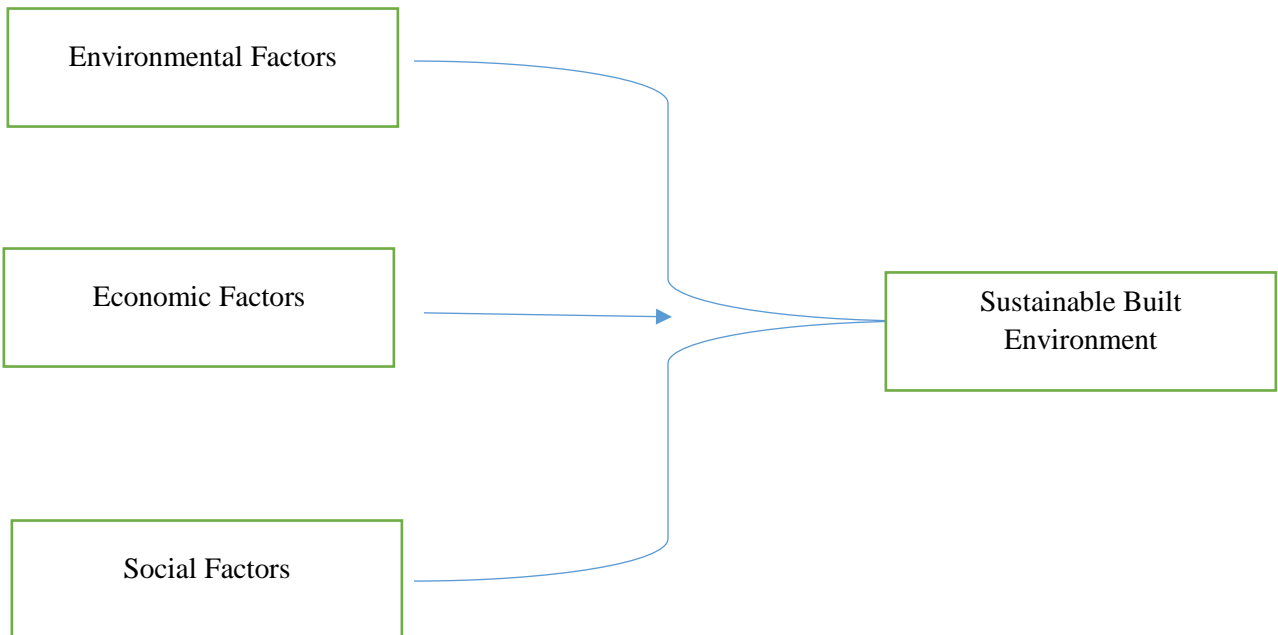
### **Independent Variables (IV)**

1. Environmental Areas of the firm
  - Energy
  - Water
  - Waste
  - Materials
  - Biodiversity
2. Economic Areas of the firm
  - Transport
  - Resource
  - Management
  - Local Economy
  - Service and Production
3. Social Areas of the firm
  - Access
  - Health
  - Inclusion
  - Social Cohesion
  - Education

### **Dependent Variable**

- Sustainable Built Environment

Figure **Error! Use the Home tab to apply 0 to the text that you want to appear here..1**  
Conceptual Framework (Structure)



The SBAT suggests that the pillars of Environmental, Economic and Social factors accompanied by their elements of energy, water, waste, materials, biodiversity, transportation, resource, management, local economy, service production, Access, health, education, inclusion and social cohesion along with all the assessment areas of their sub elements are the measuring factors for a built environment to be called sustainable.

## **CHAPTER THREE**

### **3. RESEARCH METHODOLOGY**

This chapter briefly presents the methodology applied in the course of the study. Design of the research, sources of data, data collection technique, population of the study, sampling technique, sample size, method of analysis and ethical considerations are highlighted.

#### **3.1 RESEARCH DESIGN AND APPROACH**

The choice of research design primarily depends on the objectives of the study that are going to be attained. This study used descriptive research design approach. Descriptive research examines a situation as it is; it does not involve changing or modifying the situation under investigation. (Leedly & Ormrod, 2005).

The study is qualitative in its approach; the qualitative data research relies on the measurement and analysis of judgmental and subjective conclusions. Therefore, for this study, qualitative research approach is used to assess Sustainability of Residential Building Construction firms of Ethiopia, residing in Addis Ababa.

#### **METHOD OF DATA COLLECTION TARGET POPULATION, SAMPLING TECHNIQUE AND SAMPLE SIZE**

##### **3.2. METHOD OF DATA COLLECTION**

Personal observation and experiences; building occupiers, owners and managers, residents in the study area, concerned professionals were the main sources of the primary data. The data collection methods used to collect the primary data consist of, open ended surveys and questionnaires, key informant interview and direct observation.

Contents from the SBAT tool template described on the conceptual framework are arranged in a way comfortable to cover all the areas of assessment of sustainability.

The structure and criteria of the SBAT be understood in terms of environmental, economic and social performance. Performance in each of these is captured in terms of a particular area, objective and sets of indicators. This relationship between sustainability areas, built environment objectives and indicators can be charted in the conceptual framework.

### **3.3. TARGET POPULATION**

The target population in this research as seen from top-down include the following, targets from representatives of the six groups mentioned, was involved in the study by their respective involvement manners.

- Board of directors of construction projects
- Client representatives
- Project managers
- Construction managers
- Site and Office Engineers
- Contract employees (Contractors, Construction workers)

### **3.4. SAMPLING TECHNIQUE**

Sampling itself is a term that transcends research in general and research paradigms in particular. Unfortunately, sampling has not been given prominence in qualitative research. Yet as noted by Onwuegbuzie (2003), qualitative researchers make inferences from the sample of words to each respondent's truth space when conducting thematic analyses on data from interviews, Open-Ended Surveys and Questionnaires. As the research is a qualitative type, Qualitative researchers believe that humans are complex, somewhat unpredictable beings and those individual differences and idiosyncratic needs override any notion of universal laws of human behaviors despite the research collects some sort of quantitative information to drive them into qualitative conclusions of assessments. Although there is little consensus about what qualitative research is and how it should be undertaken, there is general agreement that the goal of qualitative research is not to generalize beyond a sample to the population (Onwuegbuzie et al., 2005). The study uses a sampling technique known widely as Purposive sampling. Purposive sampling, also known as judgmental, selective, or subjective sampling, is a form of non-probability sampling in which researchers rely on their own judgment when choosing members of the population to participate in their surveys.

This survey sampling method requires researchers to have prior knowledge about the purpose of their studies so that they can properly choose and approach eligible participants for surveys conducted. Researchers use purposive sampling when they want to access a particular subset of people, as all participants of a survey are selected because they fit a particular profile. Purposive

sampling is when researchers thoroughly think through how they will establish a sample population, even if it is not statistically representative of the greater population at hand. As the name suggests, researchers went to this community on purpose because they think that these individuals fit the profile of the people that they need to reach.

The more prior information that researchers have about their particular communities of interest, the better the sample that they're going to select. As the researcher like myself, having prior knowledge on this industry and executing my undergraduate thesis on an area which have similarity to the current study, I have chosen purposive data sampling for this research.

Specifically, the Maximum variation sampling is used through the research. Maximum variation sampling also known as heterogeneous sampling, is a purposive sampling technique used to capture a wide range of perspectives relating to the thing that you are interested in studying; that is, maximum variation sampling is a search for variation in perspectives, ranging from those conditions that are view to be typical through to those that are more extreme in nature. By conditions, we mean the units (i.e., people, cases/organizations, events, pieces of data) that are of interest to the researcher. These units may exhibit a wide range of attributes, behaviors, experiences, incidents, qualities, situations, and so forth. The basic principle behind maximum variation sampling is to gain greater insights into a phenomenon by looking at it from all angles. This can often help the researcher to identify common themes that are evident across the sample.

### **3.5. SAMPLING SIZE**

Qualitative research experts argue that there is no straightforward answer to the question of 'how many' and that sample size is contingent on a number of factors relating to epistemological, methodological and practical issues. The more useable data are collected from each person, the fewer participants are needed. The researcher is to take into account parameters, such as the scope of study, the nature of topic (i.e. complexity, accessibility), the quality of data, and the study design. Indeed, the level of structure of questions in qualitative interviewing has been found to influence the richness of data generated and so, requires attention; empirical research shows that open questions, which are asked later on in the interview, tend to produce richer data.

As the research is tended to study The Assessments of Construction projects conducted by Major Contractors which have a good reputation in adding values to the countries macro economy certain contractors are to be selected by their financial performances their previous projects.

Four local (Level I) Contractors, which reside in the capital and have available projects for the research to be conducted, were selected. Data which is collected from the target population's key personnel is given major importance. The key personnel include, representatives from; (deep 1-on-1 Interviews) Project managers of Clients of each construction projects.

Four questionnaires were conducted on each of the following target populations (28)

- Board of Directors
- Project Managers
- Construction managers
- Site Engineers
- Office Engineers
- Quantity surveyors
- Data Collectors

4 construction sites consisting of 7 technical personnel, which is a total of 28 questionnaires is to be submitted for the target populations.

The other source of data of the research are direct observations on the sites conducted by the method of collecting evaluative information in which the evaluator watches the subject the usual environment without altering that environment.

Only four Construction sites are selected as a sample because it is believed to represent other level I contractors built environments that are playing biggest roles in residential housing provision as they execute their building construction in visibly the same way.

### **3.5 METHOD OF ANALYSIS**

Actual performance is measured by assessing proposed buildings using the indicators listed. Performance in terms of the indicators is calculated in the tool to provide a value from 0 to 5, with 5 indicating that all aspects are in place within housing for occupants to achieve HDI and EF targets and that therefore full performance has been achieved. The scales used in the SBAT rating are shown in table 2.

Table 3.1 Sustainable Building Assessment Tool Scales

<b>SBAT Scale</b>	<b>Sustainable Built environment performance</b>
5	Built environments provide full capability to enable occupants to achieve HDI and EF targets and live in a sustainable way.
4-5	Built environments provide excellent capability to enable occupants to achieve HDI and EF targets and live in a sustainable way.
3-4	Built environments provide strong capability to enable occupants to achieve HDI and EF targets and live in a sustainable way
2-3	Built environments provide partial capability to enable occupants to achieve HDI and EF targets and live in a sustainable way.
1-2	Built environments provide limited capability to enable occupants to achieve HDI and EF targets and live in a sustainable way.
0	Built environments provide no capability to enable occupants to achieve HDI and EF targets and live in a sustainable way.

Source: (Gibbered, 2017).

### **3.5.1. Human Development Index**

The Human Development Index (HDI) of a population is based on the following indicators:

- A long healthy life, measured by life expectancy at birth
- Knowledge, measured by the adult literacy rate and combined primary, secondary, and tertiary gross enrolment ratio
- A decent standard of living, as measured by the GDP per capita in purchasing power parity (PPP) in terms of US dollars

Each of these indicators has minimum and maximum values (goalposts) as indicated on Table 3.3.

Table 3.2 HDI goalposts

Dimensional indicator	Maximum value	Minimum value
Life expectancy at birth	85	25
Adult literacy rate (%)	100	0
Combined gross enrollment ratio (%)	100	0
GDP per capita (PPP US\$)	40,000	100

Source: (World Health Organization (WHO)).

The implications for built environments of the HDI target are that built environments must have the characteristics, and be configured, to enable occupant populations to achieve this target. Another way of stating this would be to say that built environments must have the capability to enable occupant populations to achieve the HDI targets.

### 3.5.2. Ecological Footprint

An Ecological Footprint is compiled by calculating the biologically productive land and sea required to provide the resources a human population consumes and absorb the corresponding waste. The following consumption and wastes and emission production rates are used:

- Food, measured in type and amount of food consumed
- Shelter, measured in size, utilization and energy consumption
- Mobility, measured in type of transport used and distances travelled
- Goods, measured in type and quantity consumed
- Services, measured in type and quantity consumed

The implications for built environments are that they must have characteristics, and be configured, to enable this to be achieved. Again, this can be described as a requirement for built environments to have the capability to enable occupants to follow living and working patterns that achieve the EF target. The SBAT consists of a manual which describes the tool, the criteria, and how to apply to the tool to develop ratings (the manual). It also consists of a locked preformatted Excel spreadsheet (the tool). The tool generates reports, graphs and a rating based on data entered into

the tool. Training and the manual ensure that assessments are objective and standardized. The tool generates reports provide an overall picture of the performance of the building in the form a spider diagram.

### **3.6 RELIABILITY AND VALIDITY OF INSTRUMENTS IN DATA COLLECTION**

Validity and reliability of qualitative research represent the key aspects of the quality of research. When handled meticulously, the reliability and validity parameters help differentiate between good and bad research. They also assure readers that the findings of the study are credible and trustworthy. This aspect becomes particularly vital in case studies involving primary data analysis. Here the researcher's subjectivity can highly influence the interpretation of the data.

Qualitative data is as important as quantitative data, as it also helps in establishing key research points. However, since it cannot be quantified, the question on its correctness is critical. Validity relates to the appropriateness of any research value, tools and techniques, and processes, including data collection and validation (Mohamad *et al.*, 2015). Validity also establishes the soundness of the methodology, sampling process, data analysis process, and the conclusion of the study (Golafshani, 2003).

The Sustainable Assessment Tool (SBAT) lists elements, to measure the performances of sustainability in a built environment which are within the factors of Environment, Economy and Society. Within the elements there are also sub elements of performance measurements which are listed in a way that a technical personnel in a built would easily understand from the knowhow and prior academic and minimum site knowledge achieved. The target populations are selected in a way that their response is valid and the answers they provide in their response is totally from their knowledge they have on the respective subject matter.

Quantitative research includes reliability measures where the researcher must prove that the process and the results have replicable outcomes. It is very important for qualitative research to include a reference to a quantitative aspect. The use of a simple quantitative aspect in otherwise completely qualitative research creates a very positive attitude towards the overall concept of the research and helps to establish reliability in a much easier form. This study applied the idea of using quantitative responses in a form of questionnaire to add more value on the research's reliability.

### **3.7 RESEARCH ETHICS**

The researcher had followed ethically and morally acceptable processes throughout the research process. The data was collected with the full consent of the participants and the respondents were all aware of the purpose of the study. Documents reviewed from the organization remained confidential. The findings and results from this study will not be used for another purpose. During these study respondents were free to respond their own opinion from their experience, and their personal information such as name and detailed information was not mentioned.

## **CHAPTER FOUR**

### **4. DATA ANALYSIS, PRESENTATION AND DISCUSSION**

#### **4.1 INTRODUCTION**

This chapter presents and analyzes the data collected through primary and secondary sources. To recall once again, the main purpose of this research is to assess sustainability of projects from building construction firms residing in Addis Ababa. Qualitative analysis technique ranging from simple tables and diagrams showing frequency and occurrences to establishing relationships between variables by the help of SBAT is used to analyze the collected data. This analysis of data is presented by means of percentages, tables and figures (spider diagram) which is generated from the SBAT Report spreadsheet.

The information investigation and finding covers three essential portions; the first part is the basic information of the respondents, which covers their Gender, work experience in the building construction firm, the type of organization the respondents are working at, and their current position in their respective organization.

The Second part covers Sustainable Building Assessment Tool (SBAT) area's objectives and indicators, with their environmental, economic and social aspects of assessments along with their respective sub assessment portions that include, Built environment's energy efficiency and usage of renewable energy, minimization of the consumption of mains portable water, minimization of emissions and waste directed to landfill, minimization of construction impacts, The support of biodiversity, support of energy efficient transportation, efficient use of resources, support of the local economy, support of access to facilities, support of a healthy and productive environment and if the building supports education.

## 4.2. RESPONSE RATE

From the 28 questionnaires distributed to respondents, 25 of the respondents took their time to fill the questionnaires, which accounts for 89% of the total respondents. Out of the respondents, 56% were male and 44% are female.

## 4.3. DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

### 4.3.1. RESPONDENTS WORK EXPERIENCE IN CONSTRUCTION PROJECTS

The study sought to find out the respondents work experience in Building Construction projects. This factor is critical because it can measure the quality of the responses given by the respondents. The results are presented in Table 4.1.

Table 4.1: Summary of Work Experiences of Respondents

Work Experience (Years)	Frequency	Percentage
< 5	9	36
5 – 10	9	36
10 – 15	6	24
> 15	1	4
Total	25	100

The work experience of the respondents as presented in Table 4.1 indicate that out of the 25 respondents 36% worked for years less than five, 36% worked for years ranging from five to ten, 24% worked for years ranging from ten to fifteen and 4% worked for years greater than fifteen. All the respondents are believed to be well informed and qualified for the terms used in the questionnaire.

### 4.3.2 TYPE OF RESPONDENTS ORGANIZATION

The study evaluated responses of employees from three types of organizations which play direct role in the construction firm of Ethiopia. Client, Consulting firm and the Contractor. The distribution of respondents to their respective firms is presented in Table 4.2.

With respect to type of organization of the respondents, the information delineates that the dominant response was from the consulting firms which accounts of 58.3% of all the responses. Responses from both the contractor and client side accounts of 20.8% each.

Table 4.2: Summary of Type of Organization of Respondents

Type of Organization	Frequency	Percentage
Client	5	20.8
Contractor	5	20.8
Consultant	14	58.3
Total	24	100

#### 4.3.3 RESPONDENTS CURRENT POSITION IN HIS/HER ORGANIZATION

As depicted below in Table 4.3 majority of the responses were from Project Managers in their respective organizations which accounts for 28% of all the respondents. Office Engineers account for 24% of the overall responses, Construction managers and Site Engineers take 12% of the responses each Board of Directors and Quantity Surveyors have each 8% respondents the 4% of responses is for both Site supervisor and Resident Engineers position.

Table 4.3: Summary of Respondents Current Position in his/her Organization

Current Position	Frequency	Percentage
Board of Directors	2	8
Project Manager	7	28
Construction Manager	3	12
Site Engineer	3	12
Office Engineer	6	24
Quantity surveyor	2	8
Site Supervisor	1	4
Resident Engineer	1	4
Total	25	100

## **4.4. SUSTAINABLE BUILDING ASSESSMENT TOOL (SBAT) AREA'S BY OBJECTIVES AND INDICATORS**

### **4.4.1 ENVIRONMENTAL ASSESSMENT AREAS**

The Environmental Assessment Area on the SBAT deals with the areas of environmental conditions in which buildings are being organized towards the sustainable built environment. This area assesses the building efficiency and usage of renewable energy, minimization of the consumptions of mains portable water, minimization of emissions and waste directed to landfill, minimization of the construction impacts of building materials, and the built environments support of biodiversity. In the tables preceding, the inquiries raised for the respondents contain five point SBAT scale rating method in which; 1= Built Environment provides no capacity, 2 = provides limited capacity, 3 = provides in partial capacity 4=provides with strong/excellent capacity and 5 = provides with full capacity. After the respondents' inquiry is analyzed, the results are presented as the weighing method provided by the SBAT Residential tool which is used throughout the study.

#### 4.4.1.1 ENERGY (Is the built environment energy efficient and uses renewable energy?)

Respondents were asked to put forward their general understandings on the approaches of their respective built environment towards the efficient energy and renewable energy usages based on fourteen elements of assessment. Furthermore the median and weights according to the SBAT tool are identified as they are the direct inputs for the SBAT Report.

Table 4.4 Summary of built environments' efficient energy and renewable energy

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
EN1 – Building Orientation	25	3	0	28	56	16	0	1
EN2 - Building Depth	25	3	4	24	44	20	8	1
EN3 - Roof Construction (minimizing the heat gain through roof)	25	3	12	12	36	40	0	1
EN4 - Wall Construction	25	3	0	20	56	24	0	1
EN5 - Floor Construction	25	3	0	28	40	32	0	1
EN6 - Window to Wall Ratio	25	3	0	25	29.2	37.5	8.3	1
EN7 - Ventilation openings	25	3	0	16	48	32	4	1
EN8 - Daylight	25	3	4	4	56	32	4	1
EN9 - Internal Lighting	25	4	0	4	36	52	8	1
EN10 - External Lighting	25	3	4.3	8.7	39.1	39.1	8.7	1
EN11 - Installed Equipment Power Density	25	3	0	20	36	44	0	3
EN12 - Food Cooking	25	3	12.5	41.7	29.2	16.7	0	1
EN13 - Water Heating	25	3	24	24	24	28	0	1
EN14 - Renewable Energy Generation	25	2	24	40	24	8	4	2

As it can be observed from the table more than half of the respondents said the building is oriented towards optimum exposure to daylight, sunlight and associated heat loss and gain within the building. 28% of the respondents answered the building is oriented in a limited capacity and those of 16% responded it is in a strong capacity towards bringing optimum exposure to daylight, sunlight and associated heat loss and gain within the building.

On the building depth, majority of respondents which accounts for 44% responded that the building partially accompanies the concept of limiting the building depth for good cross ventilation and day lighting within the building, 24% responded the building accounts the quality of the depth in a limited capacity and 20% of respondent think the building strongly considers the depth for the mentioned advantages.

Around 40% of respondents said that the roof construction in the built environment strongly considers the attainment of minimizing the heat gain which may lead to heat loads within the interior which in turn leads to high internal temperatures and discomfort, 36% of the respondents think the building fulfills the roof construction in a partial capacity. On the other element stated, which is wall construction, more than half of the respondents think that the built environment provides partial capacity towards minimization of uncontrolled heat flow through walls of the building that can lead to high or low internal temperatures and occupant discomfort.

Majority of the respondents (40%), believe the floor construction partially fulfills the logic of the floor consisting of exposed high thermal mass material, and 37.5% of the respondents also believe that the window to wall ratio is strongly achieved for the minimization of uncontrolled heat losses and gains. 48% of respondents said the ventilation openings of the building partially accompanies the idea of the minimum necessary ventilation opening area per room floor area provided for each useable room, 32% believe that it is strongly achieved by the built environment.

Around 56% of respondents believe that the building partially achieves the requirement of enough daylight entering, which is important for human health and avoids the need for artificial lighting, 32% think the building allows enough daylight. Majority of the respondents 52% and 39.1% also believe the built environment provides internal and external lighting in strong capacity.

Majority, 44% of respondents believe the installed equipment density provides partial capacity towards the minimization of Equipment in buildings which consume a significant and varying

proportion of energy within buildings. In other case, 41.7% of respondents believe the building uses solar cooker, biogas stove or hotbox provided to support food cooking only in a limited capacity, and 28% of respondents believe the buildings hot water heating requirements met through renewable energy sources with electrical back up in a strong capacity. And finally, majority of respondents (40%) believe the building’s renewable energy generation capacity is limited.

**4.4.1.2. WATER (Built environment minimizes the consumption of mains portable water)**

In this section respondents were asked if the built environment minimizes mains water consumption. Six elements are listed for Assessment and respondents were asked to use the SBAT scaling approach which ranges from 1 = provides with no capacity to 5 = provides with full capacity. The median of respondents answer is listed on the left of the table while the SBAT weight for the purpose of the SBAT report is at the right.

Table 4.5 Summary of Built environments minimization of mains water usage

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
WA1 – Toilets	25	2	28	32	24	16	0	1
WA2 – Wash Hand Basins	25	2	16	32	44	8	0	0
WA3 – Showers	25	3	16	28	44	12	0	1
WA4 – Hot Water	25	2	20	36	40	4	0	0
WA5 – Landscape	25	3	12	32	32	16	8	1
WA6 – Rainwater Harvesting	25	2	48	24	4	16	8	2

The first element on the table asked respondents if the Toilets are capable of minimizing the consumption of mains water portable water because Flushing toilets in housing consume very significant amounts of mains potable water. 32% of respondents believe the building is limited to provide that and 28% think the built environment does not provide water consumption minimization for mains portable water. Furthermore, majority of the respondents (44%, 44%,

40%) believe the wash hand basins, showers and hot water serving in the building provide partial impact in the minimization of the mains potable water consumption knowing that significant amounts of mains potable water can be wasted in wash hand basins as a result of high water flows and the other (32%, 28%, 36%) believe the building provides for this element in a limited capacity. 32% of respondents believe the landscaping is partially capable of not requiring irrigation or all requirements met from grey/rain water harvested water, the other equally numbered respondents believe the built environment is limited to provide the element. Finally, majority 48% of respondents believe that rain water harvesting requirement is not met while 24% of respondents believe the built environment have a limited capability in rain water harvesting.

**4.4.1.3. WASTE (The building minimizes emissions and waste directed to landfill)**

In this portion of the study, built environment’s minimization of emissions and wastes directed to landfill is assessed. Five elements, to be rated by the SBAT scaling are listed on the table. The respondents answer in percentile, the median and the SBAT weight are all provided on the table as follows.

Table 4.6 Summary of responses for minimization of waste

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
WE1 - Recycling Area	25	2	40	16	24	20	0	0
WE2 - Recycling Collection	25	2	44	28	20	8	0	0
WE3 - Organic Waste	25	2	32	36	12	20	0	0
WE4 - Sewage	25	3	16.7	29.2	12.5	33.3	8.3	1
WE5 - Construction Waste	25	3	0	20	40	36	4	1

Respondents were asked about how capable their respective built environment is in providing enough recycling area and Collection. 40% and 44% of the respondents believe the building provides none. Furthermore, 36% of the respondents believe the built environment provides limited capability in recycling Organic waste is on site. 32% believe there is no such culture at the site at all.

The fourth element at the table asked for if Sewage is treated on site, or in within the neighborhood, to provide useful by-products such as irrigation water and fertilizer. 33.3% of the respondents believe the sites have strong capability in providing those advantages. At last, the respondents were asked if reasonable amount of construction waste to be recycled or reused on site, 40% said the building is partially capable and 36% of them believe the built environment provides it in a strong capacity.

**4.4.1.4 MATERIALS (Construction impacts of building materials are minimized)**

In the preceding table, respondents were asked for their insights of their respective built environment’s minimization of the construction impacts of building materials. The respondents were given to answer the questions listed as seven elements in a SBAT scaling method. The results are on the table preceding.

Table 4.7 Summary of construction materials impact

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
MA1 - Building Reuse	25	2	16.7	33.3	41.7	8.3	0	2
MA2 - Timber Doors and Windows	25	3	0	32	40	24	4	1
MA3 - Timber Structure	25	2	44	20	12	16	8	0
MA4 - Refrigerants	25	2	36	20	16	24	4	0
MA5 - Volatile Organic Compounds	25	2	32	36	16	12	4	0
MA6 - Formaldehyde	25	2	48	20	24	8	0	0
MA7 - Locally Sourced Materials	25	3	12	28	44	12	4	1

The first element on the table assesses the building reuse rate which is if reasonable amount of the existing building structure is reused. 41.7% think that issue is partially applicable for their respective built environment, and 33.3% think limited amount of the existing building structure is reusable. The second element asks the respondents if reasonable amount of the windows and doors

(by number) used in the building are made of timber, because timber must be certified from sustainable sources. 40% think the building provides partial employment of timber windows and doors those of 32% believe it is in a limited capacity. The 3<sup>rd</sup> element on the table about the usage of timber structure Over 80% (by weight) of the roof or floor structure. 36% believe that it is not totally met by the built environment and 20% think that the building provides a limited capacity.

The other areas of assessment mentioned on the table are minimization of the effects usages of refrigerants, volatile organic compounds and formaldehydes on the site. 36%, 32% and 32% believe the built environment does not minimize the usages of the mentioned elements respectively. 20% and 36% believe the building minimizes their usage in a limited capability.

The final element on the table assesses if the building provides the usage of locally sourced materials. 44% think building materials are partially used from local sources and 28% think the built environment uses locally sourced materials only in a limited capacity.

#### **4.4.1.5 BIODIVERSITY (Built environment supports biodiversity)**

This portion lists four elements which are used to assess the built environments support to biodiversity which is the part of environmental assessment are that adds towards the overall sustainability. Results are on the table 4.8.

Table 4.8 summary of built environments support to biodiversity.

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
BI1 Brownfield Site	25	2	29.2	25	37.5	8.3	0	2
B12 Municipal Boundary	25	3	8.3	16.7	29.2	29.2	16.7	1
BI3 Vegetation	25	2	20	32	32	16	0	2
B14 Ecosystems	25	3	8	28	48	16	0	1

The table consists of elements of lists which include Brownfield site, if the Site has already been built on and a green-field site is avoided, if the site fulfils the criteria of meeting the municipal

boundary provided by the state, vegetation on the site which includes gardens, roof gardens, internal planting, vertical gardens and creepers. And finally the ecosystem which should consist of variety of plant species are assessed. 37.5% of the respondents answered the site was partially green when it was cleared for the construction to begin. Equally 29.2 % of respondents believe the municipal boundary is partially and strongly respected by the built environment. And when we come to the vegetation cover and the ecosystem of the built environment, 32% and 28% respondents think the site partially fulfils the elements with 32% and 28% of the respondents believe built environment provides those elements in a limited capacity.

#### 4.4.2. ECONOMIC ASSESSMENT AREAS

The Economic assessment areas on the SBAT deal with built environment’s economic wellbeing which sums up towards the overall sustainability. The Economic assessment area is further categorized into five areas which include, support to energy efficient transportation, built environment’s efficient use of resource, the management to support sustainability, support to local economy and usage of sustainable products and services. Those categories are further broken down to sub elements for the purpose of detailed assessment.

##### 4.4.2.1. TRANSPORT (The building supports energy efficient transportation)

Table 4.9 Summary of building’s support to energy efficient transportation

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
TR1 - Pedestrian Routes	25	3	0	17.4	43.4	30.4	8.7	1
TR2 - Cycling	25	2	28	40	24	8	0	0
TR3 - Public	25	3	4	4	48	32	12	2

This table deals with assessment of built environment’s support to energy efficient transportation. Here the 1<sup>st</sup> question asks if the building supports Dedicated, safe and easily used pedestrian paths are provided from public highways to main entrance of the building. Majority of respondents which account for 43% of the total, think that the building partially provides the service, 30.4% think the built environment has strong capability towards providing the necessity of pedestrian routes. Furthermore, 40% and 28% of respondents believe the built environment’s capacity for providing cycling roads and secure bicycle

parking facilities provided at/for each unit is limited and null, respectively. Half of the respondents believe the walking distance from the building to public transport node is neither faraway nor very near. 32% think the distance strongly achieves the minimization of the walking distance to public transportation facilities which is positively seen as a cost effective and has fewer negative environmental impacts than car use.

**4.4.2.2. RESOURCES (The building makes efficient use of resources)**

This portion on the SBAT deals with assessing the built environment for its efficient resource usage by listing four elements, which are the Site Density, Area per Occupant, Renewable Energy generation and the Food production. The results are cited as follows.

Table 4.10 Summary of building’s efficient use of resources

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
RE1 - Site Density	25	3	0	48	44	4	4	2
RE2 - Area per occupant	25	3	4	20	40	36	0	2
RE3 - Renewable Energy Generation	25	2	28	44	24	4	0	1
RE4 - Food Production	25	2	37.5	33.3	20.8	8.3	0	1

The first question is asked to assess the density of the site which is person per hectare, increased site densities enable improved efficiency in the supply of services and support better access to health, education and recreation facilities. Transportation costs and impacts are also reduced. Half of the respondents believe the site is limited to be dense as needed to provide the advantages mentioned and 44% think the built environment is partially dense. 44% of the respondents think the built environment provides only a limited capacity towards renewable energy generation and majority 37.5% of respondents believe space for food production at the site is very limited.

**4.4.2.3. MANAGEMENT (The building is managed to support sustainability)**

The management section on the SBAT is created to measure the built environments’ management quality in the support of achieving sustainability. It consists of five elements which

includes, the detailed manual provision about the usage of the building, Energy and Water metering to control their usage, recording of necessary data and whether the building has Residents association that makes necessary follow-ups towards the achievement of sustainable built environment. The results are as follows on the table below.

Table 4.11 Summary of Buildings management towards sustainability

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
MN1 - Manual	25	3	8	44	20	28	0	1
MN2 - Energy Metering	25	2	4	52	40	4	0	0
MN3 - Water Metering	25	3	8	32	52	8	0	1
MN4 - Recording	25	3	4	12	40	24	20	1
MN5 - Residents Association	25	3	8	12	40	36	4	1

In order for facilities managers to manage buildings properly and for occupants to use buildings in optimum ways it is important that they are aware of the purpose of buildings systems and how they work. As seen from the results of the table, 44% of respondents answered the buildings provide detailed manual about the building use in a very limited manner. Furthermore, 52% of the respondents think Energy metering at the site is very limited and also another 52% of the respondents believe the water metering is done fairly in a partial capacity. Finally 40% of respondents believe residents association which is an effective mechanism for ensuring that neighborhood services and facilities such as street lighting, roads, pavements, storm water channels, parks and sports facilities are managed effectively are fairly being implemented.

#### **4.4.2.4. LOCAL ECONOMY (The building supports the local economy)**

This portion discusses whether the built environment is entitled to support the local economy which is a way out to achieving the overall sustainability. The Local Economy section on the SBAT consists of three elements which include, locally sourced materials and products at the site, small enterprises given chance and construction workers support. The result is as follows.

Table 4.12 Summary of building’s support to local economy

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
LE1 Locally Sourced Materials and Products	25	3	4	16	40	36	4	2
LE2 Small Enterprise	25	3	16	20	52	12	0	3
LE3 Construction Workers Support	25	3	12	44	24	20	0	1

Materials and products that are manufactured within the country have reduced impacts associated with transport compared to similar imported materials and products. 40% and 36 % of the respondents believe the built environment partially and strongly accepts the support of locally manufactured supplies. More than half of respondents think small enterprises which are crucial to the development of a diversified vibrant local economy are partially being given market opportunity at the site. The 3<sup>rd</sup> section assesses the construction workers support at the built environment which includes valuable employment opportunities for local people is provided in a little or limited capacity.

**4.4.2.5. SERVICES AND PRODUCTS (The building supports use sustainable products and services)**

The Services and Products section provides information on the buildings’ support to usage of more sustainable products and services. Table 4.13 provides the answer by listing eight elements that include, Fresh fruit and vegetables produced within the country, Fresh locally baked bakery products are within walking distance from the building, Beans and pulse, Milk and Eggs, Clothing, furniture, equipment hire and Physical notice at central point for advertising local products and services are all located in reasonable distance from the built environment.

Table 4.13 Summary of building's support to use sustainable products and service

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
SP1 - Fruit and Vegetables	25	2	16.7	45.8	33.3	4.2	0	1
SP2 - Bakery Products	25	2	24	48	24	4	0	0
SP3 - Beans and pulses	25	2	28	44	24	4	0	0
SP4 - Milk and Eggs	25	2	24	44	24	4	4	0
SP5 - Clothing	25	3	12	44	16	16	12	1
SP6 - Furniture	25	2	16	36	32	16	0	0
SP7 - Equipment Hire	25	3	12	44	16	24	4	1
SP8 - Notice Board	25	2	12	48	24	16	0	0

As it is observed from the table getting those sustainable services that include Fresh fruit and vegetables produced within the country, Fresh locally baked bakery products are within walking distance from the building, Beans and pulse, Milk and Eggs, Clothing, furniture, equipment hire and Physical notice are all available for the built environment in a limited capacity. Majority of the respondents 45.8%, 48%, 44%, 44%, 44%, 36%, 44% and 48% have agreed that those services and products are provided in a limited capacity.

#### **4.4.3 SOCIAL ASSESSMENT ASPECTS**

The third part on the SBAT discusses about the assessment of Social Aspects of the built environment which is further sub-divided into, the buildings support of access to facilities, built environments support to healthy and productive environment, support to education, social cohesion and inclusion.

##### **4.4.3.1. ACCESS (The building supports access to facilities)**

The first table puts the assessment of the buildings support of access to facilities listing six elements within to make the measurement more legit. The elements include Access to the Internet, Banking, Groceries, Post office, Crèche and Access to primary schools. The results are on the table as follows.

Table 4.14 Summary of the buildings support for access to facilities

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
AC1 - Internet Access	25	3	0	8.3	45.8	41.7	4.2	1
AC2 - Banking	25	4	0	12	32	32	24	1
AC3 - Groceries	25	3	12	8	28	32	20	1
AC4 - Post Office	25	2	16	36	40	8	0	0
AC5 - Crèche	25	3	16	34	28	28	4	1
AC6 - Primary Schools	25	3	20	12	40	20	8	1

Access to low cost or free internet can be used to reduce transport impacts as information can be accessed locally. Access to information can also be used to support education, communication and small businesses. From the findings on the table 45.8% and 41.7% of respondents think the access to the internet on the built environment is fair and is provided in a strong capacity. Equally 32% of the respondents believe ATM or Bank can be fairly and easily accessed. Furthermore, 32% of the respondents believe the groceries accessibility is strongly considered by the built environment, 40% of the respondents believe post offices to be fairly accessible and 36% believe post offices accessibility is limited.

Access to local crèches reduce transport impacts. Living and business costs may also be lower as there is a reduced requirement for vehicular transport. 34% Of respondents think local crèche is not easily accessible from the built environment while equally 28% of the respondents believe the accessibility to be fair and strong. Furthermore, 40% of the respondents believe the access to primary schools is fair the other 20% of the respondents think there are primary schools in a walking distance from the built environment.

#### **4.4.3.2 HEALTH (Built environment supports a healthy and productive environment)**

This portion with in the social wellbeing of the built environment discusses the buildings support to a healthy and productive environment by listing 14 assessing elements consisting of Availability of Exercise facilities, Health facilities, fruit and vegetables, beans and pulses, milk

and egg, clean water, external views, daylight, openings, roof construction, wall construction, volatile organic compounds, formaldehyde and the construction workers health, which are all very essential for human development and health.

Table 4.15 Summary of responses in built environments support to a healthy and productive environment

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
HE1 - Exercise	25	3	0	32	28	32	8	1
HE2 - Health facility	25	3	4	28	40	28	0	1
HE3 - Fruit and Vegetables	25	3	12	32	28	28	0	1
HE4 - Bean and Pulses	25	2	12	52	36	0	0	0
HE5 - Milk and Eggs	25	3	16	36	24	24	0	2
HE6 - Water	25	3	0	28	36	32	4	1
HE7 - External Views	25	4	0	8	32	44	16	2
HE8 Daylight	25	3	0	8.3	54.2	37.5	0	1
HE9 - Openings	25	4	0	12	36	36	16	1
HE10 - Roof Construction	25	3	0	12	44	44	0	1
HE11 - Wall Construction	25	3	8	20	40	32	0	1
HE12 - Volatile Organic Compounds	25	2	28	40	16	16	0	0
HE13 - Formaldehyde	25	2	25	37.5	12.5	16.7	8.3	0
HE14 - Construction Worker Health	25	2	17.4	43.5	26.1	13	0	0

As it is seen on the findings from the table, equally 32% of the respondents believe the site provides limited access and also strong access to exercise facilities while 28% think the access to exercise facilities is fair. On the other hand 40% of respondents believe the access to health facilities is fairly considered by the built environment while equally 28% of respondents think

access to health is limited and easy as well. 38% of respondents think access to fruits and vegetables is limited, while equally 28% of respondents believe it is fair and easy to make it to there. Access to bean, pulses, milk and eggs is limited according to 56% and 36 % of the respondents. While equally 24% of respondents believe the milk and eggs are fairly and easily accessible. 36% of respondents believe that clean drinking water is fairly available within or near the building while 32% believe the built environment provides the service in a strong capacity.

According to 44% of the respondents external views at the site are strongly considered for the useable rooms to have glazing on external walls which provide a view. Equally 36% of respondents think the opening on the building is fair and enough. Majority 44 of the people believe the built environment is strongly capable while building roofs, which is highly attached with tenant's comfort. 40% of respondents think the wall construction is fair. And as it is seen from the findings of 40% and 37.5% of the respondents, usage of volatile organic compounds and formaldehyde isn't minimized. Concluding this portion, the construction workers health is assessed, and majority of respondents believe there is a limited access and will for the health and wellbeing of the construction workers.

#### **4.4.3.3 EDUCATION (The building supports education)**

This portion of the SBAT deals with the assessment of the built environment's support to education through the measurements of eight elements within it. Availability of Primary and Secondary schools, Ongoing Education, Internet, Notice Boards, Space for Learning, Building User Manual, and Construction Worker Education. The results from the finding is on the table as follows.

Table 4.16 Summary of the building’s support to education

Indicator	Percent of Responses							SBAT weight
	N	Median	1	2	3	4	5	
ED1 - Primary Schools	25	3	13	17.4	39.1	26.1	4.3	1
ED2 - Secondary Schools	25	3	13	26.1	26.1	30.4	4.3	1
ED3 - Ongoing education	25	3	12.5	29.2	25	29.2	4.2	1
ED4 - Internet	25	3	12.5	29.2	45.8	8.3	4.2	1
ED5 - Noticeboards	25	3	12	32	40	12	4	1
ED6 - Space for Learning	25	3	12	12	20	48	8	1
ED7 - Building User Manual	25	3	12	20	48	20	0	1
ED8 - Construction Worker Education	25	2	12	48	32	8	0	0

According to 30.4% of the respondents availability of secondary school in the neighborhood is strongly accessible and easy to find, but that of ongoing education is according to 29.2% respondents, it is limited to access. 48% of respondents think the built environment provision of space for learning is strongly achieved. Furthermore, majority of 48% of respondents believe the construction workers access to education is very limited within the built environment.

#### **4.4.3.4 INCLUSION AND SOCIAL COHESION (The building is inclusive of diversity in population and social cohesion)**

This portion of the SBAT deals with the building’s support of inclusion of diversity in population through eleven elements consisting of accessible public transport route, accessible walking routes to groceries, walking route within the site, entrances and exits, circulation within the rooms, accessible locations of windows, doors and lighting controls, bathrooms, kitchen, inclusive employment (inclusion of women, youth and disabled), the affordability of the housing to the public, communal space, covered neighborhood facilities, external neighborhood facilities and residents association. Unlike the other method of data collection which is the questionnaire, this last portion of the SBAT data is collected through direct site observation and information

from key personnel. The results were put in the following table and directly used as inputs for the final portion of the SBAT.

Table 4.17 Summary of Inclusion and Social Cohesion

Indicator	SBAT Achievable weight	Actual Weight
IN1 – Public Transport	1	1
IN2 – Groceries	1	1
IN3 – External Routes	1	1
IN4 – Entrances and Exits	1	1
IN5 – Circulation	1	1
IN6 – Window, Door and Lighting Control	1	1
IN7 – Doors	1	1
IN8 – Bathroom	1	1
IN9 – Kitchen	1	1
IN10 – Inclusive Employment	1	0
IN11 – Affordability	2	0
SC1 – Communal Space	2	0
SC2 – Covered Neighborhood Facilities	2	2
SC3 – External Neighborhood Facilities	1	0
SC4 – Residents Association	1	1

The finding from direct observation and key personnel interview from the above table shows that, the route to public transportation, groceries, walking route within the site, entrances and exits, circulation, windows doors and lighting systems, bathrooms, kitchens is easily accessible. While, inclusive employment, affordability and external neighborhood facilities are all not well considered by built environment.

In conclusion, the data and findings from each portion of the SBAT and their elements was all fed to the “Sustainable Building Assessment Tool Residential 1.04” software to generate the

overall report for all the studied built environments in a form of Spider Web Diagram. The results from the SBAT report will be summarized and concluded at the final chapter.

# SUSTAINABLE BUILDING ASSESSMENT TOOL RESIDENTIAL

1.04

Achieved

## SB SBAT REPORT

2.8

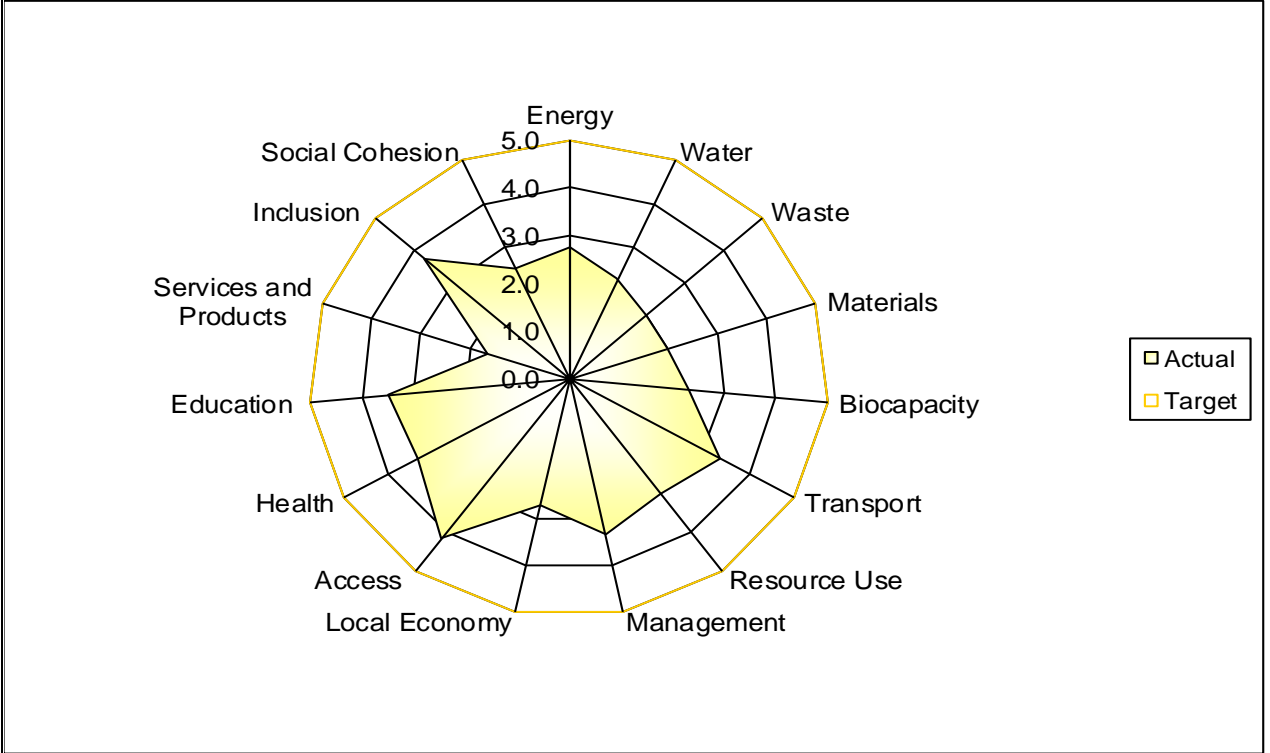
### SB1 Project

Overall Report

### SB2 Address

Addis Ababa

### SB3 SBAT Graph



### SB4 Environmental, Social and Economic Performance

Score

Environmental	2.3
Economic	3.3
Social	3.0
<b>SBAT Rating</b>	<b>2.8</b>

### SB5 EF and HDI Factors

Score

EF Factor	2.4
HDI Factor	3.3

### SB6 Targets

Percentage

Environmental	45
Economic	66
Social	59

Figure Error! Use the Home tab to apply 0 to the text that you want to appear here..2 Overall SBAT report 1

#### 4.6 GENERALIZATION OF THE FINDINGS ON SBAT REPORT

According to the findings of the study, the SBAT report is developed and the result is clearly put to see the performances of the built environment in the form of spider diagram in which the overall conclusion is drawn from. See figure 5.1.

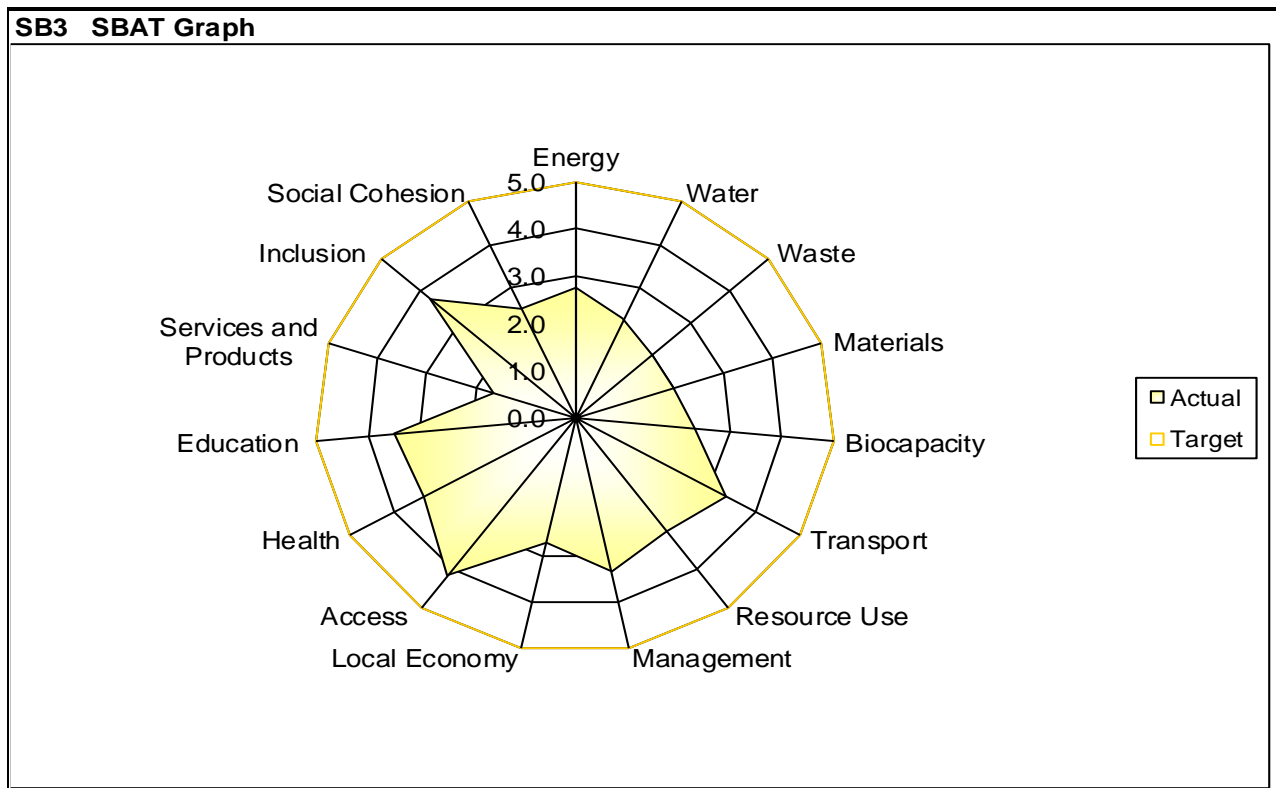


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From the spider diagram on figure 5.1, we can conclude that which performance elements need special attention through all the assessment aspects of Environmental, Economic and social areas. It is clearly seen on the spider diagram that all the elements are listed in a web circle manner with their SBAT weight ranging from 0 running to maximum 5. The Target is the last web circling the weight 5 in a yellow color, while the actual performance runs as a web circle within the spider web diagram in black. The study found out that the maximum performance score is from the Economic area of assessment which weighs an average total of 3.3. The Social

assessment has a total average weight of 3. And the minimum performance score goes to the Environmental aspects of the built environment.

The top performance scores from the findings with in the Environmental aspects of the built environment as seen from the right top quarter in the spider web diagram are efficiency of energy usage, in which it still didn't surpass the weighing score of three. All the other elements like minimization of mains water usage, efficient waste management, the construction impacts of building materials and support to biodiversity all run exactly at the performance weighing score of 2. Therefore all the mentioned aspects of Environmental performance by the built environment are the ones to give attention for necessary improvement measures.

From the bottom right quarter of the spider diagram we can conclude that Transportation, resource usages and the sustainability management aspects all surpassed the performance weighing score of 3, which according to the SBAT has a positive implication but some extent of improvement helps to widen the circle for even a better score. The support of the built environment to Local economy is the last to be visualized at the bottom of the spider web slightly to the left. From its score it is concluded that the performance weight of the element (support to local economy) needs special attention among the Economic areas of the built environment to reach the necessary target.

The left side of the spider web gives a visual implication for the Social performance of the built environment. As it is seen from the stretched pin points of the spider web circle we can conclude that one aspect of the Social condition in the built environment have performed giving an excellent score weight which is the Access to facilities that also scored the highest through all the elements in the spider web. Thus, it can be concluded that the built environments have taken their responsibility of providing Access to facilities for their built environment and surrounding.

The next top scorers from the spider web diagram at the left are, access to health, education and inclusion, in which all three surpassed the performance score weight of 3, from what the SBAT implication is derived to put strong capability of the built environment towards these elements. The performance weight score of the Social cohesion at the built environment passes through the 2 point which implies the site has to improve on its cohesiveness, socially. The last term to discuss from the spider diagram needs special consideration in the Ethiopian built environment. A performance Score weight of less than 2, which is the least among all the performance

elements. The SBAT report implies this score of built environment to provide limited capacity of building performance. The spider web circle at that point needs to be stretched by improvements in provision the access to get services and products with sustainable values.

The general implication from the SBAT report of the built environments sustainability approach on the Ethiopian construction sites shows that the overall score of 2.8 is achieved which is a positive performance score to conclude with at this point, knowing that the score range between 2 and 3 from the SBAT implies the built environment provides partial capability to enable occupants to achieve HDI and EF targets and live in a sustainable way. But the target is still too far away to reach. The negative insight comes when it is reminded that the study focused on the samples which are executed by level I construction firms only. The housing projects from these firms comprise a little part of the vast majority housing projects being built all around the capital Addis Ababa. Generally addressing, the culture of the level of assessment of sustainability in built environment of the Ethiopian construction firms needs to improve in an exponential manner with detailed follow-ups and responsible contract administration and management to walk along with the development goals.

## CHAPTER FIVE

### 5. CONCLUSION AND RECOMMENDATION

#### 5.1. SUMMARY OF FINDINGS

The Study attempted to assess the culture sustainability management of built environments in Ethiopia by studying four different building sites which were being contracted by Level I construction firms, residing in Addis Ababa, through the Sustainable Building Assessment Tool (SBAT) which is specially developed for developing nation's context. The SBAT describes 15 sets of objectives that should be aimed for Residential Buildings. It suggests that the extent to which these objectives are achieved in buildings provide a simple, yet reasonably effective, measure of the level of support for sustainable development. Objectives are arranged under the headings of Environmental, Economic and Social aspects of assessment areas.

Based on the data analyzed in chapter four, using descriptive approach for quantitative data collected through questionnaire, the researcher comes up with the following results.

- Regarding the Assessment of Environmental Aspects, a total SBAT value of 2.3 was achieved from the total achievable of 5. This value is achieved through the accumulated weights which are all measured out of 5. The individual measured weights consist of the built environment's energy efficiency and usage of renewable energy, which weighs 2.7, the buildings minimization of the usage of mains portable water that weighs 2.3, the building's minimization of emissions and waste directed to landfill weighing 2, minimization of Construction impacts of building materials weighing 2, and the buildings support to biodiversity which weighs 2.3 out of 5 possible. The overall weight of 2.3 out of the total 5 on the SBAT tool is considered the built environment provides partial capability to enable occupants to achieve HDI and EF targets and live in a sustainable way. It is visible that the overall environmental score measured below half the total achievable weight there are certain areas toward the scores should be improved.
- As for the Economic Aspects of Assessment, a total SBAT value of 3.3 is achieved from the overall five. This is the cumulative of the sub measurements all rated out of 5, within the Economic Aspects of measurements that consist of, the building's support to energy

efficient transportation that weighs 3.3, the building's efficient use of resource weighing 3, management to support sustainability weighing 3, the building's support to local economy which weighs 2.7, and the building support to sustainable products and services which weighs just 1.7 out of the total 5. Thus an overall SBAT score of 3.3 is finally achieved by the built environment in which its performance is measured to be shown, the built environment provides strong capability to enable occupants to achieve HDI and EF targets and live in a sustainable way.

- Regarding the Social Aspects of Assessment, a total SBAT score of 3 is achieved from the overall achievable of 5. And it is the cumulated measurement from the components of the economic areas consisting of the buildings support of access to facilities weighing 4.2, the built environments support to a healthy and productive environment, which weighs 3.3, support to education weighing 3.5, the buildings inclusivity of diversity in population weighing 3.8 and the building support to social cohesion which is measured to weigh 2.5. Thus the buildings access to facilities is measured to perform an excellent capacity while the social cohesion of the built environment has a performance which is of fair value. The overall performance measurement shows the Economic Aspect of Assessment is 3 out of the overall 5. The SBAT puts this performance for the built environment to be strong capability to enable occupants to achieve HDI and EF targets and live in a sustainable way.

## **5.2 CONCLUSION**

Level I construction contractors in Addis Ababa are the main artists in the show of shaping the country's environmental, economic and social values. They have the influence of shaping the aesthetics of the life standards in the country. This is the reason that their sustainability is needed to be assessed.

Sustainability in the built environments of Addis Ababa is assessed by the Sustainable Building Assessment Tool and the following conclusions were derived

- The built environment is less likely to achieve the environmental sustainability that those of the economic and social ones.
- The support to usage of sustainable services and products from the social aspect and the surge into the local economy from the economic aspect are the worst sustainability performers throughout the built environment.

- Efficient use of energy, minimization of mains portable water usage, minimization of waste sent to the landfill, minimization of construction material impacts and being ecofriendly are the measures which are all performed by the built environment below the average mark.
- The built environment provides partial capability to enable occupants to achieve Human Development Index (HDI) and Ecological Footprint (EF) targets and live in a sustainable way

### **5.3 RECOMMENDATION**

Sustainable construction is an essential aspect of projects, if properly assessed and implemented, it will have an excellent benefits on adding value to cost reduction, increased productivity, waste minimization, use of materials, quality of life, new emerging markets, room for experimentation, while preserving better living environment for the future generation. Having that in mind, the following recommendations are addressed.

- The built environments in Ethiopia should start using certain assessment tools in their management culture. Employing Sustainable Building Assessment Tool (SBAT) is the best way to assess sustainability and implement improvement measures and the tool is suited to be used in developing nation's context.
- The built environments in Ethiopia need to highly improve on the building's support to surge into the local economy that consists of, the building's support to locally sourced materials and products. Materials and products that are manufactured within the country have reduced impacts associated with transport compared to similar imported materials and products. The built environment also should support small enterprises Small business are crucial to the development of a diversified vibrant local economy. They can be supported by providing market opportunities, space, service and finance. There are many useful services that small business can provide within neighborhoods such as retail, car and equipment hire, maintenance, retail, crèches and catering. Support should therefore be provided for small businesses within residential areas. And lastly, because Construction projects can provide valuable employment opportunities for local people, Contract documentation and maintenance policy should requires majority of construction and maintenance workers employed on site to live in the nearby of the site.

- The buildings should support use of more sustainable products and services by providing Fresh fruit, vegetables Fresh locally baked bakery products, beans and pulses, milk and eggs, clothing, furniture, equipment hire and physical notice board for sustainable products and service promotion which are produced within the country are available within a walking distance of the building.
- Other areas which should be given higher priority to attain sustainability in the construction firms of Ethiopia are, the efficiency in use of energy, minimization of the usage of mains portable water, minimization of wastage, minimization of the construction impacts of materials and the support of biodiversity.
- The efficiency of energy usage by built environment is attained by giving all necessary attention towards the building's orientation, minimization of building depth, minimization of solar heat gains through roofs, minimization of uncontrolled heat flow through the walls, controlling the lighting and heat passing through the glazing, allowing Light breezes flowing directly through a building which can be used to provide ventilation and cooling without mechanical means, allowing Good day lighting in the building which is important for human health and avoids the need for artificial lighting, controlling the internal and external lighting, minimizing equipment power density, using Solar cooker, biogas stove or hotbox provided to support food cooking, increasing energy efficiency and using renewable energy sources to heat water and using renewable energy generation on housing sites to avoid carbon emissions, enable increased control over energy costs and reduce dependency on a mains electrical supply.
- Built environment should minimize the usage of mains portable water by using more water efficient toilets or toilets that do not use mains water, by restricting water flows in wash hand basins taps, restricting flow rates in showerheads, by restricting the length of piping between the location of hot water generation and hot water consumption, using rainwater and grey water for irrigation and rainwater for topping up pools.
- Emissions and waste directed to landfill is minimized by providing easily accessible storage for recycling near the point where they are needed. Once recycling material has been gathered, it should be provided to recycling contractor or store it at a central point where it can be stockpiled and much of the construction wastes should be reused on site as

part of construction processes, or be recycled. Finally a significant proportion of household waste, which is organic matter, should be easily composted and used to fertilize planting.

- Built environments attain minimization of the construction impacts of materials through using timber doors, windows and structures. Timber is a grown material and is therefore renewable. It also has a very low embodied energy content (energy required to produce and transport the product to from source to building site). Buildings also attain minimization of material impact by not using refrigerants which contribute to global warming such as HVAC or refrigeration equipment or insulation, and minimizing the use of paints, varnishes, glues or carpets that include volatile organic compounds and formaldehyde.
- Built environments should improve their friendliness to the biodiversity within the site. This is attained by starting the building projects at existing green-field sites that consist of a rich variety of plants and ecosystems and play a valuable role in providing ecological services related to carbon sequestration, temperature and humidity control. It is also attained through planting on site and planting a range of plant species and a minimum of range of different complementary species. Planting can include gardens, roof gardens, internal planting, vertical gardens and creepers.
- Built Environments should allocate enough resource, design innovative processes, allocate incentives for creative employees, give frequent training to people within the organization, encourage knowledge sharing among the employees and develop the implementation of new ideas to support and build the culture of innovative sustainable approach.

#### **5.4. AREAS OF FURTHER RESEARCH**

- This study solely Focused on Built environments which are executed by level I contractors located only at Addis Ababa. As a result, I suggest that future researches to be performed considering other levels of building contractors in Addis Ababa and other parts of the country as well.

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**APPENDIX**  
**ADDIS ABABA UNIVERSITY**  
**SCHOOL OF COMMERCE**  
**DEPARTMENT OF PROJECT MANAGEMENT**

**QUESTIONNAIRE**

**Assessment of Sustainability in Residential Building Construction Firm**

**Addis Ababa University School of Commerce**

Dear Respondents,

The aim of this questionnaire is to obtain professional opinion for the purpose of Assessment of the Sustainability of the building construction industry in Ethiopia. The information provided in this questionnaire will be used for research purposes only. All specific company and respondent information will be kept confidential at all times.

Your response is highly valuable to the outcome of the research and I kindly ask for your cooperation in filling the questionnaire. The data obtained from this questionnaire will not be discussed with friends or family members. Data from one project will not be sold to another organization.

With regards

Amanuel Ashenafi Graduate Student

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**Basic information of the respondent**

1. Name of respondent's organization (Optional)

2. Respondent's Gender

*Check all that apply.*

Male

Female

3. Respondent's work experience in building construction projects (Years)

<5

5-10

10-15

>15

4. Type of respondent's organization

Client

Contractor

Consultant

Other:

5. Respondent's current position in his/her organization

Board of Directors

Project Manager

Construction Manager

Site Engineer

Office Engineer

Quantity Surveyor

Other:

**Sustainable Building Assessment Tool Areas, Objectives and Indicators.**

**Environmental Assessment Areas**

Energy (Built environment energy efficiency and use of renewable energy)

EN1. Orientation

1 2 3 4 5

EN2. Building Depth

1 2 3 4 5

EN3. Roof Construction

1 2 3 4 5

EN4. Wall Construction

1 2 3 4 5

EN5. Floor Construction

1 2 3 4 5

EN12. Food Cooking

1 2 3 4 5

EN6. Window to Wall Ratio

1 2 3 4 5

EN7. Ventilation openings

1 2 3 4 5

EN8. Daylight

1 2 3 4 5

EN9. Internal Lighting

1 2 3 4 5

EN11. Installed Equipment Power Density

1 2 3 4 5

EN12. Food Cooking

1 2 3 4 5

EN12. Food Cooking

1 2 3 4 5

EN14. Renewable Energy Generation

1 2 3 4 5

**Water (Built environment minimizes the consumption of mains portable water)**

**WA1. Toilets**

1 2 3 4 5

**WA2. Wash Hand Basins**

1 2 3 4 5

WA4. Showers

1 2 3 4 5

WA5. Hot Water

1 2 3 4 5

WA6. Landscape

1 2 3 4 5

WA7 Rainwater harvesting

1 2 3 4 5

**Waste (The building minimizes emissions and waste directed to landfill)**

WE1 Recycling area

1 2 3 4 5

WE2. Recycling Collection

1 2 3 4 5

WE3. Organic Waste

1 2 3 4 5

WE4. Sewage

1 2 3 4 5

WA5. Construction Waste

1 2 3 4 5

**Materials (Construction impacts of building materials are minimized)**

MA1. Building Reuse

1 2 3 4 5

MA2. Timber Doors and Windows

1 2 3 4 5

MA3. Timber Structure

1 2 3 4 5

MA4 Refrigerants

1 2 3 4 5

MA5. Volatile Organic Compounds

1 2 3 4 5

MA6. Formaldehyde

1 2 3 4 5

MA7. Locally Sourced Materials

1 2 3 4 5

**Biodiversity (Built environment supports biodiversity)**

BI1. Brownfield site

1 2 3 4 5

BI2. Municipal Boundary

1 2 3 4 5

BI3. Vegetation

1 2 3 4 5

BI4. Ecosystems

1 2 3 4 5

**Economic Assessment Areas**

**Transport (The building supports energy efficient transportation)**

TR2. Pedestrian Route

1 2 3 4 5

TR2. Cycling

1 2 3 4 5

TR3. Public Transport

1 2 3 4 5

**Resources (The building makes efficient use of resources)**

RE1. Site Density

1 2 3 4 5

RE2. Area per occupant

1 2 3 4 5

RE3. Renewable Energy Generation

1 2 3 4 5

RE4. Food Production

1 2 3 4 5

**Management (The building is managed to support sustainability)**

MN1 Manual

1 2 3 4 5

Energy Metering

1 2 3 4 5

MN3 Water Metering

1 2 3 4 5

MN4 Recording

1 2 3 4 5

MN5 Residents Association

1 2 3 4 5

**Local economy (The building supports the local economy)**

LE1. Locally sourced materials

1 2 3 4 5

LE2. Small Enterprise

1 2 3 4 5

LE3. Construction Workers Support

1 2 3 4 5

**Services and Products (The building supports use sustainable products and services)**

SP1. Fruit and Vegetables

1 2 3 4 5

SP2. Bakery products

1 2 3 4 5

SP3. Beans and pulses

1 2 3 4 5

SP4. Milk and Eggs

1 2 3 4 5

SP5. Clothing

1 2 3 4 5

SP6. Furniture

1 2 3 4 5

SP7. Equipment Hire

1 2 3 4 5

SP8. Notice Board

1 2 3 4 5

**Social Assessment Aspects**

Access (The building supports access to facilities)

65. AC1. Internet Access

1 2 3 4 5

AC2. Banking

1 2 3 4 5

AC3. Groceries

1 2 3 4 5

AC4. Post Office

1 2 3 4 5

AC5. Crèche

1 2 3 4 5

AC6. Primary School

1 2 3 4 5

**Health (Built environment supports a healthy and productive environment)**

HE1. Exercise

1 2 3 4 5

HE2. Health facility

1 2 3 4 5

HE3. Fruit and Vegetables

1 2 3 4 5

HE4. Bean and pulses

1 2 3 4 5

HE5. Milk and Eggs

1 2 3 4 5

HE6. Water

1 2 3 4 5

HE7. External Views

1 2 3 4 5

HE8. Daylight

1 2 3 4 5

HE9. Openings

1 2 3 4 5

HE10. Roof Construction

1 2 3 4 5

HE11. Wall Construction

1 2 3 4 5

HE12. Volatile organic compounds

1 2 3 4 5

HE13. Formaldehyde

1 2 3 4 5

HE15. Construction Worker Health

1 2 3 4 5

**Education (The Building Supports Education)**

ED1. Primary Schools

1 2 3 4 5

ED2. Secondary schools

1 2 3 4 5

ED3. Ongoing education

1 2 3 4 5

ED4. Internet

1 2 3 4 5

ED5. Noticeboards

1 2 3 4 5

ED6. Space for Learning

1 2 3 4 5

ED7. Building User Manual

1 2 3 4 5

ED8. Construction Worker Education

1 2 3 4 5

Table 3.1: Sustainable Building Assessment Tool Areas, Objectives and Indicators.

Category	Area	objective	Indicator
Environmental	Energy	Built environment is energy efficient and uses renewable energy	EN1 Orientation, EN2 Building Depth, EN3 Roof Construction, EN4 Wall Construction, EN5 Floor Construction, EN6 Window to Wall Ratio, EN7 Ventilation openings, EN8 Daylight, EN9 Internal Lighting, EN10 External Lighting, EN11 Installed Equipment Power Density, EN12 Food Cooking, EN13 Water Heating, EN14 Renewable Energy Generation
	Water	Built environment minimizes the consumption of mains portable water	WA1 Toilets, WA2 Wash Hand Basins, WA4 Showers, WA5 Hot Water, WA6 Landscape, WA7 Rainwater harvesting
	Waste	The building minimizes emissions and waste directed to landfill	WE1 Recycling Area, WE2 Recycling Collection, WE3 Organic Waste, WE4 Sewage, WE5 Construction Waste

	Materials	Construction impacts of building materials are minimized.	MA1 Building Reuse, MA2 Timber Doors and Windows, MA3 Timber Structure, MA4 Refrigerants, MA5 Volatile Organic Compounds, MA6 Formaldehyde, MA7 Locally Sourced Materials
	Biodiversity	Built environment supports biodiversity	BI1 Brownfield Site, B14 Municipal Boundary, BI3 Vegetation B14 Ecosystems
Economic	Transport	The building supports energy efficient transportation	TR1 Pedestrian Routes, TR3 Cycling, TR3 Public Transport
	Resources	The building makes efficient use of resources.	RE1 Site Density, RE2 Area per occupant RE3 Renewable Energy Generation, RE4 Food Production
	Management	The building is managed to support sustainability.	MN1 Manual, MN2 Energy Metering, MN3 Water Metering, MN4 Recording, MN5 Residents Association
	Local economy	The building supports the local economy	LE1 Locally Sourced Materials and Products, LE2 Small Enterprise, LE3 Construction Workers Support

	Services and Products	The building supports use sustainable products and services.	SP1 Fruit and Vegetables, SP2 Bakery Products, SP3 Beans and pulses, SP4 Milk and Eggs, SP5 Clothing, SP6 Furniture, SP7 Equipment Hire, SP8 Notice Board
Social	Access	The building supports access to facilities.	AC1 Internet Access, AC2 Banking, AC3 Groceries, AC4 Post Office, AC5 Crèche, AC6 Primary Schools
	Health	Built environment supports a healthy and productive environment	HE1 Exercise, HE2 Health facility, HE3 Fruit and Vegetables, HE4 Bean and Pulses, HE5 Milk and Eggs, HE6 Water, HE7 External Views, HE8 Daylight, HE9 Openings, HE10 Roof Construction, HE11 Wall Construction, HE12 Volatile Organic Compounds, HE13 Formaldehyde, HE15 Construction Worker Health
	Education		ED1 Primary Schools, ED2 Secondary Schools, ED3 Ongoing education, ED4

		The building supports education	Internet, ED5 Noticeboards, ED6 Space for Learning, ED7 Building User Manual, ED8 Construction Worker Education
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