JIMMA UNIVERSITY
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMET CHAIR

ASSESSMENT ON THE USE OF SUSTAINABLE BUILDING CONSTRUCTION MATERIALS: A CASE OF BUILDING CONSTRUCTION PROJECTS IN JIMMA TOWN

A Thesis submitted to School of Graduate Studies, Jimma University, Jimma Institute of Technology, Faculty of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree Master of Science in Construction Engineering and Management

by

Liyouget Jembere Biru

October, 2021
Jimma, Ethiopia

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ASSESSMENT ON THE ROLE OF CONSTRUCTION PROFESSIONALS TO ADOPT GREEN BUILDING CONSTRUCTION IN JIMMA TOWN

BY

LIYUOGET JEMBERE

Approved by Board of Examiners

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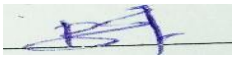
3.	Dr. Bahiru Bewket		10/28/2021
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DECLARATION

I declare that this research entitled" Assessment on The use of Sustainable Building Construction Materials: A case of building construction projects in Jimma Town" is my original work and has not been submitted as a requirement for the award of any degree in Jimma University or elsewhere.

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NAME SIGNATURE DATE

As research Advisers we hereby certify that we have read and evaluated this thesis prepared under our guidance, by Liyouget Jembere Biru entitled "ASSESSMENT ON THE USE OF SUSTAINABLE BUILDING CONSTRUCTION MATERIALS: ACASE OF BUILDING CONSTRACTION PROJECTS IN JIMMA TOWN" and recommend and would be accepted as a fulfilling requirement for the Degree Master of Science in Construction Engineering and Management.

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ABSTRACT

*The construction industry is one of the most significant producers of greenhouse gas emissions on a global level. This emission from a building is caused by non-sustainable building materials, which negatively influence the surrounding environment. It is possible to reduce environmental pollution while simultaneously improving the economic perspective, resulting in higher profit margins in the long run. It can be accomplished by improving resource utilization and resulting in less wastage during construction. As a result, the primary goal of study's to assess the uses of sustainable building materials in Jimma town. In this study, both qualitative and quantitative data were employed. The approach of purposive data sampling and primary data collection was obtained from questionnaires and interviews and secondary data obtained from different published and unpublished document. The data were analyzed using an Excel (2010) template, and the reliability of the research was determined by calculating the Cronbach's Alpha coefficient, which measures the degree of consistency. The data was analyzed using the given rate. It was discovered that the extent of applicability of sustainable building materials in Jimma town were less applied, and that among the fourteen features of sustainable building materials, the use of non or less toxic materials was ranked first with the value of (RII=0.701) and among the challenges, the cost and risk-related challenges were ranked first with the value of (RII=*0.907*). Government-related, technical and performance-related, market-related, awareness and knowledge related challenges ranked one up to five respectively, and under the role of construction professionals: carefully choice materials based on sustainable parameter was ranked first with the value of (RII=0.918). The extent of applicability of sustainable building materials was less extent in Jimma town and among five major challenges cost and risk challenges the primary challenges to implement sustainable materials in Jimma town so that to improve the uses of sustainable building materials in Jimma town; different sectors like; government creating and implementing policy and review or updating urban planning and construction code & professionals should be playing role on selection materials and improve the uses of sustainable building materials.*

Key Words; *Challenges, Environmental impact, Life cycle, Role, Sustainable building materials.*

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ACRONYMS

CO2	Carbon Dioxides
COTM	Construction Technology and Management
CSR	Corporate Social Responsibility
EPA	Environmental Protection Agency
GRIHA	Green Rating for Integrated Habitat Assessment
IAQ	Indoor Air Quality
LCA	Life Cycle Assessment
LCD	Life Cycle Design
LEED	Leadership in Energy and Environmental Design
RII	Relative Important Index
SB	Sustainable Building
SBM	Sustainable Building Materials
SC	Sustainable Construction
VOC	Volatile Organic Compound
WGBC	World Green Building Council

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The construction industry is taken huge amount of material intensity due to the various mixes of materials and components inherent in buildings and the related construction and demolition waste streams (Mustafa Ylmaza, 2015).The building sector is one of the largest contributors to global greenhouse gas emissions. This emission from buildings due to unsustainable materials is related to the embodied energy of building materials through their construction life cycle time and the emissions from operational energy use and the role of materials are becoming increasingly important and also using unsustainable materials has negative impact on the environment due to large quantity of non-renewable, non-recyclable resource. And also the materials which contain irritating, odorous, hazardous, or toxic elements adversely impact human overall health throughout-gassing of volatile components or direct contact (Usman Aminu Umar & Tukur, 2014).therefore the impact of becomes obvious considering aspects like, wastage of raw materials and resource deterioration as well as congestion of landfills. The total amount of emission and waste generated throughout the entire life cycle of physical structure is another area where the construction sector can make big difference (Excellence,2008).negative environmental impacts arise due to using unsustainable materials which is the results of various construction waste streams. With this respect, efforts in practice as well as in science are undertaken to analyze current construction materials (N. Sunke1, 2009).

Therefore Sustainability assessment and Engineering design in buildings call for effective management respect of Material selection and construction methodology (Sabnis, 2017).So using sustainable materials in construction has become more important than unsustainable materials there is also considerable health benefits, financial benefits and social benefits to consider. (Duplessis, 2007) Was stated about the benefit of sustainable materials are many benefits to being sustainable and an even greater amount of different materials to choose from financial point of view Cost reduction. Overall, building costs less than a normal building because fewer resources water and energy are needed for the completion of the project. A sustainable material in construction is the benefits it has on the people using in social point of view sustainable

building material the building for work or living. Sustainable building material has positive impact on environmental and strict environmental laws and public opinion regarding the climate crisis often demands a more environmentally friendly approach (Sabnis, 2017).

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1.2 Statement of the Problem

(Kare, 2009) stated all around the globe consumption of raw materials by the construction industries is accumulating day by day resulting with a depletion of natural resources. (Kibert, 2013) explained 40% of world's energy flow and material is due to buildings. Total quantum of material extracted from non-renewable sources thus becomes a realistic indicator of environmental impact and CO_2 emissions all over the surroundings. As a result climate change is one of the major impacts in the phenomenon of global warming, so unsustainable use of natural resources, increasing scarcity of water, and the ever-increasing volume of waste due to buildings consume huge amounts of energy across a lifecycle that spans production, construction, operation and demolition. Furthermore (Rathmann, 1998) the problem raise from the design phases since architecture didn't recognize upstream and downstream effect of the building design, construction, use and disposal. In the design phase of any building industry selection of materials is critical for the entire project. A poor choice of material may affect the quality of the project, lead to high cost during the long term operation and maintenance phases, and even endangering humans and the environment (Zhang, 2012).

Ethiopia is one of developing country and the natural resources are under the influence of various interconnected factors like population pressure, rapid urbanization, resettlement, climate change, environmental pollution and its huge population number had been putting a great burden on the sustainability of almost all types of natural resources, As a result, serious degradation of land, water, forest, rangeland, and wildlife resources that appears to feed off each other (Wassie, 2020).The problem related with the following concepts were concerned energy and resource consumption and other problem that faced in Ethiopia is rapid growth of population damaged the environment by degrading the resources that used for construction found on it (Haileleul, 2015) .The construction industry usually has a negative impact on economy, social and environment due to improper selection of material in terms of the sustainability. The applications of unsustainable construction materials have a negative impact on the environment throughout the building life cycle (Tegegn, 2018).

In Jimma town nowadays, like other town raise the construction industry however the problem concern on building construction materials from sustainability point of view mainly concern and

overseeing in Jimma town. the problem raise from the first phase of which is planning and design phase secondly selection of material. (Biratu, 2016) explained the construction professionals especially architectures and engineer they are not encouraging use of a wider variety of sustainable materials. While almost all public building projects they applicable conventional materials in Jimma town.

Therefore this research mainly concern on assessing the use of sustainable building materials and reduce environmental impact caused by non-sustainable building material through improving the use of sustainable building materials and identified the major challenges that hinder the implementation of sustainable building materials and construction professionals roles in improve the uses of sustainable building materials in Jimma town.

1.3 Research Questions

1. What is the extent of applicability of sustainable building materials in building construction projects in Jimma town?
2. What challenges that hinder the implementation of sustainable building materials in building construction projects in Jimma town?
3. What is construction professionals' role in improving sustainable building materials in building construction projects in Jimma town?

1.4 Objective

1.4.1General Objective

The general objective of this research is to assess on the use of sustainable building materials in a case of building construction project in Jimma town.

1.4.2 Specific Objectives

- To assess the extent of applicability of sustainable building construction material in Jimma town.
- To identify the challenges that hinder the implementation of sustainable building material on building construction project in Jimma town.
- To determine the role of construction professionals in improve the use of sustainable building materials in building construction project in Jimma town.

1.5 Scope of the Study

The research was conducted on the six public buildings that were on construction stage projects in Jimma town chosen for the investigation. In particular, the research examined the extent of applicability of materials having sustainable features, the challenges that hindrance the implementing of sustainable building materials, and the role of construction professionals in improving the use of sustainable building materials in Jimma town. On the other hand, the number of professionals was limited, from three responder groups: contractors, clients, and consultants, to name a few examples. Civil engineers, architects, construction technology and management professionals, surveyors, and electrical engineers are all included in this category of professionals.

1.6 Significance of the Study

The outcomes of this study will be beneficial to the building industry. Those working in the construction industry will benefit from this research because it will raise valuable awareness about the application of sustainable building materials and their features, how to improve the use of sustainable building materials, and how to incorporate the concept of sustainable building materials into their future projects. It will also be used as a reference for future scholars in the field.

CHAPTER TWO

LITERATURE REVIEW

The literature on topics including the concept and meaning of sustainability and sustainable materials, the uses of sustainable building materials, and the feature of sustainable materials, selection criteria of sustainable building materials, The challenges hinder the implementation of sustainable materials and the role of construction professionals in improving the use of sustainable building construction materials in building construction projects were reviewed in this study.

2.1 Concept of Sustainability

Sustainability concept is abroad discipline, however the origin in the Brundtland Reports of 1987.The document was stated with the tension between the aspirations of mankind towards improve better life, health and having a good environment and enhancing comfort for occupant on the one hand and the limitation of natural resource and using efficiency manner on other hand (Emas, 2015)**.** And the Theories of sustainability (AndrewT.Wilkinson, 2018) were stated the concept of sustainability is considering and manage the three pillars our economic, social and environmental. Furthermore (R.Khalili, 2011) , (Mirsaeedie, 2012) was explained based on the Triple bottom line refers to the three prongs of social, environmental and financial performance, which are directly tied to the concept and goal of sustainable development. They are highly interrelated and have equal importance.

2.1.1 Environmental Sustainability

(Morelli, 2011) defined environmental sustainability means handing of natural resources to future generations without destruction. For this reason, when determining usage level of natural resources; it must be taken into consideration not exceeding rates of renewal of these resources and rates of these resources for clearance of contaminants ,Protection of aliveness and diversity on the earth balance, resilience, and interconnectedness that allows human society to satisfy their needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity. (Basis, 2015) Suggested it is necessity to take into consideration ecological balance and saving in consumption of renewable resources. (Peter O. Akadiri, 2012) environmental sustainability has

many benefits: to minimizing polluting emissions; preventing irritation from noise and dust by good site and Waste minimization and elimination; preventing pollution in accidents and breaches of environmental requirements.

2.1.2 Economic Sustainability

Economical sustainability refers to practices that support long-term economic growth without negatively impacting social, environmental, and cultural aspects of the community. Nevertheless it is a fact that resources which can meet basic need of people are limited and reduced the cost of raw materials via providing efficiency by decreasing energy and resource input in production since waste reduction and utilizing the resource by efficiency manner are one of sustainability policy (Durmaz,2017).

2.1.3 Social Sustainability

Social Sustainability also the most important target of sustainable development focuses on some basic right and freedom just related to being a human. The ability of a community to develop processes and structures which not only meet the needs of its current members but also support the ability maintain a healthy community and resources can be handed down to next generation to sustain their existences and provide their wealthy (Basis, 2015). According to the World Health Organization report the net effect of climate change will be negative extremely high air temperatures intensify cardiovascular and respiratory diseases cause of air pollution (Thomson, 2015).

2.2 Sustainability in Construction Industry

Sustainable construction is defined as the creation and responsible management of a healthy built environment based on ecological manner which is the construction considering the environmental issues and utilizing the resource with efficiency manner (Kibert, 2013). Raynsford also provides a definition for sustainable construction Sustainable construction is the set of processes by which a profitable and competitive industry delivers built assets (buildings, structures, supporting infrastructure and their immediate surroundings (Raynsford, 2000). Sustainable construction is application of sustainable development principles to a building life cycle from planning the construction, constructing, mining raw material to production and becoming construction material, usage, destruction of construction, and management of wastes. (Yilmaz, 2015) Explained it is a holistic process which aims to sustain harmony between the

nature and constructed environment by creating settlements which suit human and support economic equality. (Charles Atombo1, 2015) also explained that Sustainable construction incorporates a recyclable aspect throughout the building's lifecycle, in terms of resources used and the impact it poses on the environment from design to construction and subsequent operation, maintenance, renovation and finally its demolition.

2.3 The Meaning of Sustainable Building

Many academics defined sustainable building depending on their understanding of the term.

Sustainable building can be defined as the building design which is considered "healthy facilities designed and built-in resource-efficient manner, using ecologically based principles." ecologically sustainable design, and green design are terms that describe the application of sustainability principles to building design which means the buildings which are designed to minimize negative effect of construction on the environment and human health during their the existence life cycle of the building; construction, operation ,repair, maintenance, and usage period, it emphasizes to produce as a way that is respectful towards environmental values ,social comfort as well as responsible for effective utilized the resources (Kibert, 2013).

According to (OECD, 2006) identified the five objectives for sustainable buildings design : Resource energy Efficiency (including Greenhouse Gas Emissions Reduction),Pollution Prevention (including Indoor Air Quality and Noise Abatement),Harmonization with Environment (including Environmental Assessment), Integrated and Systemic Approaches (including Environmental Management System).Furthermore (Hossein Zabihi,Farah Habib&et.al , 2012) defined the building practices, which struggle for integral quality in three aspects including economic, social and environmental performance this means balanced use of natural resources and proper management of the building component will contribute to saving shortage of resources, reducing energy consumption and construction waste and improving environmental quality.

2.3.1 Building Material and Sustainability

Building construction can be made through various materials mix component and the usage of materials has extensive impact on the environment which environment pollution, degradation

natural resource depletion, which is caused by the large quantity of non-renewable, recyclable resources with the potential for depriving future generations of their use (Abisuga, 2014). Thus all building, directly or indirectly affect the environment during their life cycles. During the extraction process of the raw materials, usage and demolition, different forms of pollution are caused, with adverse effect on the environment.

According (Spacey, 2018) Sustainable building materials are materials having greater performance based on some specified criteria.(Patil, 2017) was explained the most important criteria are which is commonly used to select sustainable building materials: locally availability; transportation costs and environmental impact; thermal efficiency; requirements and improve health considerations of the occupant; financial capability of the owner; recyclability of building materials and the demolished building; waste and pollution generated in the manufacturing process.

2.4 The Uses of Sustainable Building Materials

The purpose of the application of sustainability in construction field is protect our environment form hazardous substances waste and cost reduction and extended life span seem reason enough to convince anyone into building a sustainable home and also to avoid scarcity of earth's basic natural resources (Little, 2021).

2.4.1Reduce Energy Consumption

(Zhang, 2018) Explained the usage materials having sustainable feature uses are enhancing the building energy consumed required during in construction phase and latter construction and which means the energy consumption required during the operation phase, construction including the processes of material replacement, repair and maintenance after demolish or disposal during the effective life cycle. however (HuiZahao, 2018) the energy consumption of the building not only the embodied energy consumption of raw materials also using waste materials as raw materials for production, or use renewable environmental protection materials to achieve the purpose of reducing the consumption of water resources and land resources. Therefore energy saving and emission reduction in the production process is able to realized as well as the green environmental protection, improving the thermal and insulation properties of

the building and reduce operating energy use, high-efficiency windows and insulation in walls, ceilings, and floors increase the efficiency of the building envelope (Ji, 2016).

2.4.2 Health and Harmless

The building environment can have both negative and positive impacts on the occupants' quality of life. Negative impact which is caused by unsustainable materials However sustainable building materials are enhancing the human health and environments because the material having sustainable features; good lighting, thermal and insulation properties (HuiZahao, 2018), (H.Heerwagen ,2020).Improved indoor air quality and increased personal control of temperatures and ventilation have strong positive effects on the building. In addition reducing risks and discomforts, buildings should also contain features and attributes that create positive psychological and social experiences (Anon., 2020).

2.4.3 Waste Reduction

The building materials are used in the construction process traditional materials are mainly composed of sand, burnt products, wood, and concrete. Therefore, in the process of building construction; demolition, much waste of bricks, wood, and concrete is often produced. After used these traditional materials could be used again effectively, this activity can be reduce environmental pollution, reduce the construction wastage and. In order to realize the recycling of traditional building materials, the builders can collect burnt products in the process of disassembling the building, and then apply the collected materials to the outside wall of the building so that the recycling and reuse of the old materials can be effectively realized. In addition, a constructor can also recycle wood materials during construction, which can be used for making furniture or for building decoration (HaoWang, et al., 2018).This can be through reuse, reclaimed and recycled for construction, waste materials and has a significant benefit reduces the overall cost of starting a new project (Resources, 2020).

2.5 Use of Sustainable Building Materials in Civil Work

2.5.1 Use of sustainable materials in external design

In engineering projects, from external implementation to internal implementation and then to installation and repair, the construction span is often very large, and the amount covered is also

very large. Due to the continuous improvement of Volkswagen's environmental protection, green or sustainable building materials have been widely used in the actual operation of engineering projects. Environmentally friendly building materials play a fundamental role in heat preservation and thermal insulation in the engineering of the building's exterior wall, which not only effectively saves the waste of resources, but also improves the decoration of the building.(Jia-yao, 2021).

2.5.2 The Use of Sustainable Building Materials in the Interior Decoration Industry

The standard of architecture is not only the rest function for the blind, but also meets the spiritual needs of the public, which is beautiful and comfortable. Most of the time, building decoration materials is extremely harmful to the human body. Among them, materials contain toxic ingredients and are also limited by the weight of the materials themselves. The effect shown in the interior decoration work is very small, but sustainable building materials can effectively improve this part of the shortcomings. As far as the degree of restraint is concerned, green building materials have their unique advantages, such as heat insulation and noise reduction, which provide feasible factors for the public to avoid external interference (Jia-yao, 2021).

2.5.3 The uses of Sustainable Glass

Glass offers energetic plan arrangements which have possibilities to form buildings to be vitality productive through utilizes of sunshine and sun based pick up whilst conserving vitality. Glass is the foremost striking highlight in cutting edge building plans. Day lighting is fundamental for the work of the buildings, and it too makes a difference to move forward the wellbeing and efficiency and to control the organic clock of the inhabitants. Appropriate day lighting plans can maintain a strategic distance from require for fake lighting for a larger part of the day/year, and subsequently, can lead to 30–50% reserve funds within add up to vitality charge of certain buildings (Aboulnaga, 2006).Applications of glass to deliver dynamic design solutions that enable buildings to be more energy efficient by making use of the most of daylight and solar gain whilst protecting the environment and conserving energy and Reduction of the impact of embodied energy of glass (Achintha, 2016).The green glass used in construction engineering mainly includes foam glass, vacuum glass and low-emissivity coated glass. Foam glass has very

good corrosion resistance and good flame retardant effect, its thermal conductivity is low, and its density is small (Jia-yao, 2021).

2.5.4 Application of Environmentally Friendly Exterior wall Thermal Insulation Materials

The wall is the main structure of the building and bears weight, but the wall also plays a role in sound insulation and heat insulation. Wall materials will pay a huge price in the entire building construction process, but they will save a lot in an environmentally friendly way. This may be due to two aspects: green materials used for cement reinforcement and recycled waste building materials. The production and use of the first natural fiber concrete for concrete reinforcement consumes a lot of mineral resources and has a serious impact on the environment. The use of mineral additives has become very popular at home and abroad. Mix broken slag, fly ash, silica fume and recycled aggregate with concrete to replace part of the cement and reduce environmental pollution. The second is recycling waste building materials. To carry out recycling of traditional building materials, builders can collect the products burned during the building demolition process, and then apply the collected materials to the exterior wall of the building for recycling and reuse of old materials (HaoWang, et al., 2018).One way of increasing the energy efficiency in buildings is to use insulating materials. Not only do they provide greater comfort but they also fulfill (Anon., 2017)**.**

(Jia-yao, 2021) Stated about the materials that can be used for thermal, sound insulation and heat presentation for wall structures such polystyrene and rook wool: Polystyrene foam has the advantages of low thermal conductivity and low density, as well as very good thermal insulation and thermal insulation properties. Rock wool has high stability and reliability, and good fire resistance.

2.6 Common Sustainable Building Material Available Around Ethiopia

According to (Mohammad Sujayath Ali & Patel, 2020) There are many sustainable materials that applicable for building construction project which is found around in Ethiopia.

2.6.1 Bamboo

Bamboo is regarded as a sustainable and renewable building construction material which is harvested and replenished sustainably with virtually little or no impact on the environment. Bamboo has an embodied energy which is very low when compared to other construction materials like concrete, steel, and plastic. Bamboo also helps in controlling erosion and flooding as well as controlling the local climates (Dakuru, 2019). Bamboo highly versatile resource, ecofriendly materials it has an incredibly high self-generation rate and widely available and applicable is being used as an engineering material for the construction of houses and other building, bamboo have many used in different applicable for building construction for horizontal and vertical structure of the building (Anon., 2021).

2.6.2 Recycled Plastic

A large number of studies reported in recent years on the topic indicated that the uses of recycled materials. Rather than sourcing; mining and milling new components for construction, manufacturers are using recycled plastic and other ground-up trash to produce concrete (Anon., ,2018).The process of plastics recycling are to reduce high rates of plastic pollution while putting less pressure on virgin materials and also used for resource conserve practice is reducing greenhouse gas emissions and is giving plastic waste new use, rather than clogging landfills and contributing to plastic pollution (Pal, 2018).

2.6.3 Manufactured Sand

The consumption of natural river sand is very much high, because of more usage of concrete. As Ethiopia is one of the under developing countries, rapid construction is going is on around the country, and the shortage of first-class concrete is the problem. Due to more construction, river sand is becoming very much expensive and demanding. The term Manufactured sand is nothing but the aggregate material whose size is less than 5.0mm. The supply of m-sand is from crushing plant, where the hard rocks and over size stone used to crush in smaller particles (Mohammad Sujayath Ali & Patel, 2020).

2.6.4 Ferrok

Ferrok is one of the new materials it uses recycled materials such as steel dust from the steel industry, or ferrous rock leftover from industrial processes, usually sent to the landfill. It creates

a concrete-like building material, stronger than the concrete itself. It traps and absorbs carbon dioxide as part of its drying and hardening process. This makes ferrock carbon neutral and a lot less CO2 intensive as compared to traditional concrete. It is a viable alternative to cement and can be mixed and poured to form driveways, staircases, pathways, and more structures. Some researchers believe ferrock is more resilient to weather than concrete (Anon., 2018).

2.6.5 Wood

Wood is one of the most traditional and widely used building materials And wood have various environmental properties and a more diverse material than other common building materials and can be providing Carbon in wood products remains stored for as long as the product is in use. In short, wood products provide a physical storage mechanism for carbon, which provides climate benefits depending on temporal aspects energy can also be recovered. This recovery of post-use wood and wood processing residues for use in place of fossil fuels significantly lowers the energy and carbon balances of a building and the life cycle assessment (Takano, 2015).also in jimma town various wood are available.

2.6.6 Straw Bales

Straw bale is remarkably strong and durable. It is practical and functional yet can be beautiful and stylish and have good thermal, insulation and moisture storage properties this can be provide it reduces the amount of coal needed for heating and subsequently, reducing CO2 emissions and energy demand of a building because of its super insulating properties and it locks up carbon for the life of the building. Therefore the application of Straw bale in construction has considerably better heat preservation and has been shown to be a promising building alternative that meets housing needs and energy efficient goals in rural community (Bendapudi, 2012).

2.7 The principles of Life Cycle Design provide the guide lines for the selection of building materials and techniques.

The principles of Life Cycle assessment provide important guidelines for the selection of building materials. Each step of the manufacturing process, from gathering raw materials, manufacturing, distribution, and installation, to ultimate reuse or disposal, is examined for its environmental impact. The life cycle of a product categorized into three life-cycle phases pre-building phase, building phase and post-building phase. This three life cycle phases relate to the

flow of materials through the life of the building, this chart helps compare the sustainable qualities of different materials used for the same purpose. The presence of one or more of these "green features" in a building material can assist in determining its relative sustainability (Jong-Jin Kim ,1998).

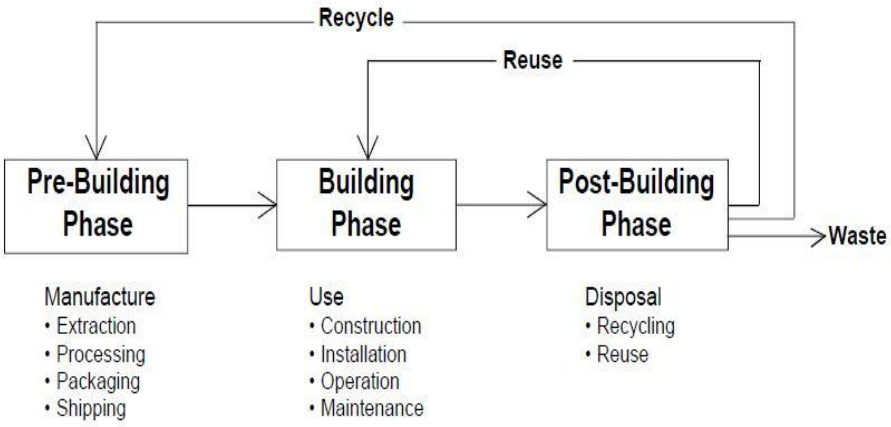

Figure 2.1 Three phases of the building material life cycle (Jong-Jin Kim ,1998)

The Pre-Building Phase describes the production and delivery process of a material up to, but not including, the point of installation. This includes discovering raw materials in nature as well as extracting, manufacturing, packaging, and transportation to a building site. This phase has the most potential for causing environmental damage. Understanding the environmental impacts in the pre-building phase will lead to the wise selection of building materials. Raw material procurement methods, the manufacturing process itself, and the distance from the manufacturing location to the building site all have environmental consequences. The Building Phase refers to a building material's useful life. This phase begins at the point of the material's assembly into a structure, includes the maintenance and repair of the material, and extends throughout the life of the material within or as part of the building. Post building phase are building materials after demolish or disposal of the previous building materials. reused the materials and used as a recycled back into other products since the materials sourced from the salvage materials and used as building component of the new projects (Biratu, 2016).

2.8 Selection of Sustainable building materials

Many researchers make a big effort to define the process of material selection or choosing process where it is difficult to find a clear definition of what are the characteristics of sustainable building materials and recognized the importance of material selection (Zhangb, 2018). The building materials have an impact on both the building and the natural environment throughout their life cycle. Which is operation, construction and demolish It is essential to select sustainable materials in the early stages of design, establish strategies for sustainable building materials. (Esin,2007) Also suggested that the selection of materials will affect the overall performance of buildings, and sustainable building materials should be considered at an early stage from a life-cycle perspective.(Jia-yao, 2021) during implementing the selection of building materials, we should not only consider the needs of cost and quality, but also consider whether the materials can be used to achieve the expected results. Since the materials achieving sustainability goals and fulfill the sustainable building materials parameters which is the materials able to recycled, reuse and energy efficiency and enhancing the sustainability.

2.8.1 The Selection Criteria of Sustainable Materials Categorized

A good sustainable solution involves Selection of sustainable building material is a crucial issue for the material industry to expansively improve material properties and promote sustainable development and plays a significant role throughout the building life cycle, which seeks to guarantee product performance and reduce the entire life-cycle which is during: construction, repair, maintenance and demolition impact to the environment and human health (Zhang H., *et al*, 2017). According to (Karako, 2017) the selection of sustainable materials is categorized four main pillars: Environmental performance, Economic performance, Building performance and Material characteristics.

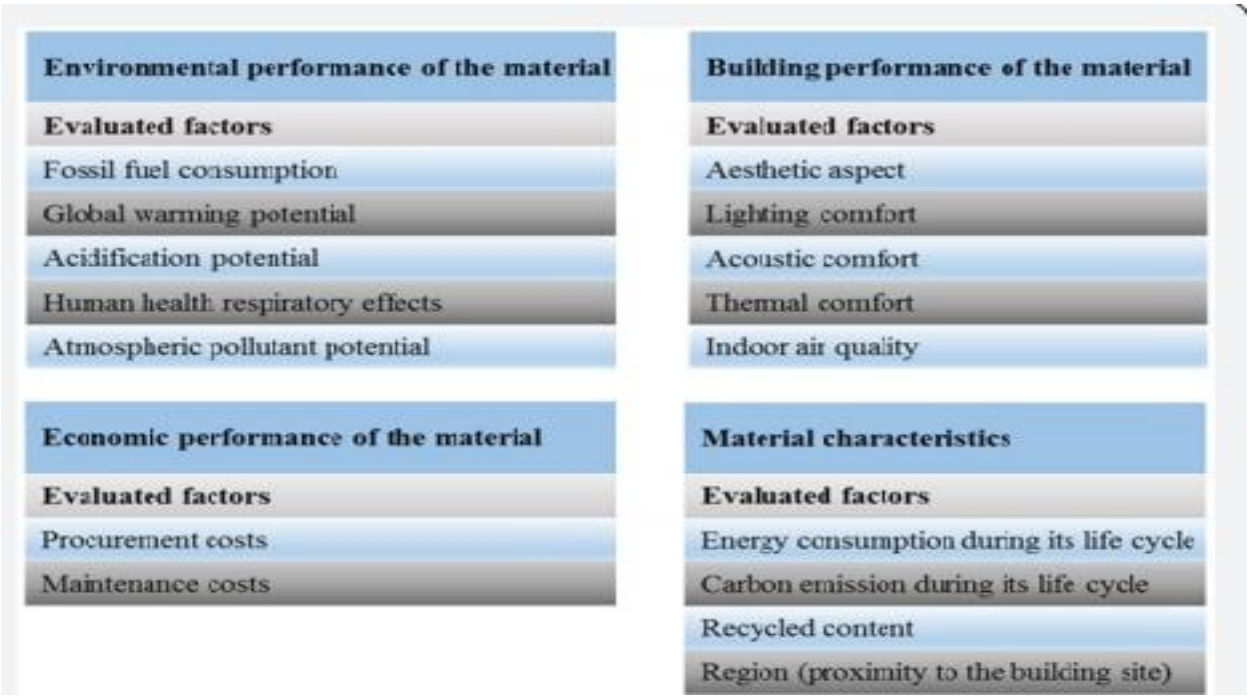

Figure 1.2 Four main Pillars of Sustainable Building Material Selection (Karako, 2017)

The selection of environmentally sustainable building materials selection based on two stream: Environmental Criteria Stream 1 – Conserve Natural Resources and Preserve Biodiversity Resources must be used more efficiently and effectively during the building life cycle process. The following criteria relating to indoor environmental quality should be considered when selecting materials, products component and assemble Efficiency in Extraction, Manufacturing and Construction, Waste Reduction, Reduce Waste during Lifecycle Process, Renew able Resources, Longevity. Environmental Criteria Stream 2;– Indoor Air Quality Most people spend about 90% of their time indoors The following criteria relating to indoor environmental quality should be considered when selecting materials (Anon., 2017) selection criteria wide range under environmental consideration based on the three phase of the building which is; pre building, ,building phase and post building phase and the authors was categorized the materials under manufacturing process, building operation and waste management different features was grouped by the affected building life-cycle phase (Kim,1998) .

The second pillar, economic performance of the material, mainly consists of procurement and maintenance costs. (Anon., 2021) Suggested evidence is growing that sustainable buildings

provide financial rewards for building owners, operators, and occupants. Sustainable buildings typically have lower annual costs for energy, water, maintenance/repair, churn (reconfiguring space because of changing needs), and other operating expenses. These reduced costs do not have to come at the expense of higher first costs. Through integrated design and innovative use of sustainable materials and equipment, the first cost of a sustainable building can be the same as, or lower than, that of a traditional building. The third pillar, building performance, focuses on aesthetic aspect, lighting/acoustic/thermal comfort, and indoor air quality (Karako, 2017).The fourth pillar, material characteristics, is the materials have such characteristics on the energy consumption and carbon emission of the material during its life cycle, recycled content and proximity of the material to the construction site (Jong-Jin Kim ,1998).

(Elias-Ozkan, 2007) According to the program of California Sustainable Design Program, there are many benefits such as: Reduced maintenance costs by specifying easy-to-maintain materials, reduced operational costs by selecting products that result in energy saving, reduced replacement of materials by selecting durable materials reduced environmental impact by reducing unnecessary resource extraction and by minimizing waste generation Reduced impacts on air quality by selecting low-emitting materials

2.9 Features of Sustainable Building Materials

Many scholars are stated about the feature of sustainable building materials and determine based on the life cycle phase of the building which are the prebuilding, building and post building materials.in the prebuilding phase the materials have response to the environment and having such features ;Waste Reduction, Pollution Prevention, Recycled Content, embodied energy reduction. The embodied energy of a material is important issues refer to the total energy required to produce that material, including the collection of raw materials. This also includes the energy of the fuel used to power the harvesting or mining equipment, the processing equipment, and the transportation devices that move raw material to a processing facility. This energy typically comes from the burning of fossil fuels, which are a limited, nonrenewable resource. The combustion of fossil fuels also has severe environmental consequences, from localized smog to acid rain. The greater a material's embodied energy, the greater the amount of energy required to produce it, implying more severe ecological consequences. For example, the processing of

wood (harvested in a sustainable fashion) involves far less energy and releases less pollution than the processing of iron, which must be extracted from mined ores. A revision of a manufacturing process that saves energy will reduce the embodied energy of the material. Conventional materials with a high embodied energy can often be replaced by a material with low embodied energy, while using conventional design and construction techniques.

so the materials have significant role for environment and human health which is reduce air and environmental pollution as well as the materials are use energy in efficiently.

In Building Phase: Reduction in Construction Waste The waste material created during the installation process. Materials that are easily installed with common tools also reduce overall waste from trimming and fitting. Energy Efficiency, Water Treatment/Conservation; generally, this involves reducing the amount of water that must be treated by municipal septic systems, with the accompanying chemical and energy costs. Using None or less Toxic Materials are less hazardous to construction workers and building occupants. Renewable Energy Systems; replace traditional building systems that are dependent on the offsite production of electricity and fuel. Solar, wind, and geothermal energy utilize the natural resources already present on a site. Durable materials that require less maintenance produce less landfill waste over the building's lifetime. In Post-Building Phase ;in this phase after demolish the materials able to reuse and recycliablity (Jong-Jin Kim ,1998) , (Badr, 2013) and (Biratu, 2016).

2.10 Standards of sustainable materials

2.10.1 Leadership In Energy and Environmental design (LEED) rating system

The LEED green building certification program is a voluntary, consensus based national rating system for developing high-performance, sustainable buildings and incorporates holistic approach that integrates all phases of design, construction, and operation. Categories include building design and construction, interior design and construction, building operations and maintenance development which is for improved environmental and human health performance. LEED emphasizes the certifies buildings according to the sustainability of the site, water efficiency, energy use and impact on the atmosphere, materials and resources, indoor environmental quality, and innovation in design and Regional priority. (John Smiciklas , Liezl de Jager &et.al 2012).

The LEED green building certification program also stated about the materials and resource which is the materials are different features which are 75 percent of construction waste was recycled or salvaged to divert construction and demolition debris from disposal in landfills and incineration facilities.23 percent of the construction costs were spent on recycled content material, including carpet, ceramic tile, gypsum board, acoustic ceiling tiles, and landscape seating, 43 percent of material costs were spent on supplies sourced within 500 miles of the building and 51 percent of wood-based materials were made of recycled content.in addition rapidly renewable materials were used and also Building occupants recycles paper, cardboard metal plastic. Redirect recyclable recovered resources back to the manufacturing process and reusable materials to appropriate sites and reuse and recycled materials which are materials reuse To reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources and Recycled content. (Energy ,2014).

2.10.2 Green Rating for Integrated Habitat Assessment (GRIHA)

GRIHA is India's National Rating System for Green buildings. It has been developed by TERI (The Energy and Resources Institute) and is endorsed by the MNRE (Ministry of New and Renewable Energy).It is based on nationally accepted energy and environmental principles, and seeks to strike a balance between established practices and emerging concepts, both national and international .The feature of GRIHA abuilding assessed based on its predicated performance over its entries life cycle inception through operation means that to minimize a building's resource consumption, waste generation, and overall ecological/environmental impact by comparing them to certain nationally acceptable limits / benchmarks. It does so, adopting the five 'R' philosophy of sustainable development, namely: Refuse, Reduce, recycle, reuse and reinvent(ADaRSH) ,2014). According to (New Delhi,Chennai& Mumbai ,2017) "A good design is not just about aesthetics but well thought combination of climate responsive design strategies and low environmental impact materials ", which is ultimately makes its sustainable building

2.10.3 BREEAM rating system

BRE Environmental Assessment Method (BREEAM) is also a voluntary measurement rating for green buildings that was established in the UK by the Building Research Establishment (BRE).

BREEAM is one of the world's foremost environmental assessment methods and rating systems for building. BREEAM sets standards for best practice in sustainable building design, construction and operation and has become one of the most comprehensive and widely recognized measures of a building's environmental performance.

BREEAM addresses wide-ranging environmental and sustainability issues and enables developers, designers and building managers to demonstrate the environmental credentials of their buildings to clients, planners and other initial parties. A BREEAM assessment uses recognized measures of performance, which are set against established benchmarks, to evaluate a building's specification, design, construction and use. The measures used represent a broad range of categories and criteria from energy to ecology. They include aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes.

2.11 The Challenges that Hinders the Implementation of Sustainable Building Materials in Developed and Developing Countries

The implementing sustainable materials from conventional materials facing challenges from different perspective and the challenges are different from developed and developing countries

In developed countries the implantation of sustainable building materials faced different challenges According to (Albert p.c Chan ,2018) found twenty challenges were critical but expanded the three top critical challenges high costs of green building materials and technologies, lack of government incentive and lack of financial schemes for example bank loan and examined the 20 challenges and categorized and classified into :government related challenges ,market related ,humane related challenges ,cost and risk related challenges ,and knowledge and information challenges. in addition (Hwang,2012) stated that sustainability comes with challenges and explained lack of team communication during green projects, lack of users', practitioners and market knowledge and interest in green building practices ,high cost of materials ,lack of interest in stakeholders ,insufficient knowledge requirement of government support, higher initial implementation costs for green building practices and technologies compared to traditional building materials, lack of government support and incentives, lack of

building codes and regulations, and poor stakeholder relationships and high level of complexity sustainable building are critical constraint.

Also developing countries faced different challenges to implementation of Sustainable building materials. (Pal, 2018). Explained the listed of challenges lack of policies, strategies, law and directions, showcase powers, and the current structure of the construction business, lack of construction specialists, like, engineers, and contractors, developers in implement of sustainable materials and absence of information concerning the use of sustainable construction materials, lack of knowledge on selection of materials and how traditional materials cause vigorous environmental issues. Also (P.C.Chan, 2016) Found different challenges lack of information of data base concerned on sustainable materials and technologies, lack of interest and demand and lack of code and regulation are most challenges in developing countries. Furthermore (Wang, ,2013) also examined different challenges lack of financial incentive and mismatch of the market mechanism. Furthermore (Kooloos, 2008) explained the selection of sustainable construction materials is difficult to architects since the material which is sustainable or eco-Friendly with environment and which is concern that embodied energy. (Nikyema, 2020) found various challenges and categorized based on human related, market, economy perspective, government police are the most challenges in Burkina Faso.

2.12The Role of Construction Professionals in improve the uses of Sustainable Building Materials

Construction professionals has important role for improving implementation extent of the sustainable building materials they contribute through their scope, experience *:* It is made up of design and construction professionals such as consultants, contractors, architects, designers, engineers, and planners. They often go through formal and intense training on green design and construction practices, making their knowledge high. During the design and implementation process, their job is to guide their clients, corporate, and government entities about sustainability practices as well as translate clients' needs into concrete projects. Due to this, they could be considered as sustainability leaders (Nikyema, 2020).

2.12.1 The Role of Architecture

The easiest way for architects to incorporate sustainable design principles in buildings is careful selection of environmentally sustainable building materials (Ar.Kaanchan M. Patil, 2017). In the design phase of any building industry, appropriate material selection is critical for the entire project and availability of materials in the market and architects and engineers are presently left nearly alone in this selection process (Franzonia, 2011).

The architects considered the 3R (Reduce, Recycle, Reuse) principle to reduce resource from nonrenewable energy and to save energy and environmental impact (HaoWang, et al., 2018).The common criteria used for Selection of Sustainable building materials; Locally materials Transport costs and environmental impact, thermal efficiency, Financial viability, recyclability of building materials and the demolished building, waste and pollution generated in the manufacturing process, energy required in the manufacturing process (Garima Mittal, 2016), (Ali, 2017). In order to improving the marketing of wood products, it has become critical to understand what architects, the foremost specifies of building materials, look for in the green materials they select. (Amany Ragheba, 2016).

2.12.2 The Role of Mechanical Engineer

The role of a mechanical engineer involves the manufacture and design of some mechanical systems in a project. The mechanical engineer must consider the production phases and what materials are consumed and potentially wasted and identify the materials what materials can be recycled, have a long lifespan, or could potentially end up in a landfill allows the engineer to play role in a sustainable design and building. Being able to construct a new building or remodel an existing building with an informed use of materials and their applications will ultimately allow the mechanical engineer to design a better, and less wasteful product or building (Moore, 2018). Mechanical engineers also play lots of role of such life cycle of the materials and waste order must be practiced (IP.Okokpujie, 2019).

2.12.3 The Role of Environmental Engineer

Environmental engineers should focus on material efficiency by using local eco-friendly material, considering use of recyclable material, reuse of material and use of materials which have less carbon footprint and have less global warming potential while designing and

developing green built environment and Environmental engineers could develop a framework to increase "reduce, reuse and recycle" strategies into planning, design, extraction of reusable material at construction and demolition stage and minimize the disposal of construction waste by implementing sustainable strategy throughout the lifecycle of construction (Saurabh Singh, September 2018).An environmental engineer should focus on allocation of resources, minimum energy consumption, low embodied energy intensity in building materials, reuse and recycling, pursue quality in creating healthy and non –toxic built environment and protecting natural environment by reducing disposal of liquid, solid and gaseous waste (Agnihotri, 2018).

2.12.4 The Role of Electrical Engineer

Electrical engineer for sustainable materials Contribute to improve energy management Misuse of renewable energy (wind, hydraulic, sun,) Optimize energy management Improve the energetic efficiency of the systems all along life and design the materials from the design and provide development of modeling, design and energy management tools development of new materials, of new functionalities (Anon., 2021).

Electrical engineer concerned on construction waste reduction, recycled content, improving air quality and regional materials and design and select the material that can be related from light, energy and atmosphere provide the materials which is reducing Light pollution and light trespass from the building and site, increase night sky access, improve day light nighttime visibility via glare reduction, and lighting fixture layout must be designed to minimize light trespass out the windows. From the construction waste point view electrical engineer should include specific direction in the project specifications so the contractor understands the plan.. From recycle content is one of the features of sustainable building materials so electrical designer should investigate the potential to meet the intent of this sustainable design strategy which is to require 10% to 20% of the building products to incorporate recycled content materials. the electrical designer should be aware of product selection that can contribute to a healthier indoor environment which material extracted, processed and manufactured regional material. Furthermore electrical engineer should identify any unique, electrically related energy or environmental aspects of the building for consideration as a potential id credit and can create market competitive and see how it can positively impact their design efforts. Communicate with other professionals (Simpkins, 2006).

2.12.5 The Role of Structural Engineer

Structural engineers could have important influence on the sustainability of a project through thoughtful use of building materials. The two primary tasks structural engineers have to consider in assessing the sustainability of a building material are comparing the material to others and identifying the right context for the material and the impact of the construction materials is part of a structural engineer's job therefore understand the advantages and disadvantages of all materials enable structural engineers to be better informed (ASCE-SEI, 2010).

2.12.6 The Role Civil Engineer

Civil engineers must choose for more environment friendly materials, should implement the use of recyclable material and must be creative in developing solution to apply sustainable design practice (Pradeep Kumar Gautam, 2015).

Selection of materials is based on the building construction progress and considering different issues such as ecological foot print, energy utilizing, and environmental impact of the materials. And the authors categorized based on the building construction stage. In the first stage are Planning and design phases in this stage engineering projects is mostly influenced in the early phases of a project lifecycle and considering sustainable design practices, the amount of energy utilized and ecological manner of materials must be considered. During the material production phase the concern about the resource utilized and energy produce from embodied and the ecological footprint of that phase. During the construction phase, the energy consumed during the construction process (process energy), the greenhouse gas and localized pollution due to the construction process are major concerns. During the operation phase conservation of energy and minimization of negative environmental impact are of paramount interest. During the disposal phase it is important that material is nontoxic and recyclable (Senadheera, 2009).

Also Civil engineer should participate in civil engineering design the typically involves maximizing the use of locally available materials and integrating sustainable approach, sustainable design process and considering in design stage the three pillars economy, environmental and social (LSF-LST, 2007).

2.13 Research Gap

There is lack of research which is concern about sustainable material in adequately. however In the previous research were stated about ;understanding of the concept of sustainable building materials, sustainable building materials features which is helps to identify the materials whether sustainable or not, through their features and how to prevent environmental degradation and natural resource depletion caused by unsustainable materials thought out life cycle of the building ,selection of sustainable building materials under different criteria and using different modeling approach ,the challenges of sustainable building materials in adopting in developing and developed countries. But In this study the research particularly focused on the extent of applicability of sustainable building materials having sustainable features, and examine the extent of applicability of the materials having sustainable features in Jimma town and The challenges that hinders the implementation of sustainable building materials among various causes of challenges but in this study were stated according to in Jimma context. Furthermore the research were incorporated the important role of construction professionals in order to improve the uses of sustainable building materials**.**

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study Area

The study area of the research was conducted in Jimma town which is south western oromia region and located about 351.9 km from Addis Ababa. It is geographical coordinates are 7°40'N 36°50'E. The Elevation is 1,780m (5840ft) above sea level (Anon., 2021).

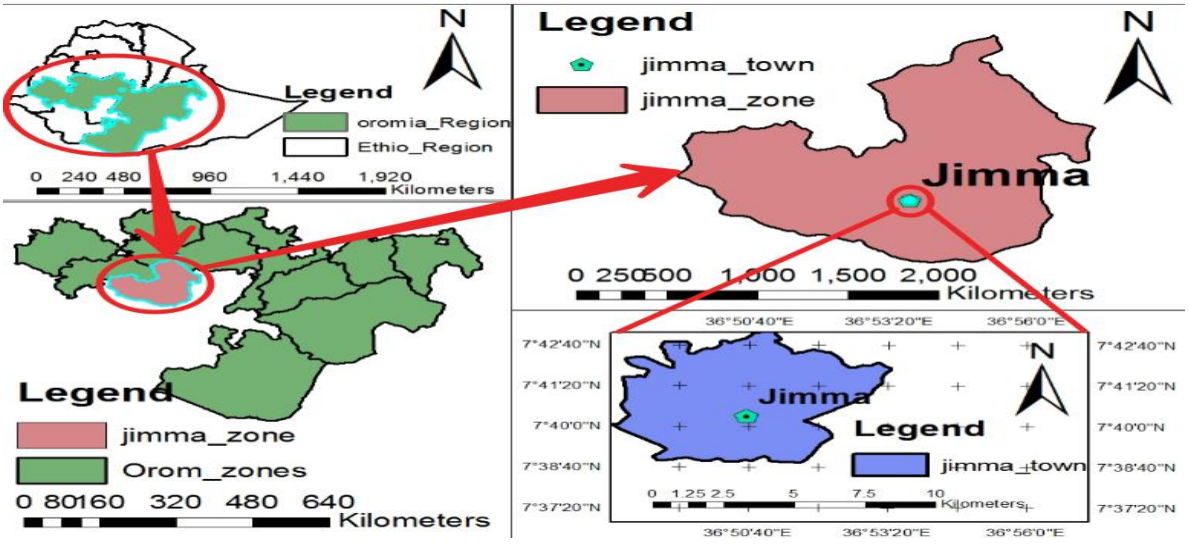

Figure 2.1 Map of study area (Anon.,2021).

3.2 Research Design

The study began with an evaluation of the data obtained from reviews of various published and unpublished publications of similar studies conducted in other countries; these were utilized as the basis for the current research and evaluated in the Jimma town. In addition, through questionnaires and interviews conducted with the targeted respondent groups, the study collected both qualitative and quantitative information. Purposive sampling was utilized in the study, which was conducted. At the same time, the populations are small and have been treated as a whole since the population from six public buildings was considered and Out of 55 questionnaire distribution only 49 questionnaires were responded and analyzed using an Excel 2010 template.

The data were ranked based on the respondents' responses, rate, and the relative importance index (RII).

3.3 Study Variables

The study variables of the research are both dependent variable and independent variable. Dependent variable

- The use of Sustainable Building materials.

Independent variable:

- Awareness and knowledge perception.
- Skilled professionals specialized with sustainable construction and materials and skilled labor.
- Police, code, law and standard.
- Cost and risk related challenges.
- Availability of sustainable materials on market.
- Technical and performance on sustainable material and technologies.

3.4 Population and Sampling Method

The study population was drawn from the targeted project, which consisted of representatives from three groups: contractor, client, and consultant, according to Jimma town municipal the given information the numbers of building construction project around 20 building construction projects those are located in Jimma town and were selected the six public buildings on construction stage. In addition various professionals handled the research, the population was small; out of 55 questionnaires just 49 respondents were responded. All population data were taken into consideration. In order to acquire meaningful information, the purposive sampling method was employed for the selection of professionals.

The non-probabilistic purposive sampling approach used in this study was classified as non-probabilistic purposive sampling. Instead, the sampling procedure was determined by the study requirements. The targeted respondents are involved in the building construction industry, and the study was created to reflect their participation. In Six public buildings constructions were to participate a small population; thus, the entire population was used as a sample, resulting in a total of 49 people being taken as a sample in this study. As a result, the questioners were divided

into three groups: the contractor group (which included 25 people), the client group (15 people), and consultants (9 people) for 49 people who participated in this survey.

3.5 Sources of Data

The information needed for the study was collected through both primary and secondary sources of information. The primary source of information was gathered through a variety of approaches, including interviews and questionnaires. The structure questionnaire filled out by the targeted group and the structure questionnaires that were developed provide answers to three questions, which are focused on the extent of applicability of sustainable materials by their feature, the challenges that hindrances the implementation of sustainable building materials, and the role of construction professional in improving the use of sustainable building materials in Jimma town. And interview with different professionals and those who involved in the six buildings construction in Jimma town based on their perceptions, job experience, and knowledge background, different professionals were interviewed to respond and provide suggestions on sustainable building materials. The results of the interviews were compiled and analyzed. On related issues, secondary sources of information were acquired from various sources, including published and unpublished journals, researches report. They served as the foundation for the current study, and the questionnaire was constructed after reviewing relevant literature.

3.6 Data Collection Procedure

The study began with evaluating various types of literature relevant to the topic under consideration. The data for the literature review was gathered from a variety of sources. These investigations have been carried out on related literature, books, and questionnaires developed by reviewing different kinds of literature that have been well-organized of respondents from the project site through questioners and interviews with various professionals.

3.7 Data Presentation and Analysis

Interviews and questionnaires were used to get primary data, and literature review, books, and journals were used to gather secondary data. The data collected from primary and secondary sources were combined and analyzed. The descriptive analysis method was used to analyze the sample for this investigation. To order variables in terms of applicable, challenges, and

importance, the relative importance index (RII) technique to ordinals was utilized. Variables were tabulated and ranked according to their relative importance index RII (Mohamed Salama, 2010). For analysis, Microsoft Excel (2010) was used.

$$RII = \frac{\sum_{i=1}^{N} w_i}{N*A} \ ,(0 \leq \ RII \ \leq 1 \ ) \text{ ---------- [3.1]}$$

Where: Wi -is the weight, rank of respondents

A: is the highest weight

N: is the total number of respondents

Table 3.1 Rating scale for Extent of Applicability of Sustainable Building Materials

Applicability	Very Less	Less	Moderately	Highly	Very High
Weight	1	2	3	4	5

Table 3.1 indicated that the extent applicability of sustainable building materials rate based on the likert scale the respondents rates based on the applicability of the materials that are practice on their project.

Table 3.2 Rating scale for Challenges of Sustainable Building Materials

Challenge	Very Less	Less	Moderately	High	Very High
Weight	1	2	3	4	5

Table 3.2 show that the rating scales of the challenges that hinders to implement sustainable building materials in Jimma town

Table 3.3 Rating scale for the Role of Construction Professionals

Important	Very less	less	Moderately	High	Very high
Weight	1	2	3	4	5

Table 3.3 shows the importance scales regarding sustainable building materials and construction professionals' role in improving the uses of sustainable building materials in Jimma town.

3.8 Reliability of the Research

Reliability of the research means an instruments to attribute measures the degree of consistency therefore Cronbach's Alpha was applied in order to measures the consistency of the questionnaire. Cronbach's Alpha was used to measures the reliability of the mean of the whole fields of the questionnaire, and the normal range of Cronbach's Alpha was not the same since the value varies between 0.0 and +1.0. Higher value explained a higher degree of internal consistency. Therefore the result ensures the reliability of the questionnaire. Cronbach's coefficient alpha was determined based on the following formula (Lim EC, 1951,cited in Nicola L. Ritter 2010). and also cheek the external consistency within the pilot survey.

$$\alpha = \frac{K}{K-1}\left[1-\left(\frac{\sum\sigma_k^2}{\sigma_{Total}^2}\right)\right] \quad \text{[3.2]}$$

Where; K is the number of item

$\sum\sigma_k^2$ =is the sum of the k item score variances

σ_{Total}^2 =is the variance of scores on the total measurement

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 General Information of the Respondents

Respondents in this study filled out questionnaires and answered interview questions, and each respondent was separated into three groups: contractor, client, and consultant. This group consists of a wide range of professionals who formerly worked for a contractor firm. There were 25construction professionals in attendance, with civil engineers making up 52 percent construction technology and management (COTM) accounting for 24 percent electrical engineers are accounting for 8 percent and surveyors accounting for 16 percent. The client firm employs fifteen construction professionals (53 percent are civil engineers, 13 percent are architects, and 33 percent are Construction Technology &Management).The consultant firm employs nine construction professionals (28 percent are civil engineers, 4 percent are architects, and 4 percent are Construction Technology &Management).This indicated that all professionals in three firms, namely the contractor, the client, and the consultant, contributed significantly to this study by filling out the structured questioner based on their working experience, perception or prior knowledge, and subject matter about sustainable materials and their application, as well as the challenges to implementing sustainable building materials. Thus, construction professionals took part in this study; civil engineers, architects, surveyors, and Construction Technology & Management (COTM) & Electrical engineers filled out questionnaires based on their profession about what they think about sustainable materials, challenges that hinders to the implementation of sustainable building materials and the role in improving the uses of sustainable materials in Jiima town.

4.1.1 Response Rate of Questionnaire

The total distribution of the questionnaire was 55 which are concerning the participant according to their position and scope of service. Out of the 55 distribution questionnaire 2 questionnaires are not valid due to incomplete and also 4 questionnaires are not return on time. Out of 100 respondents 89% was responded.

Table 4.1 Response rate of questionnaires

No	Position of respondents	distributed	Not returned	incomplete	Responded	% of valid questionnaire
1	Contractor	28	2	1	25	89.3 %
2	Client	15	0	0	15	100 %
3	Consultant	12	2	1	9	75%
	Average	55	4	2	49	89.1%

Table 4.1 shows that the response rate of the targeted groups contractors, client and consultant and in this study each respondents group are filled the questionnaire and they participate in interview and their perception also different concerned on sustainable building materials and since what are their perception on the sustainable materials and their features, challenges that hinders the implementation of sustainable building materials and the role of construction professionals in improving the uses of sustainable building materials in Jimma town from three groups and under each group different professionals were participated. Furthermore response rate of questionnaire were 89% which show that acceptable value.

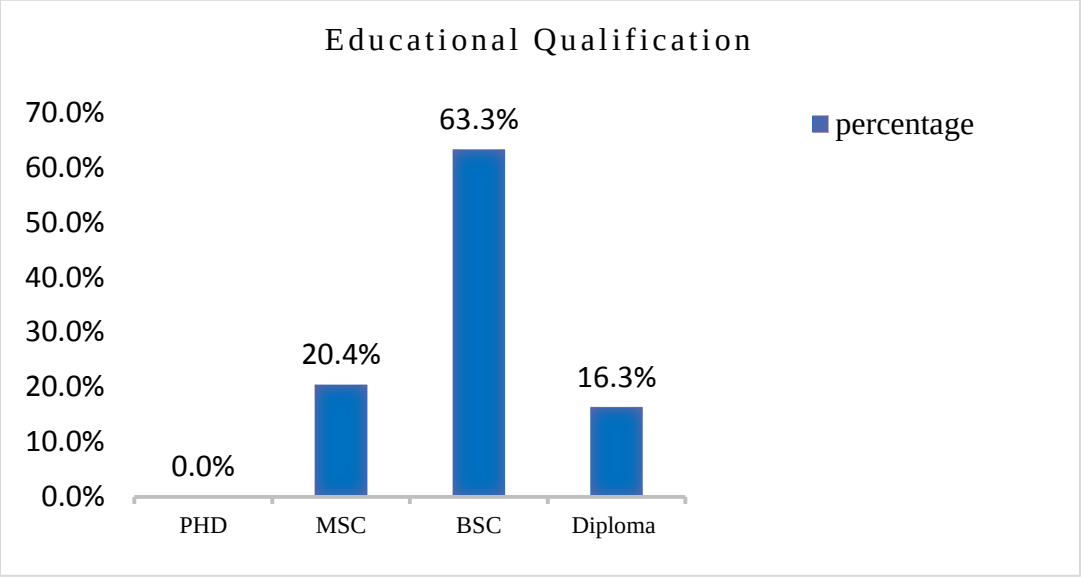

Figure 4.1 Educational levels of the Respondents

4.1.2 Educational level of the respondents

The respondents in this survey had varying educational degrees and were involved in building construction projects, with 20.4 percent having an MSc, 63.3 percent having a BSc, and 16.3 percent having a diploma. As a result, the majority respondents had BSc degree and all respondents' perceptions vary according to their educational level, and all respondents are concerned about sustainable building materials And according to their profession they perception also different and they contribute based on their professions what they are think about sustainable materials and their features and they collaborate through filled the questionnaire based on their back ground knowledge and their subject matter or department perception.

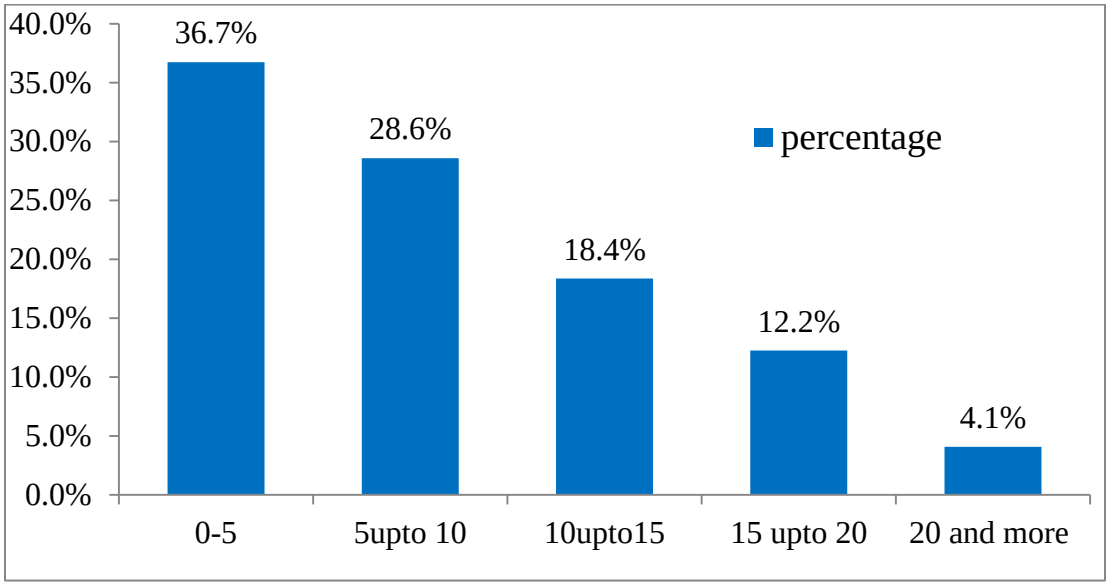

Figure 4.2 work Experience of Professionals

4.1.3 Work Experience of the Respondents

The respondents have appropriate expertise in building construction, as indicated in Figure 4.2 and they filled the structured questionnaire and participated in the interview. Because their perception various based on their work experiences and they collaborated they discussed the extent of applicability, the materials having sustainable features, challenges, and the role of construction professionals in improving the usage of sustainable building materials.

4.2 The Overall Result of the Extent of Applicability of Sustainable Building Materials.

Depending on the survey data the finding of the study has shown Table 4.2 the extent of applicability of sustainable building materials in Jimma town. Among fourteen features of sustainable building materials; only these features materials are moderately applicable. Using non or less toxic materials is ranked first with the Relative Importance Index value of (RII=0.702), using durable materials (RII=0.637) ranked second, and reuse materials ranked third (RII=0.629).However, the reduction of construction waste materials ranked fourth (RII=0.608).The analysis shows that the extent of applicability of sustainable building materials are less applicable in Jimma town since they did not apply to their project. Furthermore, the results show that the extents of conventional or unsustainable building materials are extremely applicable in Jimma town

According to the interviewees, some respondents discussed their thoughts, ideas, and feelings concerning the applicability of sustainable building materials features and the extent to which they believed that the extent of applicability of sustainable building materials features are less applicable. They told as sustainable building materials are important for reducing resources, waste and environmental impact; nevertheless, the extent of applicability of the materials having sustainable features were still low in Jimma town and interviewees told as about the materials having toxic element are less applicable and follow carefully procedures based on the manufacture manual and give for worker orientation and they told as sometimes the materials having less toxic content for example for concrete used some admixtures in order to accelerate or retarder. But most of times the applicability the materials having nontoxic features are extremely high. They also told as during the material selection based on the material chemical and mechanical properties were considered such as; unit weight, seismic gravity, water absorption and other properties are tested. However the construction site still didn't fulfill all features of sustainable materials considering. And from the durability of the materials point view they told The selection of materials have becomes important for enhancing the building longer life or durability and the durability of materials considering in every life cycle of the building and started from the design stage the architects were considered the materials based on weather

condition, seismic condition and zone. For example for improving high grade of concrete are a matter of the aggregate size, cement type as well as sand which is provide for enhance the building long life And concern on the reuse materials like formwork and the materials sourced from were recycled selected materials from other demolish site were used as fill materials. The interviewees also told about the natural and local materials are used for example wood, stone and sand.

Table 4.2 The Overall Result of the Extent of Applicability of Sustainable Building Material in Jimma town

		Weighted average	
No	Feature of sustainable building materials	RII	RANK
1	Using none toxic materials	0.702	1
2	Use durable materials	0.637	2
3	Use of reusability material.	0.629	3
4	Reduction of Construction Waste materials	0.608	4
5	Moisture resistance materials	0.588	5
6	Use of locally available materials	0.576	6
7	Use of natural materials	0.567	7
8	Pollution Prevention Measures in Manufacturing	0.547	8
9	Using energy-efficiently materials	0.531	9
10	Use of biodegradability materials.	0.510	10
11	Use of renewable energy sources of materials	0.506	11
12	Use Embodied energy reduction.	0.502	12
13	Use of recyclability materials.	0.465	13
14	Use of partial recycled content materials.	0.424	14

4.3Overall Result of Challenges that hinder the Implementation ofSustainable Building Materials in Jimma town

Other literature reviewed found different challenges of sustainable building materials. After finding the challenges, categorized the challenges based on the related ones: awareness and knowledge, cost and risk-related, government-related, technical and performance-related, and market-related challenges. And analyzed the survey based on the respondents' given rate & ranked the relative important index (RII) value. As shown in Figure 4.3

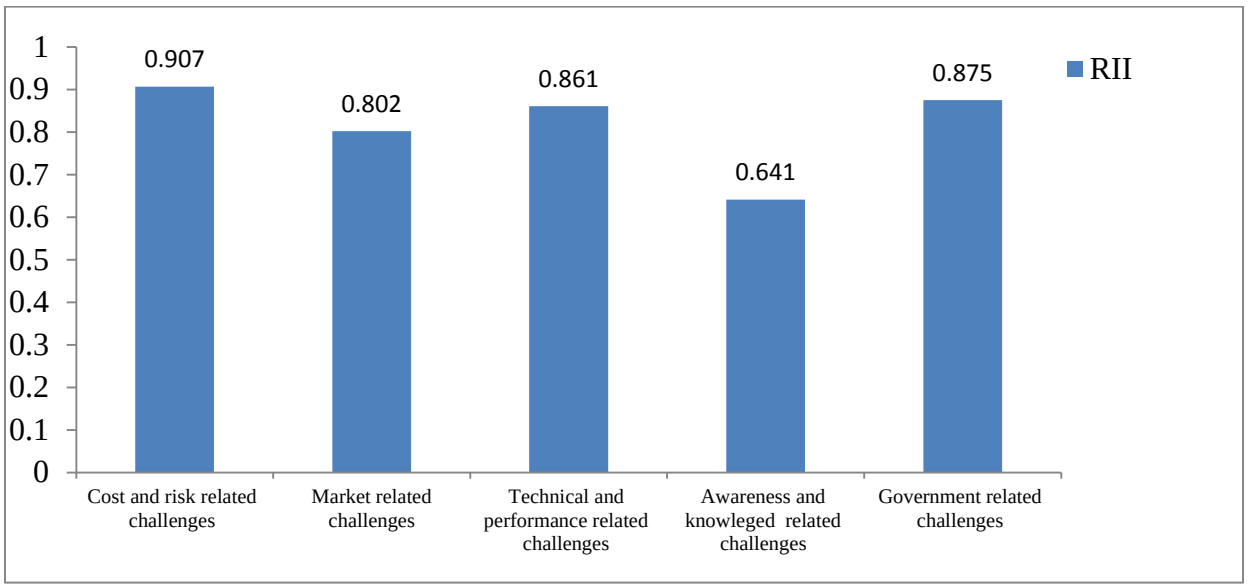

Figure 4.3 The major cause of Challenges to implement sustainable building materials.

The analysis data as show Figure 4.3 the challenge of sustainable building materials in Jimma town and among major challenges category ranked according to the respondents given rate and RII.

Cost and risk related challenges are ranked first and the value of (RII=0.907). The analysis data show that cost and risk are high challenges to implement sustainable building materials in Jimma town.

The second rank under major challenges is government related challenges and with value of (RII=0.875) the result show that the government is didn't give emphasize to implementing sustainable building materials and the government didn't involve the construction professionals during review urban planning and construction code which is concern on sustainable building design and material.

Technical and performance related challenges ranked third (RII=0.861) the result shows that high challenges in Jimma town. Since sustainable materials are required more technical approach and technologies. Since the professionals didn't familiar with sustainable technologies is a major challenge.

Market related challenges ranked fourth & (RII=802) this implies that market related challenges were highly challenge. Limited uses of sustainable materials, availability and variety of local materials in the market are still low and lack of local norms and standard in Jimma town. Furthermore the benefit of sustainable or local available materials still didn't well address the market.

Awareness and knowledge-related challenges ranked fifth with a rating of (RII=0.641). The data analysis shows that awareness concerning sustainable materials is moderately challenging because all construction professionals do not have the same perception and knowledge background about sustainable materials, how to reuse construction waste materials after disposal or demolish and how to mitigate resource and environmental impact.

The interviewee also different perception regards the challenges of sustainable building materials to implement in Jimma town. Regards on the cost and risk-related challenges, the interviewee gives different perceptions and opinions. They tell as the client worried and lack of willingness and interest to implement sustainable building materials due to lack of awareness and negative perception of local materials based on the experience and didn't recognize the final benefit gained from sustainable building materials. The interviewee also talked about the client's awareness about the newly emerged concept is fear of increasing the cost of the materials because clients are the financial former and the cost driver of any projects. They emphasize the clients should be aware of the concepts of sustainable building materials. From other interviewees' perceptions, they disagreed with this idea; they suggested not only the client also the government has no trend and did not emphasize sustainable building materials. They stated there is no standard, code like EBCS, policy, and updated local code regarding urban planning and construction, building materials. Another interviewee also suggested that regarding materials features, structures, properties, and flexibility of the materials will affect since sustainable materials are locally available materials and different structures from conventional materials and after demolish and recycled the material changes their properties and which is difficult for architecture to design and to implement. And they also suggested lack of exposures regards on the sustainable materials since there is no training or educational access as well as there is no trend.

4.3.1 Overall result of Awareness and Knowledge related Challenges

From different literature was reviewed found seven awareness and knowledge related challenges and analysis the data on the three firms including client, contractor and consultant response and ranked through RII value as shown the Table 4.3

Table 4.3 Awareness and Knowledge Related Challenges

		Weighted Average	
No	Awareness and knowledge related challenges	RII	Rank
1	Lack of awareness and information concerning the use of sustainable building materials	0.698	1
2	Negative perceptions of local materials regards durability of materials	0.678	2
3	Unfamiliarity with sustainable or green materials technologies	0.669	3
4	Lack of client knowledge and interests alternatives.	0.661	4
5	Lack of educational access for design and construction professionals	0.641	5
6	Negative perceptions amongst practitioners based on past experiences	0.629	6
7	Lack of knowledge about the role of architects	0.620	7

From Table 4.3, the overall result of awareness and knowledge related challenges and results indicated that the awareness and knowledge related challenges are moderate challenges compared with other challenges. Under this perception, seven issues are identified and ranked according to the respondents' responses and RII value. Lack of awareness and information concerning the use of sustainable building materials are ranked first with the value of (RII=0.698), which indicates that there is a knowledge gap in the difference between the conventional building materials and sustainable building materials and also showing that the company or other stakeholders they did not work on awareness creation for professionals or others who are involved in the construction industry. Negative perceptions of local materials in the durability of materials are ranked second, with a value of (RII=0.678), implying that the perception of the materials is negative when compared to previous experience and indicating a knowledge gap among professionals because the company did not put any data related to the performance of the material data.

Moreover, the third-ranked is unfamiliarity with sustainable or green materials technologies ranked (RII=0.669), this shows that sustainable building materials are different from conventional ones and applied other needed technology's and the stakeholder didn't have any trend in order to introduce with sustainable materials and technologies. Lack of client knowledge and interests alternatives ranked fourth (RII=0.661); the clients are focused on financial-related issues and did not consider the project's output and final benefit gained from sustainable materials. Lack of educational access for design and construction professionals ranked fifth (RII=0.641), which shows that the stakeholders didn't provide any educational access for construction professionals which is concern on the sustainable design, materials and technologies. .

Further, the negative perceptions amongst practitioners based on experiences ranked sixth with the value of (RII=0.629), which means most of the time, the construction industry does not give attention to sustainable building materials and the practitioners they doesn't have experience on sustainable materials during previous work. Lack of knowledge about the role of architects ranked seventh (RII=0.620), which implies that the designer or architects did not recognize the environmental impact and the maintenance cost and didn't included sustainable materials in design.

4.3.2 Cost and risk related challenges

From different literature was reviewed found four cost and risk related challenges and analysis the data on the three respondents group including client, contractor and consultant response and ranked through RII value as shown the Table 4.4

Table 4.4 Overall results of Cost and Risk Related Challenges

		Weighted Average	
No	Cost and risk related challenges	RII	Rank
1	The client fear of increased financial risks associated with sustainable materials	0.922	1
2	Lack of financing for education for design and construction professionals	0.918	2
3	High cost of materials for local sustainable materials	0.898	3

4	The professionals don't want to take any risk in the process of the sustainable materials	0.890	4
	Average	0.907	

Cost and risk-related challenges are highly challenging in Jimma town. As shown in Table 4.4, four issues were identified under this category related to the financial and risk from the different perceptions that hinder the implementation of sustainable building materials. The client fears increased financial risks associated with sustainable materials ranked first with the value of (RII=0.922), which indicated that the clients are the financial driver of the project. It shows that the increased financial risk clients did not consider the final benefit gained from sustainable materials. Moreover, the lack of financing for education for design and construction professionals ranked second with the value of (RII=0.918); this implies that the stockholder didn't fundraise to educational access for professionals, which is related to sustainable building materials and technologies, how it is designed and installed or used. Further, high costs of green or sustainable materials and technologies were ranked third with the value of (RII=0.898), which indicated that the sustainable materials and technologies are related to the cost of sustainable or green material. Last on the rank was the professionals who do not want to take any risk in the process of the sustainable materials with the value of (RII=0.890), which means in the previous experience the implementation of sustainable material has less practice on the site in Jimma town; therefore, professionals do not have any trend regards on sustainable materials how could be applicable and there is no educational access for materials and technologies so that they don't want to take any risk.

4.3.3 Technical and Performance Related Challenges

Table 4.5 shows six technical and performance-related challenges collected from different literature reviews and ranked as the relative importance index (RII) value based on the respondents' views.

Table 4.5 Overall Result of Technical and Performance Related Challenges

No	Technical and performance related Challenges	RII	Rank
1	Lack of training on sustainable materials and technologies	0.886	1
2	Lack of materials performance data	0.869	2
3	Lack of construction professionals' skills with sustainable design and materials	0.865	3
4	low availability of skilled labor	0.857	4
5	Lack of established standards, design guides and tools, and standardized details	0.853	5
6	Lack of confidence in contractor ability and availability of skilled	0.837	6
	Average	0.861	

Under technical and performance related challenges. Lack of training on sustainable materials and technologies ranked first with the value of (RII=0.886) this show that the stakeholders do not emphasize for professional skill which means they can't compromise even if the project failed due to unfamiliarity with new technologies and materials to implement or practice on the site.

Lack of materials performance data ranked second with the value of (RII=0.869) this indicated that sustainable materials are locally available materials the professionals they don't know about the materials performance, properties, strength and durability and the stakeholders they didn't provide any information or database concern on sustainable materials performance data and there is no certification about sustainable materials. Furthermore Lack of construction professionals' skills with sustainable design and materials ranked third with the value of (RII=0.865) which indicated that the stakeholders not give attention for professionals employment and Lack of professionals those who graduate by material and other engineering discipline which related sustainable materials.

Furthermore, Low availability of skilled labor ranked fourth with the value of (RII=0.857) this implies that the labor haven't adequately experience on sustainable materials since they are commonly applicable unsustainable materials and they haven't any trend on sustainable material practice on site. Lack of established standards, design guides and tools, and standardized details

ranked fifth with the value of (RII= 0.853) this implies that lack of availability of standards in order to guide for design and implement sustainable building materials.

Lack of confidence in contractor ability and availability of skilled ranked sixth and the value of (RII= 0.837) this indicated that the contractors are worried too if the project fails out since the contractors from the previous experience they didn't take any risk due the process of sustainable materials and the contractors fear to the bankrupt if the project fails out due sustainable materials and lack of information adequately available in the company about sustainable materials performance data.

4.3.4 Government Related Challenges

From other literature reviewed, the three government-related challenges were ranked based on the respondents, which are contractor, client, and consultant response, and determined by relative importance index value as shown in Table 4.6.

Table 4.6 Overall Result of Government Related Challenges in Jimma town

No	Government related challenges	RII	Rank
1	Lack of local police, standards, and law to integrate the sustainable building material.	0.882	1
2	Lack of sustainable or green materials definition in code of urban planning and construction.	0.873	2
3	Lack of access to financing for construction industry	0.869	3
	Average	0.875	

Table 4.6 show that government related challenges and Under government related challenges lack of national police, standards, code and law to integrate the sustainable building material ranked first with the value of (RII=0.882) this indicated that the government and the stakeholders didn't emphasize the materials and the environment impact which is caused by unsustainable materials. As per the results, government and environmental protection agency (EPA) didn't work together for reducing environmental impact. Lack of sustainable or green materials definition in code of urban planning and construction ranked second & (RII=0.873) this indicated that there is no code stated about the definition sustainable materials, design approach and sustainable development .Lack of access to financing for construction industry ranked third

(RII=0.869) this indicated that the government didn't provide any financial support those who implement sustainable building materials on their projects.

4.3.5 Market relegated challenges

Different kinds of literature were reviewed. The three market-related challenges were identified; the survey data was analyzed based on the respondents, contractors, clients, and consultants and were ranked with corresponding RII as shown Table 4.7

Table 4.7 Overall Result of Market Related Challenges in Jimma town

No	Market-related challenges	RII	Rank
1	Limited users' knowledge about sustainable or green design and materials on market	0.829	1
2	Lack of availability of sustainable or green materials and technology on the market	0.800	2
3	Limited local sustainable materials norms and standard	0.776	3
	Average	0.802	

As shown in Table 4.7, the limited users' knowledge about sustainable or green design and materials ranked first with the value of (RII=0.829) this shows that sustainable materials didn't aware on the market since the awareness on the benefit of local available materials and application didn't properly address on the market.

The lack of availability of sustainable or green materials and technology on the market ranked second with the value of (RII=0.800), which implies that sustainable materials are not widely available in the market and sustainable technology also did not well address on the market. Limited local, sustainable materials norms and standards materials ranked third, and the value (RII=0.776) indicated no wide application of sustainable materials due to lack of standards and norms, which helps construction professionals.

4.4 The Overall Result of the Role of Construction Professionals to improve the uses of sustainable building in Jimma town

Eight roles of construction professionals were identified from various literature reviews to improve the use of sustainable building materials in construction; to analyze survey data based on the giving rate of respondents; and to analyze survey data through an Excel template and rank them according to the relative importance index (RII). These roles are depicted in Table 4.8 as the most important roles of construction professionals.

Table 4.8 Overall Result of The Role of Construction Professionals in Jimma Town

No	The Role of construction Professionals	RII	Rank
1	The professionals carefully select materials having sustainable features	0.918	1
2	Professionals provide technical data sheet and materials performance available in company & manufacturing process	0.910	2
3	Provide certification whose accuracy and reliability of the materials	0.906	3
4	Professionals create awareness for client to reduce risk &negative perception of local materials	0.902	4
5	Professionals inside the market and encourage manufacture and improve availability of sustainable materials	0.898	5
6	Professionals follow Leadership in Energy and Environmental Design (LEED) based rating system	0.894	6
7	Construction professional work as team with government corporations institution e.g. Environmental protection agency (EPA) &corporate social responsibility (CSR)	0.890	7
8	Professionals give training for labor regards sustainable materials and technologies	0.886	8
	Average	0.901	

From Table 4.8 as show in the table the overall results of construction professionals to improving the uses of sustainable building materials in Jimma town high important and under the role of construction professionals ,The professionals carefully select materials based on sustainable parameters ranked first and the value of (RII=0.918).this implies the professionals focused on the material and the materials having sustainable building materials features which is the materials

able to reduce environmental impact and can be recycled ,reuse partial recycled content after demolish. Professionals provide technical data sheet and materials performance available in company & manufacturing process ranked second and (RII=0.910) the analysis show that the selection of materials use in building is usually made on the basis of their in the technical data sheets and the construction professionals give adequately information or data during manufacturing process base process. However, the third ranked provide certification whose accuracy and reliability of the materials with the value of (RII=0.906) this show that professionals should provide certification about material this can be helps to the practitioner to improve the perception, and having confidence to implement of local materials since the materials certified. Professionals create awareness for client to reduce risk &negative perception of local materials ranked fourth & (RII=0.902) this implies that the client is the former or financial driver of project site professionals have to take advice, suggestion to implement sustainable building construction materials and reduce risk due negative perception on local materials. Professionals inside the market and encourage manufacture and improve availability of sustainable materials ranked fifth & (RII=0.898) this show that the professionals create any information or data that can be stated performance, strength durability as well as their properties of sustainable building materials.

Professionals follow Leadership in Energy and Environmental Design (LEED) based rating system ranked sixth & (RII=0.894) this indicated that professional LEED guideline was important which is standard rating system and they guide through this standard. Construction professional work with government, corporation institution e.g. Environmental protection agency (EPA) &corporate social responsibility (CSR) are ranked seventh (RII=0.890) show that knowing the construction professionals working with government and other institution are important. The professionals and government are work as a team regards on implementing police ,code concern about sustainable material and other related issues like urban planning and construction. Professionals give training for labor regards sustainable materials and technologies ranked eighth with the value of (RII=0.886) demonstrate that training on sustainable materials and technologies are important for construction professionals in order to improve their knowledge and change their previous attitude and perception on local materials.

The interviewees were asked to respond concerning the role of construction professionals in improving the use of sustainable building materials. All respondents believed that construction professionals' role is important in enhance the uses of sustainable materials in Jimma town. The professionals give awareness for the client they give emphasize since the clients are financial former of any project and suggested providing awareness on the final benefit gained from sustainable building materials are important and improving negative perception on local materials. Another interviewees also told as test the material properties and provide any information which is stated about materials lab result and any procedures that helps to implement the material, for example recycled materials should able to know the properties since after recycled may be the materials lose their properties or provide any numerical or non-numerical data are important. Furthermore they told regards on material selection consider the materials having good thermal properties and insulation and the materials are after demolished able to recycled, reuse and able to fulfill the other feature of sustainability And also they emphasize give public awareness about sustainable building materials benefit and increasing availability of materials on markets. Also another interviewee suggested while sustainable building materials are various definitions and didn't know properly by this name on market so properly aware about sustainable materials which is the materials locally available, reduce transport cost and other feature of sustainable materials since them easily to understand and knowing. Furthermore other interviewee suggested that the government should involve and participate the construction professionals and amend the previous, urban planning and construction code especially for new emerged concept like sustainable materials, and the code should clearly state the definition of sustainable materials as well as they told as the government provide educational access and training concern sustainable materials, technology and they emphasize the legalized and published documentation which is state about sustainable materials ,their construction methods and technology and they told as established the department and work with construction firm in order to discuss about materials performance ,properties and in order to join the material from foreign product and local material this can be reduces the environmental impact and have economical point of view reduce the raw material consumption and waste materials.

4.5 Reliability of the Research

A study's reliability is defined as the absence of random errors, which allows succeeding researchers to get the same conclusions if they repeat the process step by step. The internal consistency was determined using Cronbach's alpha. Data measurements were evaluated for consistency using Cronbach's alpha methodology, and the outcomes of the three study questions were compared. The first objective stated the extent to which sustainable building materials were applicable, the second stated the challenges that hindered the implementation of sustainable building materials, and the third stated the role of construction professionals in improving the use of sustainable building materials; the results ranged from 0.791 to 0.879 for each of the three objectives, respectively and the sample stated on Appendix-D. According to the results of the three study questions addressed in Table 4.9, this range is determined acceptable.

Table 4.9 Cronbach's Coefficient Alpha Result

No	Section	Cronbach's Coefficient Alpha
1	The extent of applicability of sustainable building construction materials	0.791
2	The challenges that hinder to implement of sustainable building construction materials	0.855
3	The role of construction professionals in improve the uses of sustainable building construction materials	0.879

Table 4.10 The range of RII value

The extent of applicability of sustainable building construction materials	Very Less	Less	Moderately	Highly	Very High
W	1	2	3	4	5
N	49	49	49	49	49
A	5	5	5	5	5
N*A	245	245	245	245	245
W of 49 respondents	49*1	49*2	49*3	49*4	49*5
RII (W of 49 respondents/ N*A)	0.2	0.4	0.6	0.8	1
Challenges that hinders the Implement Sustainable Building Construction Materials in Jimma town	Very Less	Less	Moderately	Highly	Very High
W	1	2	3	4	5
N	49	49	49	49	49
A	5	5	5	5	5
N*A	245	245	245	245	245
W of 49 respondents	49*1	49*2	49*3	49*4	49*5
RII (W of 49 respondents/ N*A)	0.2	0.4	0.6	0.8	1
Role of Construction Professionals to improve the uses of sustainable building in Jimma town	Very Less	Less	Moderately	Highly	Very High
W	1	2	3	4	5
N	49	49	49	49	49
A	5	5	5	5	5
N*A	245	245	245	245	245
W of 49 respondents	49*1	49*2	49*3	49*4	49*5
RII (W of 49 respondents/ N*A)	0.2	0.4	0.6	0.8	1
Range of RII	Extent of applicability/ challenge/ important				
0.2 up to 0.39	Very less				
0.4 up to 0.59	Less				
0.6 up to 0.79	Moderately				
0.8 up to 0.99	Highly				
1	Very highly				

Table 4.10 shows that the range of relative importance index, which is based on the Likert rating scale of 1up to 5, which is one as very less, two less, three as moderately four as high, and five as very high and to determine the range of RII between 0.2 - 1 value but in this study the results For the three objectives are the range between 0.424 to 0.922.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

This chapter summarizes based on the chapter three results and derived the following conclusion and recommendation concerned on the extent of applicability of sustainable building materials ,the challenges that hinders to implement sustainable building materials and the role of construction professional to improve the uses of sustainable building in Jimma town.

5.1 Conclusion

The study conclude that the extent of applicability of sustainable materials among fourteen feature of sustainable building materials (Using recycled materials, locally available materials, of renewable energy sources of materials, embodied energy reduction materials, moisture resistance nontoxic materials ,durable materials, pollution prevention measures in manufacturing, energy-efficiently materials, recyclability material, natural materials, of biodegradability materials, partial recycled content materials, Reduction of Construction Waste materials) among all features using nontoxic materials are moderately applicable. Therefore the extent of applicability of sustainable building materials in Jimma town are less applicable the data were concluding that construction industry is not paying attention for sustainable materials rather than conventional materials.

Sustainable materials is a significant contributor to reduce environmental impact however due to various challenge didn't implement sustainable materials; namely with a few example poor awareness on benefit of sustainable materials resource utilize, unfamiliarity with sustainable materials and technology, lack of availability of local material on market, negative perception held by client, which is related they fear cost and risk related, lack implement policy and code which is concern on urban planning and construction, lack of code whose defined the definition of sustainable materials and lack of skilled professionals specialized with sustainable materials and technologies. Among five the major causes of challenge; Awareness, market, technical and performance related, cost and risk related and government related challenges cost and risk related challenges are the first hindrance to implement sustainable materials in Jimma town.

Construction professionals have significant role in sustainable development since the professionals incorporate construction and materials having participate in material selection since the selection of materials is crucial issues under sustainable parameter the professionals provide information or data base adequately available in Company about technical, performance the materials in order to improve the client perception regards on local materials and give public awareness and certify the materials and professional inside the market and create competitive market is most important in order to improve the use of sustainable building materials.

5.2 Recommendation

- The selection of materials and taking environmental issues into consideration during the design stage, construction professionals, particularly architects and engineers, should pay more attention. Additionally, the designer should provide adequate information to clients about the advantages of using sustainable building materials.

- Stakeholders should be an employee proportional manner, which means that the corporation should hire engineers from a variety of engineering disciplines, such as environmental engineers, material engineers, and others related course.

- Additionally, the government should certify the materials, which can include establishing certification standards based on the performance of the materials. The government should also encourage those who use sustainable building materials in their projects by providing them with financial and material support.

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APPENDIX-A

JIMMA UNIVERSITY
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT ON THE USES OF SUSTAINABLE BUILDING MATERIALS: A CASE OF BUILDING CONSTRUCTION PROJECT IN CASE OF JIMMA TOWN

Dear respondent,

Thank you for your willingness to participate in this study.

My name is Liyouget Jembere and I am a final year Master of Science (MSc) Student at Jimma institution of technology (JIT) specialized in Construction Engineering and Management. To fulfill this requirement here I request you to respond to your opinion on each of the questions below. I believe your opinion has an immense contribution to the study. The information you provide will solely be used to accomplish this academic requirement and not for any other purpose.

Phone number: **0920365712 or 0910467172**

Email Address: liyougetjembere@gmail.com

PART I: PERSONAL INFORMATION OF THE RESPONDENTS'

Please tick (✓) on your choice

A. Your 'Educational Qualification: ☐ PHD ☐ MSc ☐ BSc ☐ Diploma. ☐ Other

B**.** Your Profession (Working as): ☐ Architect ☐ Civil Engineer ☐ Environmental ☐Urban plane ☐Academia ☐Mechanical Engineer ☐ Electrical Engineer ☐ Construction technology &management ☐ Other please (specify)……..

C. Years of Experience: ☐ 0-5 ☐5-10 ☐ 10-15 ☐ 15-20 ☐ More than 20 year

D**.** Your Company's scope of service: ☐ Contractor ☐ Consultants ☐ Academic institution ☐ Real estate Developer ☐ Government Firm ☐ other please (specify)……

PART II: THE QUESTIONS REGARDS ON THE EXTENT OF THE APPLICABILITY OF SUSTAINABLE BUILDING CONSTRUCTION MATERIALS IN BUILDING CONSTRUCTION PROJECT IN JIMMA TOWN.

1. In the following table rank the extent of the applicability of sustainable building materials in building construction of your project in Jimma town. **1=very less applicable 2=less applicable 3=moderately applicable 4=high applicable 5=very high applicable**

No	Feature of sustainable building materials	1	2	3	4	5
1	Use of recyclability materials.					
2	Use of locally available materials					
3	Use of renewable energy sources of materials					
4	Use embodied energy reduction materials					
5	Use moisture resistance materials					
6	Using none toxic materials					
7	Use durable materials					
8	Pollution Prevention Measures in Manufacturing					
9	Using energy-efficiently materials					
10	Use of reusability material.					
11	Use of natural Materials					
12	Use of biodegradability materials.					
13	Use of partial recycled content materials.					
14	Reduction of Construction Waste materials					

PART III: THE CHALLENGES THAT HINDERS TO IMPLEMENT SUSTAINABLE MATERIALS IN BUILDING CONSTRUCTION PROJECT IN JIMMA TWON

1. From the table below please Rank in a scale of 1 – 5 the factors you feel largely challenges to implement of sustainable Building materials in your project where **1= very less challenges 2=Less challenge 3= moderately challenges 4=Very challenge, 5=Very high challenges.**

No	**Awareness and knowledge related challenges**	**1**	**2**	**3**	**4**	**5**
1	Lack of educational access for design and construction professionals					
2	Lack of client knowledge and interests alternatives					
3	Negative perceptions of local materials regards durability of materials					
4	Unfamiliarity with sustainable or green materials technologies.					
5	Negative perceptions amongst practitioners based on past experiences					
6	Lack of knowledge about the role of architects					
7	Lack of awareness and information concerning the use of sustainable building materials					
No	**Technical and performance related Challenges**					
1	Lack of materials performance data					
2	Lack of training on sustainable materials and technologies					
3	Lack of established standards, design guides and tools, and standardized details					
4	Lack of construction professionals' skills with sustainable design and materials					
5	low availability of skilled labor					
6	Lack of confidence in contractor ability and availability of skilled					
No	**Cost and risk related challenges**					
1	The client fear of increased financial risks associated with sustainable materials					
2	The professionals don't want to take any risk in the process of the sustainable					

	materials					
3	Lack of financing for education for design and construction professionals					
4	High cost of materials for local sustainable materials					
No	**Government related challenges**					
1	Lack of access to financing for construction industry					
2	Lack of sustainable or green materials definition in code of urban planning and construction.					
3	Lack of national police, standards and law to integrate the sustainable building material.					
No	**Market-related challenges**					
1	Limited local sustainable materials norms and standard					
2	Lack of availability of sustainable or green materials and technology on the market					
3	Limited users' knowledge about sustainable or green design and materials					

PART IV: THE ROLE OF CONSTRACTION PROFFESIONALS TO IMPROVE THE USE OF SUSTAINABLE BUILDING MATERIALS IN BUILDING CONSTRUCTION PROJECT

Rank in a scale of 1 – 5 the Role of construction professionals to improve the use of sustainable building materials in Jimma town. **Where 1= very less importance 2=less importance 3= moderately importance 4=Very importance, 5=Very high important**

No	Professional roles	1	2	3	4	5
1	Professionals give training for worker regards sustainable materials and technologies					
2	Professionals follow Leadership in Energy and Environmental Design (LEED) based rating system					
3	Construction professional work with government corporations institution e.g. Environmental protection agency (EPA) &corporate social responsibility (CSR)					
4	Professionals create awareness for client to reduce risk &negative perception of local materials					
5	Provide certification whose accuracy and reliability of the materials					
6	Professionals provide technical data sheet and materials performance available in company & manufacturing process					
7	The professionals carefully select materials having sustainable features					
8	Professionals inside the market and encourage manufacture and improve availability of sustainable materials.					

APPENDIX-B

Interview questions

1. Do you know the concepts of sustainability and sustainable building materials?
2. Dose applicable the materials having sustainable features and to what extent the applicability of sustainable building materials features in your project?
3. How could be minimize environmental impact which is caused by building construction process?
4. Do you have any trend on the selection of materials having sustainable features?
5. What is the pre requirement of the selection of materials in building construction?
6. What are the challenges that hinders to implement sustainable building materials in Jimma town? Under the majors challenges which challenges are the primarily that hinders the implementation of sustainable building materials in Jimma town?

   A Technical and performance related challenges

   B. Market related challenges

   C. lack of awareness rand knowledge related challenges

   D. Government related challenges

   E. Cost and risk related challenges
7. How to improve the uses of sustainable building materials in Jimma Town?
8. Does construction professionals in sustainable building materials role and what is the role of construction professional's in improving the uses of sustainable building materials?

APPENDIX-C

Table 1 RII and Rank for The extent of applicability sustainable building materials in Jimma town

		Group of Respondents							
		Contractor		Client		Consultant		Weighted Average	
No	Feature of sustainable building materials	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Use of recyclability materials.	0.472	13	0.493	14	0.400	13	0.465	13
2	Use of locally available materials	0.56	8	0.68	3	0.444	7	0.576	6
3	Use of renewable energy sources of materials	0.528	10	0.507	13	0.444	7	0.506	11
4	Use embodied energy reduction materials.	0.512	11	0.507	6	0.467	5	0.502	12
5	Using moisture resistance materials	0.632	3	0.653	10	0.467	5	0.608	4
6	Use durable materials	0.616	4	0.653	6	0.667	2	0.637	2
7	Using none toxic materials	0.736	1	0.640	5	0.711	1	0.702	1
8	Pollution Prevention Measures in Manufacturing	0.544	9	0.613	8	0.444	7	0.547	8
9	Using energy-efficiently materials	0.576	6	0.520	3	0.422	11	0.531	9
10	Use of reusability material.	0.664	2	0.613	1	0.556	3	0.629	3
11	Use of natural Materials	0.608	5	0.573	2	0.444	7	0.567	7
12	Use of biodegradability materials.	0.504	12	0.573	8	0.422	11	0.510	10
13	Use of partial recycled content materials.	0.456	14	0.440	11	0.311	14	0.424	14
14	Reduction of Construction Waste materials	0.576	6	0.667	11	0.489	4	0.588	5

Table 2 RII and Rank for the major cause of challenges that hinders to implement sustainable building materials in Jimma town

Awareness and knowledge related challenges									
		Contractor		Client		Consultant		Weighted Average	
No	Awareness, and knowledge related challenges	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Lack of educational access for design and construction professionals	0.640	5	0.72	1	0.711	2	0.678	2
2	Lack of client knowledge and interests alternatives	0.640	5	0.707	2	0.689	4	0.669	3
3	Negative perceptions of local materials regards durability of materials	0.688	1	0.707	2	0.711	2	0.698	1
4	Unfamiliarity with sustainable or green materials technologies.	0.616	7	0.680	4	0.756	1	0.661	4
5	Negative perceptions amongst practitioners based on past experiences	0.672	2	0.600	6	0.556	5	0.629	6
6	Lack of knowledge about the role of architects	0.656	3	0.600	6	0.556	5	0.620	7
7	Lack of awareness and information concerning the use of sustainable building materials	0.656	3	0.667	5	0.556	5	0.641	5
Technical and performance related Challenges									
		Contractor		Client		Consultant		Weighted Average	
No	Technical and performance related Challenges	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Lack of materials performance data	0.856	2	0.869	2	0.911	1	0.869	2
2	Lack of training on sustainable materials and technologies	0.864	1	0.886	1	0.889	2	0.886	1
3	Lack of established standards, design guides and tools, and standardized details	0.832	4	0.853	5	0.822	6	0.853	5

4	Lack of construction professionals' skills with sustainable design and materials	0.832	4	0.865	3	0.889	2	0.865	3
5	low a availability of skilled labor	0.84	3	0.857	4	0.844	5	0.857	4
6	Lack of confidence in contractor ability and availability of skilled	0.816	6	0.837	6	0.867	4	0.837	6
Market-related challenges									
		Contractor		Client		Consultant		Weighted Average	
No	**Market-related challenges**	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Limited local sustainable materials norms and standard	0.704	3	0.776	3	0.776	3	0.776	3
2	Lack of availability of sustainable or green materials and technology on the market	0.728	2	0.800	2	0.800	2	0.800	2
3	Limited users' knowledge about sustainable or green design and materials	0.776	1	0.829	1	0.829	1	0.829	1
Cost and risk related challenges									
		Contractor		Client		Consultant		Weighted Average	
No	Cost and risk related challenges	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	The client fear of increased financial risks associated with sustainable materials	0.92	2	0.907	1	0.956	1	0.922	1
2	High cost of materials for local sustainable materials	0.88	3	0.907	1	0.933	2	0.898	3
3	Lack of financing for education for design and construction professionals	0.928	1	0.893	3	0.933	2	0.918	2
4	The professionals don't want to take any risk in the process of the sustainable materials	0.872	4	0.893	3	0.933	2	0.890	4
Government related challenges									

		Contractor		Client		Consultant		Weighted Average	
No	Government related challenges	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Lack of access to financing for construction industry	0.856	2	0.867	2	0.911	3	0.869	3
2	Lack of sustainable or green materials definition in code of urban planning and construction.	0.832	3	0.893	1	0.956	1	0.873	2
3	Lack of national police, standards, and law to integrate the sustainable building material.	0.88	1	0.853	3	0.933	2	0.882	1

Table 3 RII and Rank The Role Construction Professional to Improve the Use Sustainable Building Materials in Jimma Town

		Contractor		Client		Consultant		Weighted Average	
No	The Role of Construction Professionals	RII	Rank	RII	Rank	RII	Rank	RII	Rank
1	Professionals follow Leadership in Energy and Environmental Design (LEED) based rating system	0.888	6	0.880	6	0.911	6	0.894	6
2	Provide certification whose accuracy and reliability of the materials	0.92	3	0.893	3	0.933	2	0.906	3
3	Construction professional work as team with government ,corporations institution e.g. Environmental protection agency (EPA) &corporate social responsibility (CSR)	0.88	7	0.867	7	0.889	7	0.890	7
4	Professionals create awareness for client to reduce risk &negative perception of local materials	0.904	4	0.893	3	0.933	2	0.902	4
5	Professionals provide technical data sheet and materials performance available in company & manufacturing process	0.928	1	0.907	2	0.933	2	0.910	2
6	The professionals carefully select materials having sustainable features	0.928	1	0.920	1	0.978	1	0.918	1
7	Professionals give training for labor regards sustainable materials and technologies	0.856	8	0.853	8	0.866	8	0.886	8
8	Professionals inside the market and encourage manufacture and improve availability of sustainable materials	0.896	5	0.893	3	0.933	2	0.898	5

APPENDIX -D

Table 4 Sample of Cronbach's Alpha Coefficient for the challenges that hinders to implement sustainable building materials Government Related Challenges

	q1		q2		q3		Total	
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	4	0.120	4	0.135	4	0.166	12	1.259
	4	0.120	4	0.135	4	0.166	12	1.259
	4	0.120	4	0.135	4	0.166	12	1.259
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	3	1.869	3	1.982	10	9.747
	3	1.814	4	0.135	4	0.166	11	4.503
	5	0.426	5	0.401	5	0.350	15	3.527
	5	0.426	4	0.135	5	0.350	14	0.771
	4	0.120	4	0.135	4	0.166	12	1.259
	3	1.814	4	0.135	4	0.166	11	4.503
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	4	0.135	4	0.166	13	0.015
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	5	0.350	13	0.015
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	4	0.135	5	0.350	14	0.771
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	3	1.814	2	5.603	5	0.350	10	9.747

	3	1.814	5	0.401	2	5.798	10	9.747
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	5	0.426	5	0.401	5	0.350	15	3.527
	5	0.426	5	0.401	5	0.350	15	3.527
	5	0.426	5	0.401	5	0.350	15	3.527
	4	0.120	4	0.135	4	0.166	12	1.259
	5	0.426	5	0.401	5	0.350	15	3.527
	3	1.814	5	0.401	4	0.166	12	1.259
W	213		214		216		643	
N	49		49		49			
A	5		5		5			
N*A	245		245		245			
Mean	4.347		4.367		4.408		13.122	

RII	0.869		0.873		0.882			
RANK	3		2		1			
sum of each variances		21.102		19.388		19.837		133.265
sum of variances 0f Q1,Q2,Q3	60.327							
variance of total measurement	133.265							
K	3							
Alpha	0.821							