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

ASSESSMENT ON THE ROLE OF CONSTRUCTION PROFESSIONALS TO ADOPT GREEN BUILDING CONSTRUCTION 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

Samrawit Kassahun Kifle

October 2021
JIMMA, Ethiopia

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Advisor: Engr. Bien Maunahan

Co-Advisor: Engr. Mamaru Dessalegn

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BY

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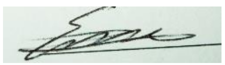
4. Engr. Esrael Kifle		10/28/2021
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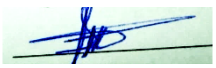
5. Engr. Ahmed Nuredin		10/28/2021
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DECLARATION

I declare that this research entitled "Assessment on the Role of Construction Professionals to Adopt Green Building Construction 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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As research Advisers, we hereby certify that we have read and evaluated this thesis paper prepared under our guidance, by Samrawit Kassahun Kifle entitled "ASSESSMENT ON THE ROLE OF CONSTRUCTION PROFESSIONALS TO ADOPT GREEN BUILDING CONSTRUCTION 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 consumes energy and natural resources and contributes to global carbon emissions. Most traditional building goals are to meet the minimum standards and requirements of building codes, most building codes do not consider energy consumption, building operation or service costs, and indoor air quality. Green buildings help to minimize carbon dioxide emissions and energy consumption and generate ecological, economic and social benefits. The objective of this research was to assess the key roles of construction professionals in adopting green building construction in Jimma town. The sources of data used for the research were primary and secondary sources of data. Structured questionnaire and interview were used to collect the primary data. Purposive sampling method was used for the research. Microsoft excel 2010 was used to compute RII, Rank, and Cronbach's alpha to analyze the collected data from the structured questionnaire, and the data was presented in a statistical descriptive way. The extent to which construction professionals integrate green building principles in Jimma town public building construction projects is less with an RII value of 0.582, the highest challenge for the construction professionals to adopt green building construction in Jimma town is government-related challenge with an RII value of 0.813, the first key role of construction professionals to adopt green building construction in Jimma town is working as a team to successfully incorporate green building concepts in building construction projects and adopt green building design and construction. It has an RII value of 0.898, which indicates that the role is highly important. The government should adopt green building standards of other countries in to the national level, enforce binding rules and regulations, environmental guidelines and legislations, encourage the green building market and arranging public awareness campaigns and media coverage regarding green buildings to educate the society and to increase the demand for green building construction. The construction professionals should develop green building standards such as LEED considering the local context, update their knowledge on emerging new construction technologies, and develop their knowledge about green building materials and carefully select them for use. Additional research can be developed by changing the scope and focusing only on one of the green building principles.

Keywords: Construction professionals, Green building construction, Green building principle

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ACRONYMS

CO_2	Carbon dioxide
EPA	Environmental Protection Agency
GB	Green Building
HOA REC&N	Horn of Africa Regional Environment Center and Network
HVAC	Heating Ventilation and Air-Conditioning
LEED	Leadership in Energy and Environmental Design
RII	Relative Importance Index
SBIC	Sustainable Buildings Industry Council
US	United States
USGBC	United States Green Building Council
WGBC	World Green Building Council

CHAPTER ONE

INTRODUCTION

1.1 Background

The construction industry is a significant industry in the world. The construction industry plays a vital role in the development of economic growth in countries around the world and is defined as a sector of the economy. Although the industry plays an important role in increasing the economic growth of a country, the industry faces many challenges that affect the overall goals of the project and stable economic growth. The Construction industry is also a hazardous industry (Team, 2017).

The construction industry has a great impact on the environment. The construction industry is an energy-intensive industry, accounting for 36% of global energy use. The operation of heavy machineries in the construction industry still depends on the use of fossil fuels, which generate 40% of global CO_2 emissions. The manufacturing and transportation of materials also have a significant impact on carbon emissions. The manufacture of concrete has produced more than 2.8 billion tons of CO_2 emitted into the atmosphere. The practice of mining in order to obtain raw materials for construction has caused pollution of the local groundwater table. The construction industry also generates hazardous waste, which, if not managed properly, will pollute the environment and affect the local society. The goal of green building is to reduce the impact of the construction industry on the environment by adopting green building methods, such as using renewable and recyclable resources, reducing energy consumption and waste, generating a healthy and environmentally friendly environment, and protecting the natural environment (Gatley, 2019).

Green buildings provide economic benefits that traditional buildings do not provide. These benefits include energy and water conservation, waste reduction, improved indoor environmental quality, improved employee comfort and productivity, reduced employee health costs, and reduced operating and maintenance costs (Kats, 2003).

Green buildings (GB) are buildings built for different purposes following proper management of natural resources. This means of causing no environmental disturbance or as little environmental disturbance as possible, using environmentally friendly materials that do not pose a health hazard, indoor solutions that promote communication, low energy consumption, the use of renewable energies, high quality and durability as building criteria, and last but specially economical execution (Michael Bauer & Schwarz, 2010).

Activities in the construction industry, such as planning, designing, and execution of building construction projects are not the responsibility of one person or an expert rather they are carried out by a combined team with various skills and expertise. Many participants are involved in the construction industry to make a valuable contribution to meet the overall objective of the project and it is very essential to understand their various roles and responsibilities (Jackson, 2010). Therefore, this research was undertaken in Jimma town taking into account the substantial contribution of construction professionals to adopt green building construction for the overall improvement of environmental circumstances and living condition of the society.

This research was conducted in Jimma town to investigate the extent to which construction professionals integrate green building principles in Jimma town public building construction projects, to identify the challenges of construction professionals in adopting green building construction in Jimma town, and to identify the key responsibilities of construction professionals in adopting green building construction in Jimma town.

1.2 Statement of the problem

The construction industry consumes energy as well as natural resources and contributes to the emission of an enormous amount of global CO_2 therefore it has a significant impact on the environment (AlSanad, 2015). Buildings are responsible for the emissions of more than 40% of all global carbon dioxide, which is one of the contributors to global warming. The rise of global temperature has consequences for all of us. Energy and water resources depletion are also problems in most areas of the world (Yudelson, 2007). The goal of most conventional buildings is achieving the minimum standards and requirements of building codes however most building codes do not consider energy consumption, operating or service costs of the building, and indoor environmental quality (living, 2019).

The Ethiopian government stated that the Ethiopian construction industry is one of the country's three main economic sectors and has contributed to the country's economic development. Due to inadequate management of construction resources, construction projects in developing countries consume a lot of resources in the process of work execution. Ethiopia is one of the developing countries that rely on improper resource management in construction projects (Mohammad Sujayath Ali & Mahaboob Patel, 2020). Building construction projects in towns of Ethiopia are showing remarkable growth time to time. Although the expansion of construction projects has advantages for the towns, it also contributes to problems such as environmental pollutions and depletion of resources. The main energy sources in Ethiopia are firewood, oil, and hydroelectric power. Alternative energy sources such as biogas and solar energy are being developed. Ethiopia is currently facing energy crisis. For example, despite the housing problem, the demand for electricity has grown faster than expected, the firewood situation has become more serious, and the shortage of charcoal has led to an increase in the price of charcoal. The use of firewood is also the main cause of deforestation. Energy conservation guidelines for buildings do not exist and energy use is not considered as main design criteria for buildings. Designers are designing more and more energy-incentive buildings that rely more on air conditioning, artificial lighting, and mechanical ventilation systems. There is a need for research studies on energy use in buildings and the possibilities of energy conservation (Tesfahunegn, 2013).

Green building technology is an effective way to minimize carbon dioxide emissions and energy consumption, and generate environmental, economic and social benefits (AlSanad, 2015). Green buildings minimize adverse impacts on the environment during design, construction and operation of the building. Green buildings preserve natural resources that have high priority and enhance quality of life of society, use energy, water and other resources efficiently, use renewable energy such as solar energy, minimize pollution and waste, provide good indoor environmental quality, consider the environment and the quality of life of occupants in design, construction and operation (WGBC, 2019). Therefore, adopting green buildings is very essential. Construction professionals could play a significant role in adopting green building. Hence, identifying the roles of construction industry professionals in adopting green building construction is significant and this research identifies the key roles of construction professionals in adopting green building construction in Jimma town.

1.3 Research Questions

1. To what extent do the construction professionals integrate green building principles in public building construction projects of Jimma town?
2. What are the challenges of construction professionals to adopt green building construction in Jimma town?
3. What are the key responsibilities of the construction professionals to adopt green building construction in Jimma town?

1.4 Objective of the Study

1.4.1 General objective

The General objective of the study is to assess the key role of construction professionals in adopting green building construction in Jimma town.

1.4.2 Specific Objectives

- To investigate the extent to which the construction professionals integrate green building principles in public building construction projects of Jimma town.
- To determine the challenges of construction professionals to adopt green building construction in Jimma town.

- To identify the key responsibilities of the construction professionals to adopt green building construction in Jimma town.

1.5 Scope of the Study

This study was conducted to assess the key role of construction professionals in adopting green building construction in Jimma town. The construction professionals for this study were from four firms: contractor, client, regulatory body, and consultancy firm. Architects, civil engineers, structural engineers, electrical engineers, construction technology and management professionals, and surveyors are the construction professionals included in the study. The civil engineers and construction technology and management professionals refer to the professionals who did not specialize and who did not state their specialization area on the questionnaire. The research focuses on the team role of the construction professionals. The focus of this research is confined to public building construction projects in Jimma town that are currently on construction stage.

1.6 Significance of the Study

This study identified the key roles of construction professionals to adopt green building construction in Jimma town. The building construction sector of Jimma town will be one of the beneficiaries of the research because the research has identified the extent of integration of green building principles, the challenges of construction professionals to adopt green building construction in the town, and the key roles of construction professionals to adopt green building construction in the town. The other beneficiaries of the study will be construction professionals in the town of Jimma because the study can help the construction professionals to enhance their understanding on what they need to do to successfully adopt green building construction in the town. This research will also be significant for the people working in the building construction industry of Jimma town because it will provide awareness and help to exchange knowledge and information on the key role of construction professionals in adopting green building construction in Jimma town. In addition, other researchers will use this research paper as a reference for additional study on this issue. This research will also provide information to increase the awareness of readers outside of the construction profession about the key role of construction professionals in adopting green building practices by providing information.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conventional and Green Building

Conventional building construction refers to traditional construction methods that have been passed down from generation to generation of construction knowledge associated with on-site construction using reinforced concrete (Amjad Nasser, et al., 2017).

The traditional method of construction through application of common practices and resources is known as conventional building. Achieving the minimum standards and requirements of building codes is the goal of most conventional buildings however, most building codes do not consider energy consumption, operating or service expenses of the building and indoor air quality. Conventional construction method is expensive construction method for end users due to high annual operating cost (living, 2019).

The Exact meaning of a green building is still on progress to be achieved (SBIC & Shapiro, 2007; 2014). Many organizations and individuals have defined green building as per their understanding. Some of the definitions of green building are the following.

Green building is a way of building practice which provides enhancement to the efficiency of the building. The features of such building include responsible use of resources such as energy, water and materials for building and sites and minimized negative impacts on human health and the environment throughout the whole life of the building. Concepts of green building are not limited only on the building itself but it includes issues like site planning, community and land use planning (Alliance, 2021).

Green building is a way of constructing structures using procedures and methods that have the attributes of environmental protection and resource efficiency throughout the whole life of the building (EPA, 2016).

Buildings that are designed with positive attributes which can reduce adverse impact on the built environment, on the health of the society, and the natural environment through efficient utilization of resources, enhancement of productivity, reduction of waste, pollution, and environmental degradation are defined as green buildings (Jadhav, 2016).

Green buildings are buildings that are constructed by taking social, environmental and economic factors in to consideration. The characteristics of these buildings include reducing waste and pollution during manufacturing and construction, reducing the energy required to produce materials, using non-toxic materials and renewable energy systems, and protecting resources and durability (Pradeep Kumar & Dr. Sandeep Shrivastava, 2015).

The main difference of green buildings and conventional buildings is the concept of integration. In green buildings, construction professionals of different disciplines work together as a team from the pre-design phase up to the post-occupancy to improve the environmental sustainability, performance, and cost savings of the building (Zafar, 2019).

2.2 Goals of Green Building

The need to plan and design green buildings may be inspired by many reasons. Some of the goals of green building planning and design include goals for solving environmental problems, to improve human health and comfort, economic goals, political goals, social goals, and goals that reflect the unique needs of the human spirit. Goals for solving environmental problems include reducing air, water and soil pollution, protecting natural habitats, biodiversity and clean water sources, reducing global warming, and minimizing the impact of different mining and construction activities on the environment. Goals to improve human health and comfort covers issues such as enhancing indoor air and water quality, improving thermal comfort and reducing noise pollution. Economic goals include reducing energy expenses, increasing productivity, attractiveness of marketing and public relations, and creating green jobs. The aspects that are covered by political goals includes aspects such as minimizing dependence on foreign fuel sources, improving national competitiveness, avoiding the depletion of non-renewable fuels, and minimizing pressure on electric power grids and risk of power outages. Societal goals covers issues such as adopting fair labor practices, providing convenience for the disabled, caring for consumers, protecting historic buildings, and providing affordable housing. Goals that reflect the unique needs of the human spirit include issues related to feelings like to express a deep connection with nature and love for nature, and satisfy the pursuit of beauty (Shapiro, 2014).

Green building objectives to be followed when constructing buildings include site selection and structural design efficiency, energy, water and material efficiency, indoor environmental quality, life cycle assessment, optimization of operation and maintenance, reduction of waste, and impact on the electrical grid (College, 2021).

2.3 Benefits of Green Building

Green buildings integrate design techniques, materials, and technologies that reduce the overall impacts of buildings on the environment and society. Better site selection, design, material selection, and construction, maintenance, demolition, and possible reuse are the means to achieve green buildings and reduce the overall impact of buildings on the environment and social life. The benefits of adopting green buildings include minimal site disturbance, reduced use of fossil fuels, minimal water consumption, and fewer pollutants released during construction, occupancy, and removal of the building (Mohanty, 2012).

Green buildings preserve the natural environment, improve air and water quality, and reduce wastes thus it has environmental benefits. Reduction in operational expenses of the building and improvement on occupant productivity are some of the economic benefits of green building. Societal benefits of green building include enhancing the overall quality of life, health and comfort of end users, enhancing indoor air quality, and reducing pressure on local utilities (Alliance, 2021).

Green buildings provide economic benefits that traditional buildings do not provide. These benefits include energy and water conservation, waste reduction, improved indoor environmental quality, improved employee comfort and productivity, reduced employee health costs, and reduced operating and maintenance costs (Kats, 2003).

2.4 Fundamental Principles of Green building

The components of green buildings are energy efficiency and renewable energy, water efficiency, environmentally friendly building materials and specifications, waste reduction, toxic substance reduction, indoor air quality and smart growth and sustainable development (Davis, 2021).

Green buildings incorporate different practices and technologies in order to reduce consumption of natural resources, enhance human wellbeing and comfort and lessen adverse environmental impacts. Some of the key characteristics of green buildings rather than traditional buildings include integrated and innovative design processes, site selection and structural design efficiency, energy efficiency and environmental protection, water and waste management, materials and resources efficiency and enhancement of indoor environmental quality (Mohanty, 2012).

The six main and related principles of green design include optimize site potential, minimize energy use and use of renewable energy strategies, conservation and protection of water resources, conservation and protection of water resources, use environmentally preferable products, enhance indoor environmental quality, and optimize operations and maintenance practices. The principle of optimizing site potential includes issues such as appropriate siting, consideration of any existing buildings or infrastructures before commencing any construction, proper orientation of streets and buildings to achieve passive and active solar functions, location of access roads and parking, and giving primacy to any high priority resources that need to be protected such as trees, waterways and animal habitats. Minimize energy use and use of renewable energy strategies principle addresses aspects such as the significance of minimizing energy loads, limiting the amount of fossil fuels needed, and using renewable energy systems such as solar water heating. Conservation and protection of water resources principle covers topics including minimizing, controlling and treating runoff from the site, designing and constructing buildings to protect the water used inside and outside the building; perform appropriate inspections to minimize leakages. Aspects covered by the principle of use of environmentally preferable products include the identification and designation of products that are made from recycled materials, are durable, reduce material consumption, conserve natural resources, energy, and water, and reduce waste and pollution. Enhance indoor environmental quality principle covers aspects such as providing excellent acoustic, thermal and visual qualities that have a great impact on human health, comfort and productivity. Other aspects to be consider in indoor environmental quality include maximum natural lighting, adequate ventilation and humidity control, and the use of products with low or non-volatile organic compounds; and optimize operations and maintenance practices include materials and systems that are cost-effective and minimize life cycle costs, simplify and reduce operating requirements, and require less water, energy, toxic chemicals, and cleaning agents to maintain (SBIC, 2007).

The criteria areas used by leadership in energy and environmental design in order to rate buildings are sustainable sites, water, energy and atmosphere efficiency, materials and resources, indoor environmental quality, innovation and design processes (Pradeep Kumar & Dr. Sandeep Shrivastava, 2015).

2.5 Green Building Technologies

Green building technology is the application of environmentally responsible and resource efficient strategy options throughout the entire life of the building starting from planning to deconstruction. Green building technology is often referred as sustainable building technology which is defined as a building designed with features such as consuming less energy, good design flexibility, small maintenance cost, enhanced air quality, and etc. (Gaur, 2020).

Green building technologies refers to technologies and techniques that are used in constructed environments to reduce environmental impacts while ensuring the comfort, functionality, and productivity of the buildings (Gibberd, 2020).

2.5.1 Passive Design Technologies

Passive design is a technology that directly uses natural energy, the sun and the wind without using electricity or other facilities. Passive design incorporates energy-saving design methods which consider orientation, shape and envelope of the building as well as other necessary factors (Jiyoung Lee & Lim, 2015).

Passive design technologies are design technologies which take beneficial options of the surrounding environmental conditions to enhance energy and cost savings while meeting basic building facilities and requirements such as indoor comfort, safety, health, etc. The fundamental elements of passive design include building location and orientation, building layout and massing, and building envelope (Jadhav, 2016).

The location and orientation of the building on the site has a significant impact on the performance of the building, as it will affect the light and heat that the building receives from the sun, the access to views, transportation and other site provisions, and the impact of other buildings on the building or the impact of the building on other existing buildings. Massing is the process of determining the overall layout, shape, and size and form factor of the building and it should be done at early stages of the building along with location and orientation of the building. Selection of massing depends on project details such as the goal of the project and the site of the project. Effective massing for green buildings help to reduce energy use, reduce material usage, harvest rain water, protect the natural environment, and integrate the building with urban planning provisions. Building envelope is defined as the physical separator between the exterior environment and built environment. The main components of the building envelope are roof, wall, floor and fenestrations (building openings such as windows and doors). The choice of building envelope depends on climatic conditions, aesthetic value, available materials and also culture. Building envelope has a substantial impact on the performance of the building because it controls the amount of light and heat gained from sun and air enters in the building (Jadhav, 2016).

2.5.2 Active Design Technologies

Active design strategies use purchased energy options such as electricity and natural gas in order to operate mechanical and electrical system components such as air conditioners, heaters, ventilators and light bulbs to keep the building comfortable for occupants. Active strategies also include systems such as electric and solar thermal panels and wind turbines which generate energy (Anon., 2021).

In active design technology there is use of mechanical systems such as ventilation and floor heating systems and use of technological systems that uses natural sources of energy such as solar and geothermal energy (Jiyoung Lee & Lim, 2015).

Active design technologies use energy and the most significant aspect considered in the active design technologies for green buildings is energy efficiency of the building. Some of the areas of active design technologies include heating, ventilating and air conditioning (HVAC system), lighting, building service equipment such as pumps and lifts, plug loads. Active lighting is also needed in the building to provide good visual comfort for users. The purpose of green building is to provide best visual comfort at lowest energy cost. The use of technologies such as timers and sensor based controls could reduce energy use. Occupancy sensors can help control lighting activity by ensuring lights are on only when they are actively used. In building service equipment, for example, elevators can be controlled by using software that automatically enter a sleep mode, turning off lights, ventilation, music, and video screens when the elevator is unoccupied. Plug loads can also be reduced by using different technologies such as energy efficient equipment and timer controlled plugs (Jadhav, 2016).

2.5.3 Water and Waste Management Technologies

Buildings use large amount of water for various purpose such as for kitchen activities, sanitation, laundry and landscaping. Apart from water consumption buildings also generate waste from the very beginning of the construction phase up to its demolition throughout its life time. Therefore water and waste management are very significant aspects of green buildings. Water consumption in the building can be reduced by using water efficient fittings, regularly checking for leaks and maintaining equipment, recycling grey water for use of washing, gardening, and irrigation or flushing toilet, harvesting rain water and adopting water efficient landscaping. Wastes in the building can be reduced by using waste reduction, re use and recycling methods (Jadhav, 2016).

The overall water use for buildings, landscaping and neighborhoods can be reduced by using “reduce, re-use and recycle” strategies to reduce consumption of potable water. Gray water which is waste water from sinks and showers and recycled water obtained from onsite waste water treatment in buildings can be used for flushing toilets. Both gray water and municipally treated waste water can be used for landscape irrigation (Yudelson, 2007).

Ways for reducing construction waste include reducing construction mistakes, ordering the right amount of materials, getting the right-size materials for the job, properly storing materials, recycling and reusing materials, trying out new building methods, choosing building products with minimal packaging and working with suppliers (Anon., 2018).

Apart from construction waste, a lot of waste is generated by people who occupy, use and manage buildings. Building owners and facility managers can make certain provisions in the building such as recycling bins, multiple special purpose waste chutes and options to use less paper and plastic in buildings (Jadhav, 2016).

2.6 Green Building Councils

Green building councils are autonomous and non- profitable organizations comprising of organizations and businesses sectors working in the building and construction industry. The world green building council is a global network comprised of about seventy green building councils around the world. The world green building council works in speeding up the uptake of sustainable buildings for every person and everywhere; enhancing the environment, health and wellbeing, and resources and circularity aspects of the building and the construction sector (council, 2020).

Networks of green building councils grew by sixty eight percent from forty one to sixty nine and members of green building councils increased by seventy percent from twenty one thousand to thirty six thousand from the year 2010 to 2020 (Cox, 2020).

2.7 Most Widely Used Green Building Rating Systems

2.7.1 BREEAM

The British Research Establishment Environmental Assessment method (BREEAM) is a voluntary environmental assessment method which was established by Building research establishment (BRE) in 1990. The purpose of establishing this assessment method was to objectively measure the environmental performance new and existing buildings in United

Kingdom (UK). As the system evolves, the goals of the system were set for buildings to have a better rating (Breeam, 2009).

British Research Establishment Environmental Assessment method (BREEAM) is a certification system that approves the sustainability of buildings and large scale developments (Amjad Nasser, et al., 2017).

The Building Research Environmental Assessment Method (BREEAM) is a system established by the Building Research Establishment (BRE) in the United Kingdom (UK). It is established for measuring and rating the sustainability and environmental performance of non-domestic buildings in the areas of management, health and well-being, energy, transport, water, material and waste, land use and ecology, and pollution (Shapiro, 2014).

The Building Research Environmental Assessment Method (BREEAM) includes eight main categories of environmental impacts. These are management, health and wellbeing, energy, land use and ecology, materials, waste and pollution, and transport (Mayra Portalatin & Shouse, 2014).

2.7.2 LEED

The Leadership in energy and environmental design (LEED) is a rating system which was developed by the United States green building council (USGBC) in 1998 GC. The first LEED rating system was developed for new construction (Mayra Portalatin & Shouse, 2014).

Leadership in energy and environmental design (LEED) is a rating system which is developed by the United States green building council (USGBC) for the design, construction, operation and maintenance of green building councils (Amjad Nasser, et al., 2017).

The United States green building council (USGBC) developed the leadership in energy and environmental design rating system as an agreement between its members, suppliers, architects, engineers, contractors, and building owners. The five main credit areas of leadership in energy and environmental design which are sustainable site practice, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality turn out to be the measures of green building design (Shapiro, 2014).

The United States green building council (USGBC) established the leadership in energy and environmental design (LEED) rating system which defines a guideline for developing a sustainable building. This rating system functions by dividing the building in to five categories and lists opportunities for the building to get points in each category. The final number of point determines the green level of the building and the building is rated as certified, silver, gold and platinum. The five categories of the LEED rating system are sustainable site, water conservation, energy and atmosphere, materials and resources and indoor environmental quality (Rabin, 2005).

2.7.3 Green Globe

Green Globes is an interactive, flexible and affordable online assessment protocol, rating system and guidance for green building design, operation and management. It provides market recognition of a building's environmental attributes through third- party assessment (Greenglobes, 2021).

Green Globes is offered in 2000 GC in Canada, the United States and the United Kingdom. It has two rating systems which are for existing buildings and new buildings. The Green Globe for Continual Improvement of Existing Buildings in Canada is managed by the building's owners and managers association (BOMA) of Canada. Green Globes in the United States is managed by the Green Building Initiative (GBI). In the United Kingdom, the existing buildings version of Green Globes is called Gem U.K. The categories of environmental impacts included in Green Globes are effluents and other impacts, emissions Energy Indoor environment Project management, resources, site and water (Mayra Portalatin & Shouse, 2014).

2.7.4 Green Star

Green star is established in 2002 GC in Australia. It is a green building rating system used in Australia, and has been adapted and licensed to the New Zealand and south African green building councils for use in their respective markets. Green Star ratings are available for every building type except for free-standing homes (Mayra Portalatin & Shouse, 2014).

Green Star evaluates and rates buildings, fit outs and communities against a range of environmental impact categories. Green Star rating tools for individual building and fit out design, construction and operations assess projects against the categories of management, indoor environmental quality, energy, transport, water, materials, land use and ecology, emissions and innovation. The Green Star communities rating tool assesses community and precinct-level projects against the six categories which are governance, design, livability, economic prosperity, environment and innovation (Mayra Portalatin & Shouse, 2014).

2.8 Extent of applicability of Green Building in Ethiopia

Ethiopia does not have green building standards and is not a member of the Green Building Council, but some buildings have been certified and are being certified according to international standards. These include the LEED-Gold certified Horn of Africa Regional environment center and network (HoA- REC&N) building, the LEED-Certified new Embassy Compound (American Embassy), PVH Arvind manufacturing (Hawassa industrial park) which is under process LEED-Registered, Ethio-American doctors group hospital which is LEED-Registered and Commercial bank of Ethiopia, Headquarter building which is Under process for LEED – Silver (Negash, 2019).

The headquarter office of the horn of Africa Regional environment center and network (HoA - REC&N) became the first Ethiopian LEED Certified building by receiving the prestigious Leadership in Energy and Environmental Design (LEED)® Gold Green Building Certification from the US Green Building Council in the United States on 16 March 2017 (HoA-REC&N, 2017).

The headquarter office of the horn of Africa Regional environment center and network (HoA - REC&N) which is located in the Gulele Botanic Garden has received the prestigious Leadership in Energy and Environmental Design (LEED) Gold Green Building Certification from the USGBC in the United States on 16 March 2017 and became the first and the only Ethiopian LEED Certified building so far (Negash, 2019).

HoA-REC&N is LEED certified for its sustainable sites, water-saving, energy efficiency, environmentally friendly building materials, and indoor environmental quality. The building can achieve energy savings up to 53%, and its plumbing can achieve a total water consumption reduction of up to 45%. More than 95% of its regularly occupied spaces have access to views to the outside, and 20% percent of the building's materials are locally sourced such as adobe bricks and eucalyptus (HoA-REC&N, 2017).

2.9 Challenges to Adopt Green Building Construction

Although green buildings have many benefits, there are also challenges when adopting green buildings. The characteristics of green buildings can be more complex compared to conventional buildings, thus the construction of such buildings can be time-consuming. Some green materials are not really "green" so study is needed for assurance of their green nature. The initial cost of green building can be more expensive compa+red to conventional buildings, and it can be difficult to obtain financing for green building projects from banks since many technologies and methods are still relatively new. Green building materials are not always as easy to obtain as traditional materials, and finding skilled workers who specialize in green design is difficult to obtain (Fraser, 2019).

Enhancing the sustainability of the entire element of the building is a great challenge in green building construction. Focusing on the skills required to make the building sector green as a whole is very important. Public policies and also how householders and businesses that respond to this policy highly determine the extent to which green building techniques and technologies are implemented on a large scale. Building regulations and other government interventions are highly significant in mass adoption of the techniques and technologies required. The designs that achieve high standards of energy efficiency and the energy performances of new buildings intended to be green may not be achieved without sufficient high quality professional level skills among architects and engineers. In adequate skills among policy makers may render systems that are intended to promote green building. Shortage of skills can retard the development of green building (office, 2011).

The barriers to implementing green building in the construction industry include insufficient guidelines, low level of knowledge, financial constraint, regulation and governance, time consumption, and attitude and market (Ha Chin Yee & Jing, 2020).

Managing green building construction projects is more difficult when compared to conventional building projects. Challenges in managing green building construction projects include an increase in project cost, lack of communication and interest of project team members, high cost of implementation of green practices, lack of interest from customers. Green building construction projects also need collective work and good communication of project teams for effective results (Bon-Gang Hwang, 2012).

Some challenges which militate the practice of green building include lack of urban planning and land use policy, lack of enforcement of sustainable building policies, lack of financial instruments for green buildings, lack of awareness and education on green building concepts, limited research on green building concepts, empowerment of stake holders, and lack of incentives from the government (Nkeleme Emmanuel Ifeanyichukwu & Achigbu Onyemaeze Ikenna, 2021).

Higher costs for the application of green building design and materials that save energy, lack of motivation, weak mechanisms, and insufficient legal enforcement are major barriers to apply green strategy and development in the process of housing development of China (Xiaoling Zhang & Wu, 2011).

Lack of motivation to promote green building, inadequate information on the costs of green building, inadequate information on the economic and financial benefits and opportunities of green buildings are the top three factors affecting growth of green buildings in South Africa (Eric Kwame Simpeh, n.d.)

Major barriers to implementing green building in the Nigerian construction industry include lack of adequate awareness, less client demand, absence of incentives, and poor knowledge of green building methods among professionals. Inadequate education, reluctance to introduce green building construction by owners of firms, poor supply chain management process, and unavailable legislation were also identified as other barriers (Adetayo Olugbenga Onososen & Adeyemo, 2019)

Lack of or inadequate government programs focusing on green construction, lack of or inadequate government policies concerning green construction, lack of government tax incentives available for green construction geared towards the public, international sustainable design policies and standards not being adapted to fit local needs, low awareness of the society on the benefits of sustainable construction, lack of or inadequate information diffusion networks on sustainable construction geared towards the public, lack of or minimal availability of education (formal and informal) for design and construction professionals, lack of green technologies available on the market, fear of increased financial risks associated with sustainable technologies are the most prevalent barriers for the adoption of green building materials and technologies in Burkina Faso (G A Nikyema, 2020).

Challenges such as lack of customer interest, lack of awareness and education, lack of professionals, lack of government incentives, economic challenges, and lack of certification systems like LEED are the main obstacles to the application of green buildings principles in Addis Ababa. In addition, research has shown that understanding the concepts, benefits, and technologies of green buildings is the most important concern. In addition, financial incentives, research, and policies have also been identified as necessary strategies. However, for everyone's work, from the beginning to the end of the project, the integration of all stakeholders including developers, designers, governments, material manufacturers, contractors, and construction managers is very important (Mohammedata, 2018).

As indicated in this section of the literature review, the challenges to adopt green building construction can be classified as challenges related to the nature (characteristics) of green building, clients, contractors, market, construction professionals, and government.

2.10 Construction Professionals

A construction professional is a person whose occupation is construction-related and who has the knowledge, experience, and skills through education and training qualifications regarding construction to carry out their role and responsibility effectively. Construction professionals include architects, contractors, engineers, surveyors, and so on. In construction, the term “professional” does not cover all occupations. Highly skilled workers such as carpenters, electricians, plumbers, steelworkers, and so on, maybe described as “trades” or “craft” workers rather than professionals. All occupations in the construction activity cannot be considered as construction professions. A prolonged education, training, and work experience are required to qualify as a construction professional. For example, it may take seven years which is a period of education and working in practice to qualify as an architect (engineers, 2021).

Construction professionals are defined as architects, engineers, and surveyors (Abdul Aziz Hussin, 2009). Architects, project managers, civil engineers, structural engineers, mechanical engineers, electrical engineers, and quantity surveyors are identified as key experts in the construction industry (UKessays, 2018). There are numerous diverse engineering specialties but the foremost common ones related to construction activities are structural engineers, electrical engineers, civil engineers, and mechanical engineers (Jackson, 2010). The experts who need the foremost consideration are architects, engineers, surveyors, and project managers (attorneys, 2018).

There are many construction professionals in the construction industry and as per the definition of the above literature, the key professionals in the construction industry are architects, engineers (civil engineers, structural engineers, mechanical engineers, electrical engineers), quantity surveyors, and project managers. The roles of these construction professionals are discussed below.

2.10.1 Architect

Architects can be defined as certified professionals that are qualified in the art and science of building design. Architects should have a long term experience and pass an exam in order to have a license or to be became certified. Their work is converting the program or the need of the owner in to plans and drawings that describe the intended work to be constructed by others (Jackson, 2010).

An architect is a professional that translates the user's needs into the builder's requirements. Architects must be able to understand the building and operational codes under which their design must conform and they should have the necessary knowledge so that they will not omit any necessary requirements, or create incorrect, incompatible, vague, or confusing requirements (Abdul Aziz Hussin, 2009).

The architect helps organize the owner's ideas for the new building, develops the building's shape, and convenes a group of engineering experts to help formulate the concepts and details of the foundation, structural support, and mechanical, electrical, and communication services (Allen & Iano, 2009).

Architects participate in the entire construction process adjusting their plans according to budget constraints, environmental factors, and client needs. Typical work activities for architects include the manual creation of architectural designs and detailed drawings, the use of computer-aided design applications, the handling of other basic factors such as urban planning legislation, environmental impact, and project budgets, and working closely with other professional teams, such as architectural services engineers, construction managers and surveyors, regarding the feasibility of potential projects, request planning permits and suggestions from government and legal departments, prepare and submit reports, proposals, requests, and contracts, formulate project requirements and formulate plans to resolve any issues that may occur during the construction process, participate in the project and team management, and regularly conduct construction site monitoring and client meetings (Targetjobs, n.d.).

2.10.2 Construction Project manager

A construction project manager is a professional in the construction industry who takes part in the overall project planning, distributing resources, time, budget, resource and risk management, creating benchmarks, and managing relationships with key stakeholders (Wong, 2019).

The key responsibilities of project managers are project planning, setting goals of the project, drafting contracts, supervising works, delivering the project on time and within allocated budget, keeping the client and superiors in the loop, and managing disputes and risks (Cherkaou, 2020).

2.10.3 Engineers

Engineers are the principal designers for heavy civil and industrial projects. Engineers should attend a four or five-year college program, have a specific number of years of experience, and pass a professional licensing exam to satisfy the qualification requirement. There are many different engineering specialties but the most common ones associated with construction activities are civil engineers, structural engineers, mechanical engineers, and electrical engineers (Jackson, 2010).

Civil engineering is considered one of the oldest engineering disciplines, involving many specialties. Civil engineers are involved in the design of roads, buildings, bridges, tunnels, dams, site drainage, parking lots, runways, and water supply and sewer systems (Jackson, 2010). The general responsibilities of civil engineers include formulating detailed designs, conducting feasibility assessments and site inspections, preparing and implementing project plans, researching and providing project estimates, reviewing government regulations and regulations, monitoring and optimizing safety procedures, production processes, and regulatory compliance. Make suggestions or propose alternative solutions to problems, confidently cooperate with customers and other professional subcontractors, and do project management tasks (Betterteam, 2021).

Structural engineers are one of the engineering specialties among the different types of engineering specialties that design the structural elements or the skeleton of the structure such as foundations, beams, girders, and columns (Jackson, 2010). Structural engineers take part in the designing and constructing of buildings that are safe and capable of bearing the loads in which they will be exposed, as well as improving the structural integrity of existing buildings. Key tasks of a structural engineer include preparing reports, designs, and drawings, calculating loads and stresses, choosing proper construction materials, giving technical advice, obtaining approval of planning and/or building regulations, coordinating with important professional staff such as architects, monitoring and inspecting work undertaken by contractors, administering contracts, managing projects, inspecting different properties to check conditions (targetjobs, n.d.).

Mechanical engineers are involved in the design of heating, ventilating, air conditioning, plumbing, and firefighting systems in the building. They coordinate their efforts with the architectural design, the structural design, and the electrical design (Jackson, 2010). The field of mechanical engineering covers all aspects of architectural design, from structural integrity to material selection. All building machinery, including HVAC equipment, pipes, and ventilation shafts from the outlet components to the different levels of the structure, and all related pumps and pipes that connect these independent systems to each other, are considered part of the scope of the mechanical engineer (Cornelius, 2018).

Electrical engineers' job responsibilities include preparing and developing cost estimates for materials and labor before commencing planning and construction, designing electrical systems for the construction project, supervising and managing electrical contractors, resolving any issues or problems regarding electrical systems, and performing system tests on electrical systems and devices periodically (Electric, 2020). Electrical engineers design electrical systems for construction projects and work closely with designers to determine how to effectively incorporate electrical elements. Electrical engineers supervise and manage teams of electrical contractors and subcontractors. Electrical engineers should quickly revise plans when there is a change in existing electrical plans and specifications to resolve the issues and prevent delays. Electrical site engineers develop cost estimates for both material and labor at the commencement of the construction planning process and manage construction schedules related to electrical elements of job sites. Electrical engineers should work closely with both planners and utility providers to the timely accomplishment of their work without delays and maintain profitability, regularly determine schedules in collaboration with Sub-contractors to ensure the electrical work is completed simultaneously with other elements of the project, and conduct tests of electrical systems throughout the construction process (Daware, 2020).

2.10.4 Quantity Surveyor

A surveyor is a professional who works in the construction industry, he or she manages and controls costs on a construction project. The main divisions among quantitative surveyors are quantity surveyors working on behalf of the client organization and quantity surveyors who work for construction contractors. Quantity surveyors working on behalf of the client organization are called professional quantity surveyors. They control construction costs by properly considering the impact of design decisions to get better results for the money spent, accurately measure the work required, and apply their knowledge of costs and prices on labor, materials, and skills required by the factory customers with quality services to minimize additional costs. Quantity surveyors who work for construction contractors are known as prime contractor surveyors. The contractor's quantity inspector will be required to perform work such as measuring and pricing construction projects actually performed by the contractor. The contractor's surveyor works in the areas of project subcontract formation, cash flow forecasting, and organization of operation and maintenance manuals (Abdulla, 2018).

2.11 Role of Construction Professionals in Green Building Construction

The main difference between green buildings and conventional buildings is the concept of integration. In green buildings other than conventional construction, professionals of different professions work as a team and together starting from the pre-design phase up to the post-occupancy in order to enhance the building for environmental sustainability, performance, and cost-saving (Zafar, 2019).

Due to the activities of the construction industry, environmental problems are occurring, to overcome these problems and obtain possible social and economic benefits, green buildings are being adopted. In green buildings, all participants, including architects, contractors, engineers, etc., must work together to successfully complete integrated green design and construction, and ultimately achieve the goal of building sustainable development (Yong Han Ahna & Minjae Suhc, 2016).

There are many ways to adopt green buildings. These are to improve productivity and occupant health by reducing waste, controlling pollution, and efficiently using energy, water, and other resources. Using sustainable design and materials to construct environmentally friendly buildings can bring many benefits to building owners and customers (Jadav, 2019).

Constructing green buildings do not mean using only the latest green technologies and materials. The construction of a green building is a process that includes improving each element of the design and then re-evaluating, integrating, and optimizing the influence and interrelationship of various elements and systems in the building and the site as part of the overall architectural solution. From the use of site planning and on-site rainwater management strategies to the detailed design and layout of the envelope structure and regulations for natural building ventilation, it is important to carefully consider the different aspects of the building. Therefore, the responsibility of construction professionals in green building construction projects is much higher. The construction of green buildings requires the cooperation of professionals from the beginning to achieve common goals (ShafIque Alam, 2016).

The knowledge and experience of professionals working in green building construction should be enhanced and upgraded by providing regular upgrading courses to keep the professionals updated with the evolving information on technologies, products, and materials relevant to green building construction in order to optimize their role in achieving the project (Bon-Gang Hwang, 2012).

Nowadays Architects, engineers, and construction companies are more interested in building sustainable structures due to the different benefits encountered such as reduction of pollution and different impacts of construction on the environment. Engineers can include green design, recycling of wastes from construction, use of materials that are sustainable, and consider energy efficiency in the construction of buildings that are green. Some examples of green design include using locally available building materials such as woods and stone to minimize transportation time and cost, ventilation systems for efficient cooling and heating, efficient use of space on which the structure will be built, adopting techniques and design to collect rainwater and use of non-toxic construction materials. Some materials such as wood, brick, concrete, and steel can be recycled from other construction projects and engineers can use this material in their projects. Some examples of sustainable materials with the lowest environmental impact during their production and lifecycle include timber, bamboo, and cork (Lawson, 2019).

Construction professionals such as architects, civil, structural, and environmental engineers should be able to design systems and facilities with high energy efficiency, renewable energy systems, and efficient water management systems should be able to choose materials and building systems depending on the environmental impacts they have and their life cycle cost. Most of the time engineers give training to construction teams such as electricians, bricklayers, and plumbers before starting green building works. And giving awareness about the availability of green solutions, financing options, environmental and economic benefits of implementing green building is very significant (Organization, 2011).

There are many construction professionals in the construction industry and as per the definition of the literature in section 2.10, the key professionals in the construction industry are architects, engineers (civil engineers, structural engineers, mechanical engineers, electrical engineers), quantity surveyors, and project managers. The roles of these construction professionals in green building construction are discussed below.

2.11.1 Architect

Architects involved in the designing and construction of green buildings are known as green architects. Green architects work to create buildings that are energy efficient and environmentally friendly. They integrate architectural principles and designs with the concept of sustainability such as using sustainable building materials and practices to design buildings and facilities that have a less negative impact on the environment. Generally, green architects are responsible for designing buildings that can be sustainable over the lifetime of the building (bricks, 2018). Architects need to make the green traditional architecture advanced by incorporating new and advanced green building materials and technologies to make the building more sustainable and energy-efficient (Ali, 2017).

2.11.2 Construction Project Manager

Construction project managers are responsible for setting sustainable goals early in feasibility study; developing strategies for formulating an initial budget and schedule in the presence of an integrated group; conducting planning and strategy meetings; forming basic communication and providing information regarding sustainable building benefits for the owners (Delnavaz, 2012).

Project managers that practice a people-oriented approach and permit their team members to take responsibility for their own work will gain more from their team members and can become successful in managing green building construction (A. Elgadi, 2016).

Project managers could play an important role in successful project delivery. They have a more specific role in sustainable building projects because of the unique nature of the project that causes many challenges. Project managers should be aware of the challenges of sustainable construction and have adequate knowledge about the issue to properly place their role and take responsibility for the possible achievement of the green concept throughout the whole building process (Delnavaz, 2012).

2.11.3 Engineers

Engineering projects are extensive with lots of different issues incorporated. The performance of engineers in a given project has a substantial impact on achieving green building. Engineers can play a vital role by incorporating their knowledge and skill in planning and construction of green buildings projects that preserve natural resources and the economy (technology, 2002). Engineers could play a vital role in sustainable development through planning and building projects that protect natural resources, projects that are cost-efficient and projects that sustain human and natural environments (organizations, 2002). Engineers play an important role in planning, designing, building and ensuring a sustainable future and they ought to work with other experts, such as environmentalists, economists and sociologist and actively involve with in multidisciplinary teams to effectively address the issues and challenges of sustainable development (J.Gopi Krishna, 2015).

Civil engineers should select and bring environment-friendly and recyclable materials for use and must come up with creative solutions to support sustainable or green building design practice (Pradeep Kumar & Dr. Sandeep Shrivastava, 2015). Civil engineers could play an important role based on their area of specialty such as enhancing the use of material through proper analysis and design, minimizing impacts of the built environment on the existing environment, and restoring degraded sites (USGBC, 2021).

Structural engineers could help to mitigate deterioration and save scarce resources by using materials that have less embodied energy, details, and techniques that ensure durability, maintainability, and reusability, methods that accelerate and facilitate construction or rehabilitation (Don Allen & Webster, 2010). The most important contribution of structural engineers to sustainability is to improve the structural resilience of buildings to natural and man-made disasters. Structural engineers help meet LEED points such as water efficiency, renewable energy on-site, and Indoor environment points by designing related structural elements (such as rainwater storage and wastewater treatment tanks, support for solar panels and wind turbines, support for lighting supports and other daylighting technologies) (Tariq Chaudhary, 2013) .

The three key areas among the many in which mechanical engineers play larger roles in creating a sustainable building design are material selection, right-sizing, and energy resources. Mechanical engineers are involved in the manufacture and design of some mechanical systems in a project and they need to identify materials that can be recycled, have a long lifespan, and end up in a landfill in order to play his or her role in a sustainable design and building. Mechanical engineers determine and select the right sized products in order to save time, energy, and resources while meeting the needs. Mechanical engineers also have contributed to finding and creating alternative sources for valuable resources such as electricity, gas, or water in sustainable (Anon., 2018). Mechanical engineers make environmentally sound plans. Providing natural light and natural ventilation is the vital part of this plan which is innovative energy-saving features that include renewable energy resources (Cornelius, 2018).

There are many factors that will increase the demand for sustainability in electrical engineering practices, but the main factors that increase the demand are raising energy costs and quality of life issues such as lighting, air quality, and comfort. Electrical engineers play an important role in solving the sustainability of architectural design. Some of the functions of electrical engineers include reducing light pollution, optimizing energy efficiency, and producing on-site renewable energy such as solar energy. Electrical engineers use sustainable lighting technologies to minimize light pollution, increase visibility at night, and ensure that indoor and outdoor lighting work effectively (group, 2019). Electrical engineers design the lighting systems of buildings. Well-trained electrical engineers are primarily concerned with the achievement of energy efficiency in green buildings. For example, electrical engineers might work closely with architects to plan areas of a building where daylighting is the primary source of light. They may use sensors that automatically trigger traditional lighting only when the daylight is insufficient, thereby helping to reduce energy usage (Liming, n.d.).

2.11.4 Quantity surveyor

Quantity surveyors provide advice to clients to help them form their sustainability targets, information on different options to the design team to help them select the most cost-effective option for a sustainable design. Quantity surveyors participate in the preparation of tender documentation, pre-qualification of tenders, and tender evaluations which are very important in choosing the best contractor for a green project. Quantity surveyors also help clients in achieving their sustainable objectives over the life cycle of a green project using their knowledge in cost management and construction methodologies (Luu H.T, 2013).

Quantity Surveyor is the cost expert in the construction industry. Quantity surveyors need to develop their traditional roles and involve green buildings practice in conjunction with the ever changing construction trend to stay relevant in the industry (Wong, 2017).

Nowadays, developers engage with quantity surveyors at an early stage of development before the commencement of any construction to use their expertise in the feasibility, design, and planning stage to best minimize investing extra costs for achieving the different levels of green building rating certification. The role of quantity surveyors is expanded in green building projects in order to keep up with sustainable needs. Quantity surveyors should have knowledge on the green building technologies and innovations and upgrade their knowledge on the new and emerging building materials that allow them to advise on the cost of developments and inform the design team on the parameters of efficiencies, design factors, and concepts (Lee, 2019).

Quantity surveyors need to increasingly develop their skills and knowledge in order to effectively provide advisory services on cost for green projects to clients and other industry professionals. Quantity surveyors need to have an understanding of green products and materials to remain sustainable in the profession (Luu H.T, 2013).

2.12 Research gaps

The topic of green building is getting more attention now a days and researchers are doing researches on the issue. Previous researches that are directly related to this topic were not conducted, but researches that were conducted about green building in Addis Ababa, Ethiopia include research by Fikeremariam Negash having an objective to study the potential application of green building attributes in Ethiopia, by Taeka Haileleul aiming to find out the nature of the selected buildings based on the green building framework and also to recommend possible remedial solutions to the selected buildings based on environmental planning and landscape design, and by Nura Mohammedata aiming to contribute to the enhancement of the transformation of the building practice to green building practice by assessing the nature of the buildings based on the green building principles in order to understand the gap, its challenges, opportunities and proper approaches for application and implementation in Addis Ababa.

The research which was conducted by Fikremariam Negash has meet three specific objectives; investigates the building design and construction professional's awareness about green building, ranks the green building attributes and prepare a pre-assessment checklist of the ranked attributes for a building, and prospects and trace-back the Ethiopian first and only gold-certified green building attributes and their scores. The result of the research indicates that green building and sustainability education to professionals is an immediate necessity to minimize the undesirable effect of their profession and to encourage their contribution to the sector, energy efficiency, water efficiency, and sustainable material and resource were the three most important attributes of green building regarding the potential green building attributes in Ethiopia based on the response of the respondents while transportation, Indoor environmental quality and sustainable site and ecology are the lowest of the priorities. In the case study of the LEED gold-certified building, Energy and atmosphere, sustainable sites, and water efficiency are the top attributes that are incorporated in the building with a higher percentage from the allocated credit and the building reduces the adverse impacts arises from its construction in terms of the attributes advantage.

The research which was conducted by Nura Mohammedata studied the building practice and efforts of application of green building principles in selected buildings of Addis Ababa, identified the challenges and opportunities in implementing green building practice in Addis Ababa according to practitioners, and identified appropriate strategies for application and implementation of green building practice, design and development of vertical greenery. The result of the research revealed that the major gaps between the surveyed buildings and green building were sustainable site, water efficiency and sustainable material and resources which need adequate space, professionals of different disciplinary and different technologies. The finding of the study revealed that the obstacles to the application of the principle are lack of clients' interest, lack of awareness and education, shortage of professionals, lack of incentives from the government, economic challenges and absence of certification system such as LEED, the appropriate strategies are raising awareness about the idea, benefits and technologies about green buildings, financial incentives, research and policies, and integration of all actors including developers, designers, government, material producers, contractors and building managers from the start to finish of the project.

The research which was conducted by Taeka Haileleul assessed the nature of the buildings that were selected as case studies in terms of building layout, indoor environment quality, waste, energy and water management and building material; compared the assessed buildings' nature among themselves and generally with green buildings; examined the key issues involved in providing green building theories to the sampled buildings; and recommended possible remedial solutions based on environmental planning and landscape design. The results of the research showed that most of the assessed buildings were built not considering the environment and the society.

This research focuses on the construction professionals. The research was conducted in Jimma town. This research assessed the key role of construction professionals in adopting green building construction in Jimma town. The three objectives that were addressed by this research are investigating the extent to which the construction professionals integrate green building principles in public building construction projects of Jimma town, determining the challenges of construction professionals to adopt green building construction in Jimma town and identifying the key responsibilities of the construction professionals to adopt green building construction in Jimma town.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research Area

This research was conducted in Jimma town. Jimma is situated in the southwestern Oromia Region in Ethiopia. Jimma is the largest city in the southwestern Oromia Region. It is a special town of the Oromia Region which is surrounded by Jimma Zone. Jimma has a latitude and longitude of 7°40'N and 36°50'E respectively (Wikipedia, n.d.).

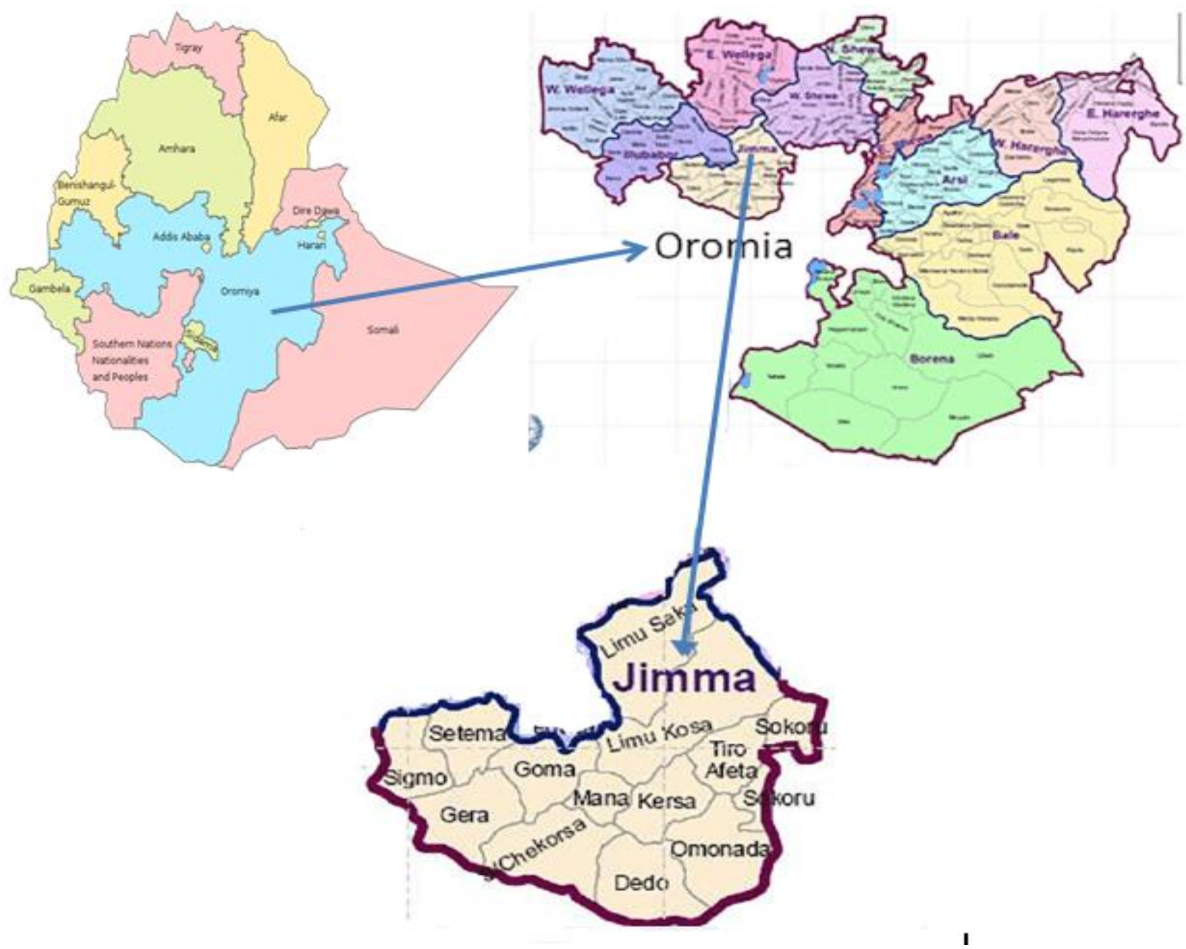

Figure 3.1 Location of Jimma town *(en.wikipedia.org, n.d.)*

3.2 Research Design

The objective for the research was set by identifying the problem encountered in the town. The data for this research was gathered from both primary and secondary sources. The research data was both qualitative and quantitative. Populations of the research were construction professionals and the sampling method employed was purposive sampling method. Microsoft Excel 2010 was used to analyze the data and the data was presented in a statistical descriptive way. The research results were presented in the form of tables and charts. Relative importance index method was used to compute the statistical data.

3.3 Study Variables

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

Dependent variable

- Role of construction professionals to adopt green building construction

Independent variable

- Attitude of construction professionals
- Role of government
- Stakeholders (Client and Contractor role)
- Availability of green building materials and adequate manufacturers
- Cost

3.4 Population and Sampling Method

The sampling method used for this research was purposive sampling method. Populations of this study were construction professionals and they were selected from four firms. The firms selected for this study were contractor, client, regulatory body, and consulting firm. The number of questionnaire distributed for the construction professionals was based on the number of public building projects that are found in Jimma town and based on the objective of the research. The numbers of public building projects identified as on construction stage from municipality of Jimma town were six. The numbers of questionnaires distributed for construction professionals were sixty based on the number of professionals found in the projects. And the numbers of valid questionnaires returned are forty seven therefore the number of construction professionals (populations) considered in this research were forty seven. Sample size was not determined because the population number was small.

3.5 Sources of Data

Both primary and secondary data were used as sources of data for this research. The primary sources of data for the research were interview and questionnaires, while the secondary sources of data for this research include different past research papers on the issue, books, various websites, journals, and articles.

3.6 Data Collection Procedure

In this research different literatures were reviewed, structured questionnaires were prepared and distributed to construction professionals, and interviews were conducted with construction professionals. The data for this research was gathered from both primary and secondary sources. This study's principal data sources were a structured questionnaire and an interview. Books, various websites, published papers, and articles were used as secondary sources of data. Secondary data were used to improve knowledge of the study and to build the structured questionnaire and interview. The research data was both qualitative and quantitative.

3.7 Data Presentation and Analysis

The data in this study was analyzed using Microsoft Excel 2010 and presented in a statistical descriptive way. The research results were presented in the form of tables and charts. In the study, the relative importance index (RII) method was used to compute the statistical data, and then the results were tabulated and ranked. In the calculation of the relative importance index the following formula was used (Mohamed Salama, 2010):

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

Where:

W_i is weight of the certain variable which is ranked by the respondents

A is the highest weight and

N is the total number of respondents

The respondents were asked to rate the issues based on a 5- point likert scale therefore w_i ranges from 1 to 5. Tables 3.1, 3.2, and 3.3 show the rating system provided for the respondents to rate the issues that are found in the questionnaire.

Table 3.1 Rating system for part I of the questionnaire to meet specific objective 1

Extent of integration of green building principles by construction professionals in public building construction projects of Jimma town	Very less	Less	Moderately	Highly	Extremely
Weight	1	2	3	4	5

Table 3.2 Rating system for part II of the questionnaire to meet specific objective 2

Challenges of construction professionals to adopt green building construction in Jimma town	Very less	Less	Moderate	High	Very high
Weight	1	2	3	4	5

Table 3.3 Rating system for part III of the questionnaire to meet specific objective 3

Level of importance of the roles of construction professionals to adopt green building construction in Jimma town	Very less	Less	Moderately	Highly	Extremely
Weight	1	2	3	4	5

A valid structured questionnaire was prepared in order to answer the research questions and meet the specific objectives of the research. The respondents were asked to rate the issues based on a 5- point likert scale. Table 3.4 shows the range of the RII value for classifying the extent of integration of green building principles in public building construction projects of Jimma town, the level of the challenges of construction professionals to adopt green building construction in Jimma town, and the level of importance of the roles of construction professionals to adopt green building construction in Jimma town. How the range of RII value was computed is shown in Appendix- C.

Table 3.4 Range of RII value

Range of RII	
0.2 up to 0.39	Very less
0.4 up to 0.59	Less
0.6 up to 0.79	Moderate/ Moderately
0.8 up to 0.99	High/ Highly
1	Very high/ Extremely

3.8 Data Quality Assurance and Reliability of the Research

Reliability means consistency; it is a measure of the stability or consistency of test scores. The reliability coefficient is a measure of test scores. Cronbach's alpha is a reliability coefficient which measures internal reliability of tests with multiple possible answers. It is the most commonly used internal consistency coefficient (Glen, 2016). A validated structured questionnaire was used to assure the quality of the data of the research. In order to measure the consistency of the result of the questionnaire Cronbach's coefficient alpha was used. The Cronbach's coefficient alpha was calculated for all of the numerical data obtained from the questionnaire and sample result is presented on appendix D. To determine Cronbach's coefficient alpha the following formula was used (Cronbach, 1951, cited in Nicola L.Ritter 2010).

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

Where α = Cronbach's coefficient alpha,

K = number of items

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

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

The normal range of the value of Cronbach's coefficient alpha is between 0.0 and +1.0, with greater values showing greater internal consistency. The Cronbachs's alpha value ranging from 0.00 to 0.69 shows poor internal consistency, from 0.70 to 0.79 shows fair internal consistency, from 0.80 to 0.89 shows good internal consistency and from 0.90 to 0.99 indicates excellent or strong internal consistency (J.Taylor, 2013).

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 General Information and Respondent's Profile

The structured questionnaire designed for this study was distributed to sixty construction professionals and a semi-structured interview was conducted with three construction professionals. According to the data, a total of forty-seven construction professionals completed and answered all of the questions in the questionnaire. Eleven respondents did not answer any of the questions and did not return the questionnaire. Two of the respondents did not answer all of the items on the questionnaire; they only answer some of them. Hence this data is deemed inappropriate. After checking the consistency of the results of the forty seven respondents using the Cronbach's Alpha method, the reliability of the data was accepted. The forty-seven construction professionals who answered all of the questionnaire's questions are from four firms: contractor, client, regulatory body, and consultancy firm. Twenty-two construction professionals are from the contractor side. Fourteen construction professionals are on the client's side. Seven construction professionals work for a consultancy firm, and four construction professionals work for a regulatory body. The purpose of distributing questionnaires especially to construction professionals working in different firms is considering that they may be able to provide important information to the study based on their knowledge, background, and expertise.

Response Rate of the Questionnaire

A response rate is defined as the ratio of the number of people who complete the survey to the number of people who make up the total sample group. In most cases, a survey response rate of 50% or more should be considered excellent (Davis, 2019).

Table 4.1 displays the questionnaire response rate for each set of respondents as well as the total respondents. The four firms listed in Table 4.1 were chosen considering that they could give important information to this study based on their knowledge, background, and expertise. Gathering data from multiple firms is more significant than receiving data from a single firm.

Table 4.1 Response rate of questionnaire

Group of respondents	Distributed questionnaire	Not Answered	Partially Answered	Totally Answered	Percentage of totally answered
Contractor	29	5	2	22	75.862%
Consultant	7	0	0	7	100%
Regulatory	4	0	0	4	100%
Client	20	6	0	14	70%
Total respondents	60	11	2	47	78.333%

Ten of the twenty-two construction professionals on the contractor side are civil engineers (four of the ten civil engineers are project managers), eight of them are construction technology and management professionals, two are surveyors, one is a structural engineer, and one is an electrical engineer. Nine civil engineers, two structural engineers, one architect, an electrical engineer, and a construction technology and management professional are the construction professionals on the client's side. Four construction professionals from a consulting firm are civil engineers, two are architects, and one is a construction technology and management professional. And the members of the regulatory body are all civil engineers, and there are four of them.

Level of Education of respondents

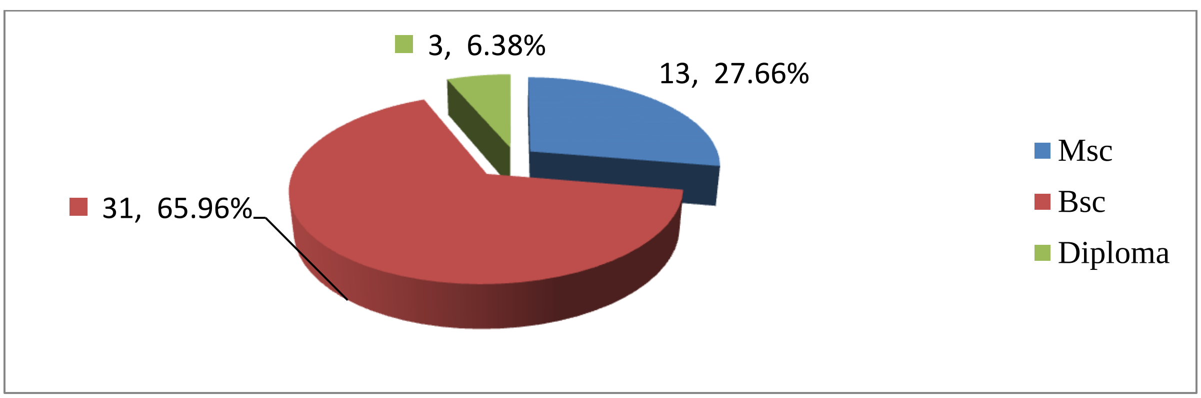

Figure 4.1 Number and percentage of the level of education of respondents

Work Experience of Respondents

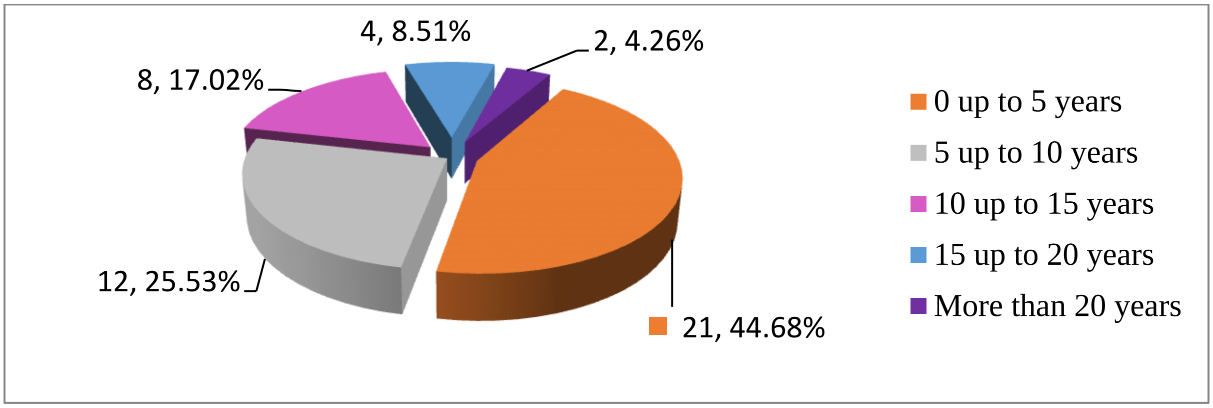

Figure 4.2 Number and percentage of work experience of respondents

Figures 4.1 and 4.2 depict the overall respondents' level of education and work experience. The data was obtained from various professionals with varying levels of education and work experience because data collected from professionals with different levels of education and work experience will be more meaningful than data collected from respondents with a specific background.

Reliability of the Research

Cronbach's alpha Value indicating Reliability of the Research

Table 4.2 Cronbach's alpha value

Item No	Objectives	Cronbach's coefficient alpha
1	To investigate the extent to which the construction professionals integrate green building principles in public building construction projects of Jimma town	
	Sustainable Site practices	0.827
	Use of sustainable materials	0.780
	Minimize energy use and use of renewable energy strategies	0.771
	Efficient use of water (Conserve and Protect Water)	0.781
	Indoor environmental quality	0.905

	Waste and pollution control	0.751
	Average	0.8025
2	To determine the challenges of construction professionals to adopt green building construction in Jimma town	
	Challenges related to construction professionals	0.791
	Government-related challenges	0.829
	Client-related challenges	0.743
	Contractor-related challenges	0.783
	Market-related challenges	0.805
	Challenges related to the nature of green buildings	0.807
	Average	0.793
3	To identify the key responsibilities of the construction professionals to adopt green building construction in Jimma town	0.745

Item No	Objectives	Cronbach's coefficient alpha
1	To investigate the extent to which the construction professionals integrate green building principles in public building construction projects of Jimma town	0.8025
2	To determine the challenges of construction professionals to adopt green building construction in Jimma town	0.793
3	To identify the key responsibilities of the construction professionals to adopt green building construction in Jimma town	0.745

As indicated in Table 4.2, Cronbach's coefficient alpha value obtained from the questionnaire data was between 0.745 and 0.8025; this value indicates that the data is within the range of fair and good internal consistency.

4.2 The Extent of Integration of Green Building Principles by Construction Professionals in Public Building Construction Projects of Jimma Town

In the first section of the structured questionnaire the respondents were asked to rate the extent of integration of green building principles in public building construction projects of Jimma town. This part of the questionnaire was formed based on the literature reviewed in chapter two. The green building principles stated in the questionnaire are sustainable site practices, use of sustainable materials, minimizing energy use and use of renewable energy strategies, efficient use of water, indoor environmental quality, and waste and pollution control. In this part of the questionnaire, the construction professionals were asked questions on every six themes and asked to rate the extent of integration of each sub-topic of the above-listed green building principles and practices in their building construction projects. In Figure 4.3, the RII values for the extent of integration of green building principles are shown.

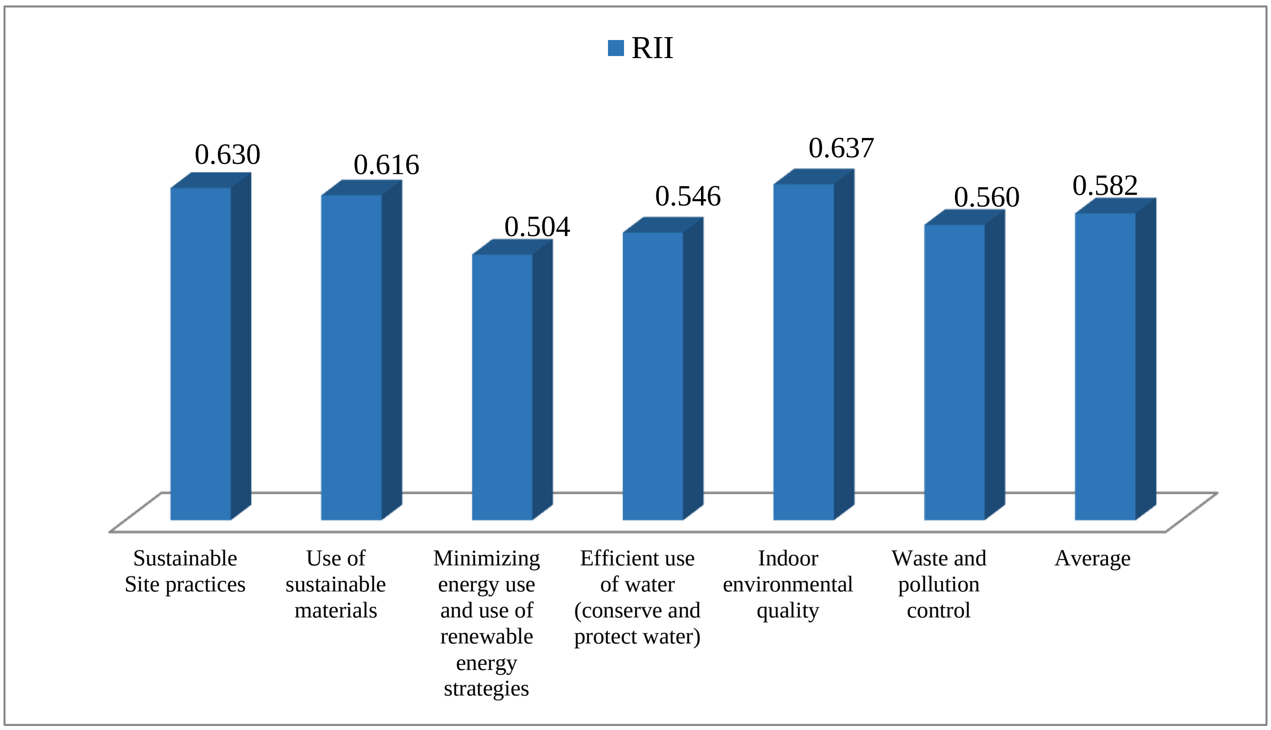

Figure 4.3 Result of integration of green building principles by construction professionals in public building construction projects of Jimma town

Figure 4.3 is the overall result of the total respondents on the extent of integration of green building principles in public building construction projects of Jimma town. As indicated in Figure 4.3, the average RII value of the green building principle is 0.582; therefore, the respondents' response shows that the green building principle is less integrated or applied in public building construction projects of Jimma town, and this issue requires more focus since it is less applied.

As shown in Figure 4.3, the principle of Indoor environmental quality is ranked first with an RII value of 0.637 among the other listed principles, and the RII value indicates the principle is moderately applied in public building construction projects of Jimma town.

As indicated in Figure 4.3, Sustainable site practice is the second most integrated or applied principle in public building construction projects of Jimma town with an RII value of 0.630, and the RII value indicates this principle is moderately applied in public building construction projects of Jimma town.

Figure 4.3 shows "use of sustainable materials" is ranked third with an RII value of 0.616 among the other listed principles, and the RII value indicates the principle is moderately applied in public building construction projects of Jimma town.

Figure 4.3 indicates that the waste and pollution control principle is ranked fourth with an RII value of 0.560. The RII value indicates this principle is less applied in public building construction projects of Jimma town.

Figure 4.3 indicates that the efficient use of water (conserve and protect water) principle is ranked fifth with an RII value of 0.546 and the RII value indicates this principle is less integrated or applied in public building construction projects of Jimma town.

Figure 4.3 shows that minimizing energy use and use of renewable energy strategies is ranked last with an RII value of 0.504; the RII value indicates this principle is less integrated or applied in public building construction projects of Jimma town, and it needs more focus than the other green building principle since it is the least applied principle among the different green building principles.

The result of the extent of integration of each of the green building principles mentioned on the questionnaire for respondents' rating is discussed below.

1. Sustainable Site Practices

Table 4.3 Result of integration of sustainable site practices

Item No	Green building principle	Total respondents	
1	Sustainable Site practices	RII	Rank
	Consideration of existing buildings and infrastructures before constructing new building	0.736	1
	Proper site selection for suitable building location and orientation	0.668	2
	Protecting high priority resources from damage due to construction activity	0.617	3
	Providing adequate open space and corridors for interactions	0.591	4
	Providing adequate green space	0.587	5
	Properly managing storm water	0.583	6
Average		0.630	

As indicated in Table 4.3, the average RII value of the extent of integration of sustainable site practices is 0.630, and this value indicates that sustainable site practice is moderately applied in public building construction projects of Jimma town. Table 4.3 shows consideration of existing buildings and infrastructures before constructing new buildings with an RII value of 0.736 is the topmost integrated sustainable site practice among the listed sustainable site practices. The RII value indicates that the principle is moderately integrated. More work is needed on properly managing storm water than the other sustainable site practices since it is the least applied sustainable site practice with an RII value of 0.583, which indicates a less level of application of the principle. For example, construction professionals could install a permeable surface that allows infiltration to manage storm water.

2. Use of Sustainable Materials

Table 4.4 Result of extent of integration of the principle of use of sustainable materials

Item No	Green building principles	Total respondents	
2	Use of sustainable materials	RII	Rank
	Proper use of material	0.723	1
	Using durable materials	0.677	2
	Using locally available materials	0.664	3
	Using non-toxic materials	0.643	4
	Using bio-based materials(naturally occurring or minimally processed materials)	0.540	5
	Using recycled materials	0.451	6
Average		0.616	

As shown in Table 4.4, the average RII value for the use of sustainable materials principle is 0.616, indicating that sustainable materials are moderately integrated or applied. As indicated in Table 4.4, Proper use of the material is the topmost integrated practice with an RII value of 0.723 in public building construction projects of Jimma town, among the other principles in the section of use of sustainable materials principle**.** And Table 4.4 indicates that using recycled materials is the least applied principle with an RII value of 0.451 among the use of sustainable materials principles; the RII value indicates the principle is less applied and increasing the use of recycled materials needs more attention. For example, waste building materials such as steel, brick and concrete and could be recycled and used.

3. Minimize Energy Use and Use of Renewable Energy Strategies

Table 4.5 Result of integration of minimize energy use and use of renewable energy strategies

Item No	Green building principles	Total respondents	
3	Minimize energy use and use of renewable energy strategies	RII	Rank
	Providing natural ventilation for rooms to minimize the use of electricity for ventilation.	0.664	1
	Providing natural lighting for rooms to minimize the use electricity for lights during day.	0.549	2
	Providing proper insulation to minimize the use of heaters.	0.506	3
	Recommending the use of energy efficient appliances such as light bulbs that conserve energy to clients	0.468	4
	Incorporating renewable energy systems such as solar water heating	0.332	5
Average		0.504	

As shown in Table 4.5, the average RII value of minimizing energy use and use of renewable energy strategies is 0.504; this indicates "minimize energy use and use of renewable energy strategies" is less integrated or applied. As shown in Table 4.5, providing natural ventilation for rooms to minimize the use of electricity for ventilation is the topmost integrated principle with an RII value of 0.664 in public building construction projects of Jimma town, among the other principles of "minimize energy use and use of renewable energy strategies." As shown in Table 4.5, incorporating renewable energy systems such as solar water heating is the least applied principle in this section. An RII value of 0.332 indicates the principle is very less applied and needs more attention.

4. Efficient Use of Water (Conserve and Protect Water)

Table 4.6 Result of integration of efficient use of water (conserving and protecting water)

Item No	Green building principle	Total respondents	
4	Efficient use of water (Conserve and Protect Water)	RII	Rank
	Minimizing leaks by insuring proper inspections during construction	0.621	1
	Providing rainwater harvesting mechanisms	0.617	2
	Reducing and controlling site run-off to minimize pollution of natural water sources	0.596	3
	Reducing water use in a building by fixing water efficient fittings	0.464	4
	Recycling waste water	0.430	5
Average		0.546	

As indicated in Table 4.6, the average RII value efficient use of water (Conserve and Protect Water) is 0.546; this value shows that efficient use of water (Conserve and Protect Water) is less integrated or applied in public building construction projects of Jimma town. Table 4.6 shows minimizing leaks by ensuring proper inspections during construction is ranked first; therefore, it is the topmost integrated principle in public building construction projects of Jiima town among the principles of efficient use of water (Conserve and Protect Water) according to the respondents. As shown in Table 4.6, recycling wastewater is the least applied practice in this section, with an RII value 0.430 indicates the principle is less applied and needs attention.

5. Indoor Environmental Quality

Table 4.7 Result of integration of principle of indoor environmental quality

Item No	Green building principles	Total respondents	
5	Indoor environmental quality	RII	Rank
	Providing natural ventilation	0.689	1
	Providing natural lighting	0.660	2
	providing thermal insulation	0.651	3

	Providing sound insulation	0.621	4
	Providing good access to views to the outside	0.566	5
Average		0.637	

As indicated in Table 4.7, the average RII value for the principle of indoor environmental quality is 0.637. This RII value shows the principle of indoor environmental quality is moderately integrated or applied in public building construction projects of Jimma town. As shown in Table 4.7, providing natural ventilation is the topmost integrated principle of indoor environmental quality with an RII value of 0.689. The least applied principle of indoor environmental quality is providing good access to views to the outside with an RII value of 0.566 indicating less level of application of the principle.

6. Waste and Pollution Control

Table 4.8 Result of integration of waste and pollution control

Item No	Green building principle	Total respondents	
6	Waste and pollution control	RII	Rank
	Ordering the right size materials for the work needed to reduce wastage	0.753	1
	Ordering the right amount of materials needed to reduce wastage	0.651	2
	Reducing construction mistakes to reduce wastes due to demolition	0.609	3
	Storing materials properly to reduce deterioration	0.460	4
	Re-using materials	0.451	5
	Recycling waste materials	0.434	6
Average		0.560	

Table 4.8 shows that the average RII value for waste and pollution control principles is 0.560, and this value indicates the principle is less integrated or applied in public building construction projects of Jimma town. As shown in Table 4.8, ordering the right size materials for the work needed to reduce wastage is the highest applied principle among the principles under the waste and pollution control section. Table 4.8 indicates that recycling waste materials is the least applied practice in this section with an RII value of 0.434 indicating the principle is less applied, and attention was not given to this principle.

4.3 Challenges of Construction Professionals to Adopt Green Building Construction in Jimma Town

In the second section of the structured questionnaire, the respondents were asked to rate the challenges of construction professionals in adopting green building construction in Jimma town. This part of the questionnaire was prepared based on the reviewed literature. This section of the questionnaire contains six main topics on the challenges of construction professionals in adopting green building construction in building construction projects of Jimma town. The six main topics are challenges related to construction professionals, government-related challenges, client-related challenges, contractor-related challenges, and market-related challenges and challenges associated with the nature of the green building. In this part of the questionnaire, the construction professionals were given questions under every six topics and asked to rank the challenges of construction professionals in adopting green building construction projects in Jimma town.

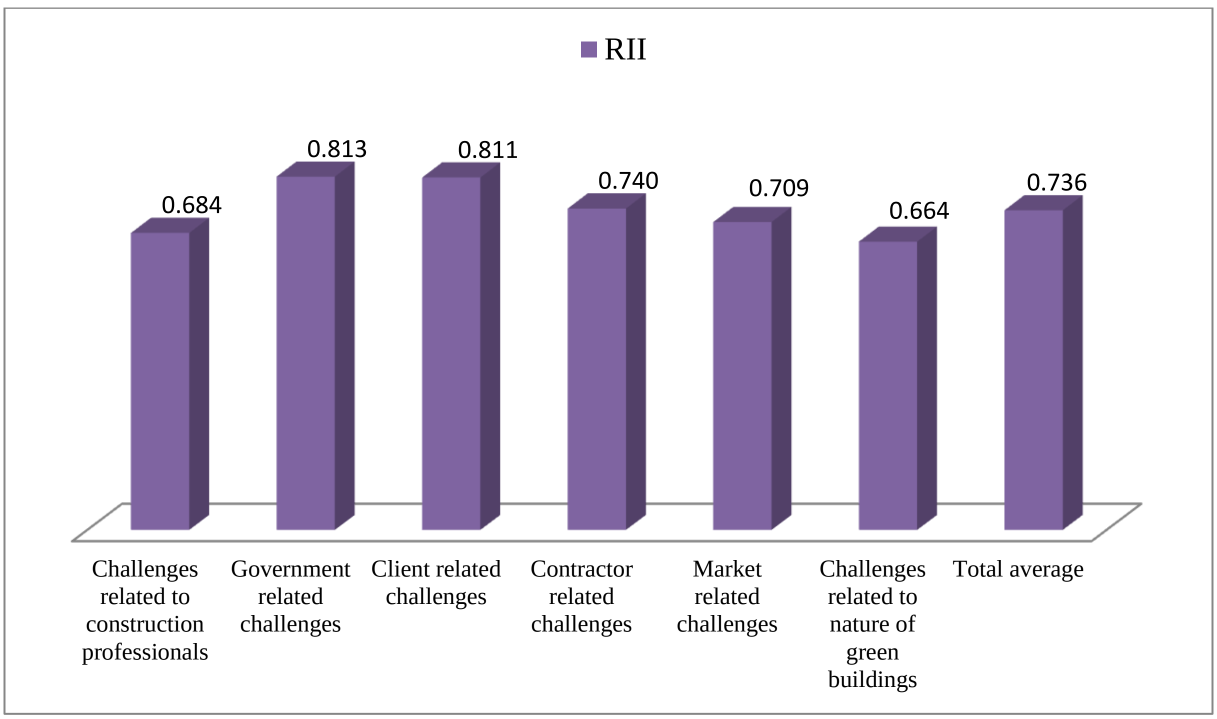

Figure 4.4 Result of challenges of construction professionals to adopt green building construction in Jimma town

As Figure 4.4 indicates, the average RII value of the challenges of construction professionals to adopt green building construction in public building construction projects of Jimma town is 0.736. This value shows the challenge of construction professionals to adopt green building construction in public building construction projects of Jimma town is moderate.

As indicated in Figure 4.4, the government-related challenge is ranked first with an RII value of 0.813 indicating the government related challenge is a high challenge for construction professionals to adopt green building construction in Jimma town according to the perception of the respondents. As shown in Figure 4.4, government-related challenge is the highest challenge than the other listed challenges and this indicates the government is not giving enough attention for green building construction according to the perception of the respondents but my point of view differs from the respondents because now a days the government is giving attention to green buildings and the media coverage about green buildings by the government is good and there is less availability of market of green building materials and products in the town and according to my perception, market related challenges could be the highest challenges in adopting green building in the town.

As shown in Figure 4.4, client-related challenge is ranked second with an RII value of 0.811, indicating client-related challenge is a high challenge for construction professionals to adopt green building construction in Jimma town. As shown in Figure 4.4, client-related challenge is the second- highest challenge among the other listed challenges in this section.

As indicated in Figure 4.4, contractor-related challenge is ranked third with an RII value of 0.740 indicating contractor-related challenge is a moderate challenge for construction professionals to adopt green building construction in Jimma town.

As indicated in Figure 4.4, market-related challenge is ranked forth with RII value of 0.709 indicating market-related challenge is a moderate challenge for construction professionals to adopt green building construction in Jimma town.

As shown in Figure 4.4, challenges related to construction professionals is ranked fifth with RII of 0.684, indicating different factors related to construction professionals such as their knowledge about green building is a moderate challenge for construction professionals to adopt green building construction in Jimma town according to the respondents.

As shown in Figure 4.4, challenges related to the nature of green buildings are ranked last with an RII value of 0.664, indicating challenges related to the nature of green buildings are a moderate challenge for construction professionals to adopt green building construction in Jimma town.

According to the interviewees' response, the challenges of construction professionals that hinder the adoption of green building in Jimma town are lack of demand from clients and the local government, lack of awareness of the society about green building, lack of experience of workers on green building construction and lack of implementation of green building construction by the local government. The challenges that present on data obtained from both the questionnaire and the interview are lack of implementation of green buildings by the local government, lack of demand from clients, and lack of experience of workers on green building construction.

Each of the challenge categories of the challenges of construction professionals to adopt green building construction mentioned on the questionnaire for respondents' rating are discussed below.

1. Challenges Related to Construction Professionals

Table 4.9 Result of challenges related to construction professionals

Item No	Challenges	Total respondents	
1	Challenges related to construction professionals	RII	Rank
	Lack of technical experience in green building construction	0.723	1
	Inadequate awareness on green building materials and products	0.715	2
	Lack of team work and co-operation among construction professionals in incorporating green building concept in building construction projects	0.681	3
	Inadequate knowledge on green building concepts and technology	0.668	4

	Fear of taking risks to adopt new concept in building construction	0.664	5
	Reluctance of construction professionals to add further responsibility on their technical and professional responsibilities without significant financial or professional reward	0.655	6
Average		0.684	

Table 4.9 shows that lack of technical experience in green building construction with an RII value of 0.723 is the highest challenge of construction professionals to adopt green building construction with an RII value of 0.723 among the other challenges under this section. The RII value indicates that lack of technical experience in green building construction is a moderate challenge for construction professionals to adopt green building construction in Jimma town. Professionals lack technical experience in green building construction.

2. Government-related Challenges

Table 4.10 Result of Government-related challenges

Item No	Challenges	Total respondents	
2	Government-related challenges	RII	Rank
	Lack of policies and standards on green building construction.	0.851	1
	Lack of enforcement by the local government to adopt green buildings	0.830	2
	Lack of offering training to construction professionals regarding green building construction.	0.804	3
	Lack of incentives and financial reward to construction professionals	0.766	4
Average		0.813	

As indicated in Table 4.10, lack of policies and standards on green building construction with an RII value of 0.851 is the highest challenge of construction professionals to adopt green building construction in Jimma town under this section and the RII value indicates that lack of policies and standards on green building construction is a high challenge for construction professionals to adopt green building construction in Jimma town.

3. Client-related Challenges

Table 4.11 Result of client-related challenges

Item No	Challenges	Total respondents	
3	Client-related challenges	RII	Rank
	Lack of awareness about green building construction	0.855	1
	Fear of increase in cost by clients	0.817	2
	Lack of demand for green building construction by clients	0.762	3
Average		0.811	

As indicated in Table 4.11, lack of awareness of clients about green building construction is ranked first with an RII value of 0.855. This value indicates lack of awareness of clients about green building construction is a high challenge for the construction professional to adopt green building construction in Jimma town.

4. Contractor-related Challenges

Table 4.12 Result of contractor-related challenges

Item No	Challenges	Total respondents	
4	Contractor-related challenges	RII	Rank
	Lack of awareness about green building construction	0.791	1
	Fear of taking risks to adopt new construction method	0.728	2
	Lack of competency among contractors and subcontractors for green building construction	0.702	3
Average		0.740	

Table 4.12 indicates that lack of awareness about green building construction is ranked first with RII value of 0.791. This value indicates lack of awareness about green building construction is a moderate challenge for construction professionals to adopt green building construction.

5. Market-related Challenges

Table 4.13 Result of market-related challenges

Item No	Challenges	Total Respondents	
5	Market-related challenges	RII	Rank
	Lack of adequate manufactures which produce green building materials and products	0.740	1
	Lack of availability of natural green building materials on the market	0.677	2
Average		0.709	

Table 4.13 indicates lack of adequate manufactures which produce green building materials and products is ranked first with an RII value of 0.740, and this value shows lack of adequate manufactures which produce green building materials and products is a moderate challenge for construction professionals to adopt green building construction in Jimma town according to the respondents perception, but according to my point of view market related challenges could be a high challenge for the construction professionals in adopting green building construction because green building materials and products are less available in Jimma town.

6. Challenges Related to the nature of Green Buildings

Table 4.14 Result of challenges related to the nature of green buildings

Item No	Challenges	Total respondents	
6	Challenges related to the nature of green buildings	RII	Rank
	Increase in initial cost of green buildings when compared to conventional buildings.	0.694	1
	Additional design, specification and construction needs and requirements of green buildings when it is compared to conventional buildings	0.685	2
	Increase in project duration.	0.613	3
Average		0.664	

Table 4.14 shows that increase in the initial cost of green buildings is ranked first with an RII value of 0.694. This value indicates that an increase in green buildings' initial cost is a moderate challenge for construction professionals to adopt green building construction in Jimma town.

4.4 The role of construction professionals to adopt green building construction in Jimma town

In the third section of the structured questionnaire which is about the roles of construction professionals to adopt green building construction in Jimma town, the respondents were asked to rate the importance of the roles of construction professionals to adopt green building construction in Jimma town. The section contains nine topics that describe what construction professionals could do to adopt green building construction in Jimma town. The questions of the structured questionnaire were formed from various literatures that were reviewed.

Table 4.15 Result of role of construction professionals to adopt green building construction

		Total respondents	
Item No	Roles of construction professionals in adopting green building in Jimma town	RII	Rank
1	Work as a team to successfully incorporate green building concepts in building construction projects and adopt green building design and construction.	0.898	1
2	Develop their knowledge on green building concepts, technologies, materials and products to design and construct both structurally stable and environmental friendly building by working in cooperation.	0.864	2
3	Develop their knowledge on green building concepts related to their specific roles to carry out their individual role and carefully incorporate and apply the concept without affecting the goal of the project.	0.851	3
4	Working with other professionals such as environmentalists to effectively adopt green building construction without affecting the	0.834	4

	surrounding environment.		
5	Working with the local government in establishment of a green building program and strategies	0.821	5
6	Giving awareness to clients and contractors regarding green building such as the cost, technologies and methods	0.809	6
7	Giving education and training for other workers such as tradesmen or craft workers about green building construction for effective adoption of green building.	0.796	7
8	Arranging public awareness campaigns regarding green buildings in co-operation with the local government	0.766	8
9	Carry out researches regarding green buildings in the town in order to identify gaps, challenges and opportunities to adopt green buildings effectively	0.736	9

Table 4.15 indicates that the top roles of construction professionals that are very significant to adopt green building construction in Jimma town are “working as a team to successfully incorporate green building concepts in building construction projects and adopt green building design and construction” with RII value of 0.898 , “knowledge development on green building concepts, technologies, materials and products to design and construct both structurally stable and environmental friendly building by working in cooperation” with RII value of 0.864 , “ knowledge development on green building concepts related to their specific roles to carry out their individual role and carefully incorporate and apply the concept without affecting the goal of the project.” with RII value of 0.851, “working with other professionals such as environmentalists to effectively adopt green building construction” with RII value of 0.834, “Working with other professionals such as environmentalists to effectively adopt green building construction without affecting the surrounding environment.” with RII value of 0.821 and “Giving awareness to clients and contractors regarding green building such as the cost, technologies and methods” With RII value of 0.809. These RII values indicate that the above-listed issues under this section are highly important roles of construction professionals to adopt green building construction in Jimma town, according to the respondent’s response.

According to the interviewees' response, the construction professionals should carefully plan for green building, involve green building designs during the design stage, and work in cooperation than alone to implement green building design and construction effectively.

Working with environmental protection agencies and professionals who work on environmental protection and working with the local government and non-government organizations to implement different programs and strategies on green building is another issue raised by interviewees on the role of construction professionals in adopting green building construction Jimma town. The interviewees also noted that construction professionals should give awareness to society and share their knowledge and experience and also with other workers.

According to the response of the interviewees, construction professionals could apply strategies such as executing public awareness programs in cooperation with the local government on the streets of Jimma town, transmitting programs about green building through mass Media by working in cooperation with different mass media such as radios and television networks, publishing different writings and kinds of literature on magazines and newspapers.

In addition to these ideas, the other issue raised by one of the interviewees was about the involvement of all of the stakeholders to overcome the challenges that hinder the adoption of green building construction. As stated by the interviewee, all construction industry stakeholders should perform their roles and co-operate for the successful adoption of green building construction in Jimma town.

Working with environmentalists, working with the local government, giving awareness to the society, working in co-operation, sharing experience with each other and with other workers, and executing public awareness programs in cooperation with the local government are the roles of construction professionals to adopt green building construction that are raised on the questionnaire and also by the interviewees.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The extent of integration of green building principles in public building construction projects of Jimma town is less with an RII value of 0.582; therefore, it needs proper attention. From the green building principles, Indoor environmental quality is the most applied principle followed by sustainable site practice, use of sustainable materials, waste and pollution control, minimizing energy use and use of renewable energy strategies, and efficient use of water (conserve and protect water) respectively.

The government-related challenge is the highest challenge with an RII value of 0.813 for construction professionals to adopt green building construction in Jimma town, followed by client-related, contractor-related, market-related, and challenges related to construction professionals' challenges related to the nature of green buildings respectively according to the perception of respondents.

The top roles of construction professionals to adopt green building construction in Jimma town according to the respondents are "Working as a team to successfully incorporate green building concepts in building construction projects and adopt green building design and construction" with RII value of 0.898 , "knowledge development on green building concepts, technologies, materials and products to design and construct both structurally stable and environmental friendly building" with RII value of 0.864 , "knowledge development on green building concepts related to their specific roles to carry out their individual role and carefully incorporate and apply the concept without affecting the goal of the project" with RII value of 0.851, "working with other professionals such as environmentalists to effectively adopt green building construction without affecting the surrounding environment" with RII value of 0.834, working with the local government in establishment of a green building program and strategies with RII value of 0.821 and "giving awareness to clients and contractors regarding green building such as the cost, technologies and methods" with RII value of 0.809.

5.2 Recommendations

The following recommendations are made based on the findings of the research.

I. For the government

- Adopt Green building standards of other countries to the national level
- Enforce binding rules and regulations, environmental guidelines and legislations
- Encourage the green building market
- Arranging public awareness campaigns and media coverage regarding green buildings to educate the society and to increase the demand for green building construction.

II. Recommendations for construction professionals

- Develop green building standards such as LEED considering the local context
- Update their knowledge on emerging new construction technologies
- Construction professionals should develop their knowledge about green building materials and carefully select them for use. For example, paints with no or less VOC content could be used by reading the label carefully.

The following recommendations are made for further research

- This research can be developed by changing the scope. For example, it can be carried out for other towns in Ethiopia.
- Additional research can be developed focusing only on one of the green building principles listed in this research for a detailed study concentrating on one topic.

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APPENDIX A

STRUCTURED QUESTIONNAIRE

Dear all respondents, First of all I would like to thank you for your willingness and cooperation. My name is Samrawit Kassahun, and I am a Master of Science (MSc) student specializing in Construction Engineering and Management at Jimma University.

This questionnaire aims to obtain relevant data for the research concerning the role of construction professionals in adopting green building in the building construction projects of Jimma town.

I kindly request you to contribute to this research work by completing this questionnaire. I strongly believe that your opinion has a significant contribution to the study. Your identity and the company you represent shall remain confidential, and all data found from the survey will only be used for an academic purpose.

I would like to express my deepest gratitude to all of you who took your precious time to respond this questionnaire. Please contact me through (Mobile number: +251921940760 or 0940629031).

General: Questions regarding your personal information; Please mark (✓) on your choice

1. Your Profession

Architect [ ]   Civil engineers [ ]

Quantity Surveyor [ ]   Mechanical Engineer [ ]

Structural engineer [ ]

Electrical Engineer [ ]

Others profession [ ], please specify: ___________________________________

2. Level of education

Doctorate degree [ ] Master's Degree [ ] Bachelor's Degree [ ] Diploma [ ]

Other [ ], please specify: ___________________________________

3. Work Experience in the company, in years: 0-5 [ ] 5-10 [ ] 10-15 [ ] 15-20 [ ] More than 20 years [ ]

4. The Company's scope of service:

   Contractor [ ]   Consultancy service [ ]   Client [ ]   Regulatory body [ ]

   Other [ ], please specify: ____

Part I: Questions about integration of green building principles in building construction projects of Jimma town.

1. Rank on a scale of 1 up to 5 that to what extent you integrate these green building principles in your project.

1= Very less integrated 2= Less integrated 3= moderately integrated

4= highly integrated 5= extremely integrated

Table A- 1 Questionnaire for objective one

	Principles	mark ✓ on your option on the space provided				
1	Sustainable Site practices	1	2	3	4	5
	Proper site selection for suitable building location and orientation					
	Protecting high priority resources from damage due to construction activity					
	Consideration of existing buildings and infrastructures before constructing new building					
	Providing adequate open space and corridors for interactions					
	Providing adequate green space					
	Properly managing storm water					
2	Use of sustainable materials	1	2	3	4	5
	Using durable materials					
	Using non-toxic materials					
	Proper use of material					
	Using locally available materials					
	Using bio-based materials(naturally occurring or minimally processed materials)					
	Using recycled materials					
3	Minimize energy use and use of renewable energy strategies	1	2	3	4	5

	Providing natural lighting for rooms to minimize the use electricity for lights during day.					
	Providing natural ventilation for rooms to minimize the use of electricity for ventilation.					
	Recommending the use of energy efficient appliances such as light bulbs that conserve energy to clients					
	Providing proper insulation to minimize the use of heaters.					
	Incorporating renewable energy systems such as solar water heating					
4	Efficient use of water (Conserve and Protect Water)	1	2	3	4	5
	Reducing water use in a building by fixing water efficient fittings					
	Reducing and controlling site run-off to minimize pollution of natural water sources					
	Recycling waste water					
	Providing rainwater harvesting mechanisms					
	Minimizing leaks by insuring proper inspections during construction					
5	In door environmental quality	1	2	3	4	5
	Providing natural lighting					
	Providing natural ventilation					
	Providing sound insulation					
	providing thermal insulation					
	Providing good access to views to the outside					
6	Waste and pollution control	1	2	3	4	5
	Ordering the right amount of materials needed to reduce wastage					
	Ordering the right size materials for the work needed to reduce wastage					

	Reducing construction mistakes to reduce wastes due to demolition					
	Storing materials properly to reduce deterioration					
	Re-using materials					
	Recycling waste materials					

2. If there are other green building practices in your mind that you integrate in your project other than listed above, please list and rate them.

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Part II: Questions regarding the challenges of construction professionals to adopt green building construction projects in Jimma town.

1. Rank on a scale of 1-5 the below challenges of construction professionals in adopting green building construction in Jimma town.

1= very less challenge   2= Less challenge   3= moderate challenge

4= High challenge   5= very high challenge

Table A- 2 Questionnaire for objective two

	Challenges	mark ✓ on your option on the space provided				
1	Challenges related to construction professionals	1	2	3	4	5
	Lack of technical experience in green building construction					
	Inadequate knowledge on green building concepts and technology					
	Inadequate awareness on green building materials and products					
	Lack of team work and co-operation among construction professionals in incorporating green building concept in building construction projects					
	Fear of taking risks to adopt new concept in building construction					
	Reluctance of construction professionals to add further responsibility on their technical and professional responsibilities without significant financial or professional reward					
2	Government-related challenges	1	2	3	4	5
	Lack of enforcement by the local government to adopt green buildings					
	Lack of offering training to construction professionals regarding green building construction.					
	Lack of incentives and financial reward to construction professionals					
	Lack of policies and standards on green building construction.					
3	Client-related challenges	1	2	3	4	5
	Lack of demand for green building construction by clients					
	Lack of awareness about green building construction					

	Fear of increase in cost by clients					
4	Contractor-related challenges	1	2	3	4	5
	Lack of awareness about green building construction					
	Lack of competency among contractors and subcontractors for green building construction					
	Fear of taking risks to adopt new construction method					
5	Market-related challenges	1	2	3	4	5
	Lack of availability of green building materials					
	Lack of adequate manufactures which produce green building materials					
6	Challenges related to the nature of green buildings	1	2	3	4	5
	Additional design, specification and construction requirements of green buildings when compared to conventional buildings.					
	Increase in initial cost of green buildings when compared to conventional buildings.					
	Increase in project duration.					

2. If there are other challenges that will affect the role of construction professionals in adopting green building. Please specify and rate them.

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Part III. Questions regarding the role of construction professionals in adopting green building in Jimma town

1. From the below lists of roles of construction professionals in adopting green building, please rank on a scale of 1 up to 5 the importance of the contribution of the roles of the construction professionals in adopting green buildings.

1= Very less important 2= Less important 3 = moderately important

4= highly important 5= extremely important

Table A- 3 Questionnaire for objective three

		Please mark (✓) on your choice				
Item No	Roles of Construction Professionals	1	2	3	4	5
1	Develop their knowledge on green building concepts, technologies, materials and products to design and construct both structurally stable and environmental friendly building by working in cooperation.					
2	Develop their knowledge on green building concepts related to their specific roles to carry out their individual role and carefully incorporate and apply the concept without affecting the goal of the project.					
3	Working with the local government in establishment of a green building program and strategies					
4	Giving awareness to clients and contractors regarding green building such as the cost, technologies and methods					
5	Work as a team to successfully incorporate green building concepts in building construction projects and adopt green building design and construction					
6	Working with other professionals such as environmentalists to effectively adopt green building construction without affecting the surrounding environment.					
7	Giving education and training for other workers such as tradesmen or craft workers about green building construction for effective adoption of					

	green building.					
8	Arranging public awareness campaigns regarding green buildings in co-operation with the local government					
9	Carry out researches regarding green buildings in the town in order to identify gaps, challenges and opportunities to adopt green buildings effectively					

2. If there are other roles of construction professionals in adopting green building in your mind other than listed above, please list and rate them.

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APPENDIX B

Semi-Structured Interview Questions for Construction Professionals

Semi-structured interview questions for construction professionals

1. What are the benefits of adopting green building construction in Jimma town?
2. What is the significance of construction professionals in adopting green building construction in Jimma town?
3. What are the Challenges of construction professionals in adopting green building in Jimma town?
4. What are the measures needed to be taken by construction professionals to overcome their challenges in adopting green building in Jimma town?
5. What kind of strategies could be applied to raise awareness of the society of Jimma town about green building?

APPENDIX C

Range of RII Value

Table C-1 Range of RII Value

Extent of integration of green building principles by construction professionals in public building construction projects of Jimma town	Very less	Less	Moderately	Highly	Extremely
W	1	2	3	4	5
A	5	5	5	5	5
N	47	47	47	47	47
W of 47 respondents (W*47)	47	47*2	47*3	47*4	47*5
N*A	235	235	235	235	235
RII = [W of 47 respondents /(N*A)]	0.2	0.4	0.6	0.8	1
Challenges of construction professionals to adopt green building construction in Jimma town	Very less	Less	Moderate	High	Very high
W	1	2	3	4	5
A	5	5	5	5	5
N	47	47	47	47	47
W of 47 respondents (W*47)	47	47*2	47*3	47*4	47*5
N*A	235	235	235	235	235
RII = [W of 47 respondents /(N*A)]	0.2	0.4	0.6	0.8	1
Level of importance of the roles of construction professionals to adopt green building construction in Jimma town	Very less	Less	Moderately	Highly	Extremely
W	1	2	3	4	5
A	5	5	5	5	5
N	47	47	47	47	47
W of 47 respondents (W*47)	47	47*2	47*3	47*4	47*5
N*A	235	235	235	235	235
RII = [W of 47 respondents /(N*A)]	0.2	0.4	0.6	0.8	1
Range of RII					
0.2 up to 0.39	Very less				
0.4 up to 0.59	Less				
0.6 up to 0.79	Moderate/ Moderately				
0.8 up to 0.99	High/ Highly				
1	Very high/ Extremely				

APPENDIX D

Result of Respondents of Each Group and Total Respondents

Table D- 1 Result of objective 1showing the response of each group

Item NO	Green building principles	Contractor		Client		Consultant		Regulatory body	
1	Sustainable Site practices	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Proper site selection for suitable building location and orientation	0.555	2	0.743	1	0.829	2	0.650	4
	Protecting high priority resources from damage due to construction activity	0.545	3	0.614	5	0.714	3	0.750	2
	Consideration of existing buildings and infrastructures before constructing new building	0.664	1	0.714	2	0.886	1	0.800	1
	Providing adequate open space and corridors for interactions	0.491	5	0.671	3	0.714	3	0.650	4
	Providing adequate green space	0.536	4	0.629	4	0.657	4	0.650	4
	Properly managing storm water	0.555	2	0.571	6	0.657	4	0.700	3
2	Use of sustainable materials	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Using durable materials	0.645	2	0.714	3	0.657	4	0.750	2
	Using non-toxic materials	0.536	4	0.729	2	0.686	3	0.850	1
	Proper use of material	0.673	1	0.771	1	0.771	1	0.750	2
	Using locally available materials	0.636	3	0.643	4	0.743	2	0.750	2
	Using bio-based materials(naturally occurring or minimally processed materials)	0.527	5	0.514	5	0.629	5	0.550	5
3	Minimize energy use and use of renewable energy strategies	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Providing natural lighting for rooms to minimize the use electricity for lights during day.	0.573	3	0.657	1	0.714	1	0.500	2
	Providing natural ventilation for rooms to minimize the use of electricity for ventilation.	0.600	2	0.457	2	0.600	2	0.600	1

	Recommending the use of energy efficient appliances such as light bulbs that conserve energy to clients	0.473	4	0.414	3	0.514	4	0.450	3
	Providing proper insulation to minimize the use of heaters.	0.664	1	0.414	3	0.600	2	0.400	4
	Incorporating renewable energy systems such as solar water heating	0.355	5	0.329	5	0.314	5	0.250	5
4	Efficient use of water (Conserve and Protect Water)	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Reducing water use in a building by fixing water efficient fittings	0.427	4	0.543	4	0.400	4	0.450	4
	Reducing and controlling site run-off to minimize pollution of natural water sources	0.645	3	0.586	3	0.457	3	0.500	3
	Recycling waste water	0.400	5	0.500	5	0.371	5	0.450	4
	Providing rainwater harvesting mechanisms	0.664	2	0.614	2	0.514	1	0.600	1
	Minimizing leaks by insuring proper inspections during construction	0.673	1	0.629	1	0.514	1	0.600	1
5	In door environmental quality	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Providing natural lighting	0.609	2	0.657	1	0.743	3	0.800	1
	Providing natural ventilation	0.664	1	0.657	1	0.800	1	0.750	3
	Providing sound insulation	0.573	4	0.629	4	0.657	4	0.800	1
	providing thermal insulation	0.600	3	0.657	1	0.771	2	0.700	4
	Providing good access to views to the outside	0.527	5	0.557	5	0.657	4	0.650	5
6	Waste and pollution control	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Ordering the right amount of materials needed to reduce wastage	0.800	2	0.514	3	0.486	2	0.600	1
	Ordering the right size materials for the work needed to reduce	0.818	1	0.814	1	0.543	1	0.550	2

	wastage								
	Reducing construction mistakes to reduce wastes due to demolition	0.618	3	0.671	2	0.486	2	0.550	2
	Storing materials properly to reduce deterioration	0.455	5	0.486	4	0.457	4	0.400	5
	Re-using materials	0.473	4	0.486	4	0.314	5	0.450	4
	Recycling waste materials	0.455	5	0.471	6	0.314	5	0.400	5

Table D- 2 Result of objective 1, showing the response of the total 47 respondents

Item No	Green building principles	Total Respondents	
1	Sustainable Site practices	RII	Rank
	Proper site selection for suitable building location and orientation	0.668	2
	Protecting high priority resources from damage due to construction activity	0.617	3
	Consideration of existing buildings and infrastructures before constructing new building	0.736	1
	Providing adequate open space and corridors for interactions	0.591	4
	Providing adequate green space	0.587	5
	Properly managing storm water	0.583	6
	Total	0.630	
2	Use of sustainable materials	RII	Rank
	Using durable materials	0.677	2
	Using non-toxic materials	0.643	4

	Proper use of material	0.723	1
	Using locally available materials	0.664	3
	Using bio-based materials(naturally occurring or minimally processed materials)	0.540	5
	Using recycled materials	0.451	6
3	Minimize energy use and use of renewable energy strategies	RII	Rank
	Providing natural lighting for rooms to minimize the use electricity for lights during day.	0.549	2
	Providing natural ventilation for rooms to minimize the use of electricity for ventilation.	0.664	1
	Recommending the use of energy efficient appliances such as light bulbs that conserve energy to clients	0.468	4
	Providing proper insulation to minimize the use of heaters.	0.506	3
	Incorporating renewable energy systems such as solar water heating	0.332	5
	Total	0.504	
4	Efficient use of water (Conserve and Protect Water)	RII	Rank
	Reducing water use in a building by fixing water efficient fittings	0.464	4
	Reducing and controlling site run-off to minimize pollution of natural water sources	0.596	3
	Recycling waste water	0.430	5
	Providing rainwater harvesting mechanisms	0.617	2
	Minimizing leaks by insuring proper inspections during construction	0.621	1
	Total	0.546	
5	In door environmental quality	RII	Rank
	Providing natural lighting	0.660	2
	Providing natural ventilation	0.689	1

	Providing sound insulation	0.621	4
	providing thermal insulation	0.651	3
	Providing good access to views to the outside	0.566	5
	Total	0.637	
6	Waste and pollution control	RII	Rank
	Ordering the right amount of materials needed to reduce wastage	0.651	2
	ordering the right size materials for the work needed to reduce wastage	0.753	1
	Reducing construction mistakes to reduce wastes due to demolition	0.609	3
	Storing materials properly to reduce deterioration	0.460	4
	Re-using materials	0.451	5
	recycling waste materials	0.434	6
	Total	0.560	

Table D- 3 Result of objective 2 showing the response of each group of respondents

	Challenges	Contractor		Client		Consultant		Regulatory body	
1	Challenges related to construction professionals	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Inadequate knowledge on green building concepts and technology	0.655	5	0.686	3	0.571	6	0.850	3
	Inadequate awareness on green building materials and products	0.700	1	0.714	2	0.714	1	0.800	5
	Lack of technical experience in green building construction	0.700	1	0.771	1	0.629	3	0.850	3
	Lack of team work and co-operation among construction professionals in incorporating green building concept in	0.664	4	0.671	4	0.629	3	0.900	1

	building construction projects								
	Fear of taking risks to adopt new concept in building construction	0.691	3	0.600	6	0.657	2	0.750	6
	Reluctance of construction professionals to add further responsibility on their technical and professional responsibilities and liabilities without significant financial or professional reward	0.655	5	0.614	5	0.600	5	0.900	1
2	Government-related Factors	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Lack of enforcement by the local government to adopt green buildings	0.827	2	0.814	3	0.829	1	0.900	1
	Lack of offering training to construction professionals regarding green building construction.	0.773	3	0.843	1	0.800	3	0.850	3
	Lack of incentives and financial reward to construction professionals	0.745	4	0.800	4	0.771	4	0.750	4
	Lack of policies and standards on green building construction.	0.864	1	0.829	2	0.829	1	0.900	1
3	Client-related factors	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Lack of demand for green building construction by clients	0.745	3	0.786	3	0.714	3	0.850	1
	Lack of awareness about green building construction	0.836	1	0.914	1	0.829	1	0.800	2
	Fear of increase in cost by clients	0.791	2	0.857	2	0.829	1	0.800	2

4	Contractor-related challenges	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Lack of awareness about green building construction	0.791	1	0.771	1	0.800	1	0.850	1
	Lack of competency among contractors and subcontractors for green building construction	0.745	2	0.643	3	0.686	2	0.700	3
	Fear of taking risks to adopt new construction method	0.736	3	0.729	2	0.657	3	0.800	2
5	Market-related challenges	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Lack of availability of green building materials	0.627	2	0.700	2	0.743	2	0.750	1
	Lack of adequate manufactures which produce green building materials	0.682	1	0.786	1	0.829	1	0.750	1
6	Challenges related to the nature of green buildings	RII	Rank	RII	Rank	RII	Rank	RII	Rank
	Additional design, specification and construction needs and requirements of green buildings when compared to conventional buildings.	0.755	1	0.600	1	0.657	3	0.650	2
	Increase in initial cost of green buildings when compared to conventional buildings.	0.727	2	0.600	1	0.743	1	0.750	1
	Increase in project duration.	0.618	3	0.571	3	0.686	2	0.600	3

Table D- 4 Result of objective 2 showing the response of the total 47 respondents

	Challenges	Total respondents	
1	Challenges related to construction professionals	RII	Rank
	Inadequate knowledge on green building concepts and technology	0.668	4
	Inadequate awareness on green building materials and products	0.715	2
	Lack of technical experience in green building construction	0.723	1
	Lack of team work and co-operation among construction professionals in incorporating green building concept in building construction projects	0.681	3
	Fear of taking risks to adopt new concept in building construction	0.664	5
	Reluctance of construction professionals to add further responsibility on their technical and professional responsibilities and liabilities without significant financial or professional reward	0.655	6
		0.684	
2	Government-related Factors	RII	Rank
	Lack of enforcement by the local government to adopt green buildings	0.830	2
	Lack of offering training to construction professionals regarding green building construction.	0.804	3
	Lack of incentives and financial reward to construction professionals	0.766	4
	Lack of policies and standards on green building construction.	0.851	1
	Total	0.813	
3	Client-related challenges	RII	Rank
	Lack of demand for green building construction by clients	0.762	3
	Lack of awareness about green building construction	0.855	1
	Fear of increase in cost by clients	0.817	2

	Total	0.811	
4	Contractor-related challenges	RII	Rank
	Lack of awareness about green building construction	0.791	1
	Lack of competency among contractors and subcontractors for green building construction	0.702	3
	Fear of taking risks to adopt new construction method	0.728	2
	Total	0.740	
5	Market-related factors	RII	Rank
	Lack of availability of green building materials	0.677	2
	Lack of adequate manufactures which produce green building materials	0.740	1
	Total	0.709	
6	Challenges related to the nature of green buildings	RII	Rank
	Additional design, specification and construction requirements of green buildings when compared to conventional buildings.	0.685	2
	Increase in initial cost of green buildings when compared to conventional buildings.	0.694	1
	Increase in project duration.	0.613	3
	Total	0.664	

Table D- 5 Result of objective 3 showing the response of each group of respondents

		Contractor		Client		Consultant		Regulatory body	
Item No	The role of construction professionals in adopting green building in Jimma town	RII	Rank	RII	Rank	RII	Rank	RII	Rank

1	Develop their knowledge on green building concepts, technologies, materials and products to design and construct both structurally stable and environmental friendly building by working in cooperation.	0.827	2	0.900	2	0.914	1	0.850	3
2	Develop their knowledge on green building concepts related to their specific roles to carry out their individual role and carefully incorporate and apply the concept without affecting the goal of the project.	0.818	4	0.886	3	0.886	2	0.850	3
3	Working with the local government in establishment of a green building program and strategies	0.764	7	0.886	3	0.829	4	0.900	2
4	Giving awareness to clients and contractors regarding green building such as the cost, technologies and methods	0.827	2	0.814	7	0.771	8	0.750	6
5	Work as a team to successfully incorporate green building concepts in building construction projects and adopt green building design and construction	0.891	1	0.943	1	0.857	3	0.850	3
6	Working with other professionals such as environmentalists to effectively adopt green building construction without affecting the surrounding environment.	0.809	5	0.857	5	0.800	6	0.950	1
7	Giving education and training for other workers such as tradesmen or craft workers about green building construction for effective adoption of green building.	0.782	6	0.829	6	0.800	6	0.750	6

8	Arranging public awareness campaigns regarding green buildings in co-operation with the local government	0.764	7	0.757	8	0.829	4	0.700	8
9	Carry out researches regarding green buildings in the town in order to identify gaps, challenges and opportunities to adopt green buildings effectively	0.764	7	0.743	9	0.657	9	0.700	8

Table D- 6 Result of objective 3 showing the response of the total 47 respondents

		Total respondent	
Item No	The role of construction professionals in adopting green building in Jimma town	RII	Rank
1	Develop their knowledge on green building concepts, technologies, materials and products to design and construct both structurally stable and environmental friendly building by working in cooperation.	0.864	2
2	Develop their knowledge on green building concepts related to their specific roles to carry out their individual role and carefully incorporate and apply the concept without affecting the goal of the project.	0.851	3
3	Working with the local government in establishment of a green building program and strategies	0.821	5
4	Giving awareness to clients and contractors regarding green building such as the cost, technologies and methods	0.809	6
5	Work as a team to successfully incorporate green building concepts in building construction projects and adopt green building design and construction	0.898	1
6	Working with other professionals such as environmentalists to effectively adopt green building construction without affecting the surrounding environment.	0.834	4

7	Giving education and training for other workers such as tradesmen or craft workers about green building construction for effective adoption of green building.	0.796	7
8	Arranging public awareness campaigns regarding green buildings in co-operation with the local government	0.766	8
9	Carry out researches regarding green buildings in the town in order to identify gaps, challenges and opportunities to adopt green buildings effectively	0.736	9

APPENDIX E

Sample Excel Results of RII and Cronbach's Coefficient Alpha

Table E- 1Sample excel result from objective 1, RII and chronbach's alpha result of "integration of sustainable site practices" from objective 1

Item no	K1	Variance of K1	K2	Variance of K2	K3	Variance of K3	K4	Variance of K4	K5	Variance of K5	K6	Variance of K6	Total (sum of K1- K6)	Variance of total
1	4	0.44	2	1.18	5	1.74	3	0.002	2	0.88	3	0.007	19	0.007
2	4	11.10	2	1.91	5	18.18	4	11.62	4	11.65	4	11.68	23	529
3	4	4	3	0	4	9	3	1	3	4	3	9	20	400
4	2	4	3	9	3	9	1	1	1	1	1	1	11	121
5	5	17.41	3	9	3	9	3	9	3	9	4	16	21	441
6	2	16	4	16	2	4	3	9	1	1	3	9	15	225
7	4	16	4	16	5	25	3	9	4	16	2	4	22	484
8	2	4	2	4	3	9	1	1	3	9	2	4	13	169
9	2	4	3	9	2	4	2	4	3	9	3	9	15	225
10	3	9	2	4	3	9	3	9	3	9	2	4	16	256
11	1	1	2	4	2	4	2	4	2	4	3	9	12	144
12	2	4	3	9	2	4	2	4	3	9	2	4	14	196
13	4	16	5	25	4	16	4	16	4	16	3	9	24	576
14	3	9	4	16	3	9	3	9	4	16	4	16	21	441
15	2	4	2	4	4	16	2	4	2	4	2	4	14	196
16	3	9	1	1	5	25	3	9	2	4	2	4	16	256
17	1	1	1	1	3	9	1	1	1	1	3	9	10	100
18	5	25	4	16	4	16	3	9	5	25	5	25	26	676
19	3	9	3	9	3	9	2	4	2	4	3	9	16	256
20	2	4	2	4	3	9	1	1	2	4	1	1	11	121
21	1	1	3	9	4	16	2	4	1	1	3	9	14	196
22	2	4	2	4	1	1	3	9	4	16	3	9	15	225
23	4	16	2	4	5	25	4	16	3	9	3	9	21	441
24	4	16	2	4	4	16	3	9	2	4	3	9	18	324

25	2	4	3	9	2	4	2	4	3	9	1	1	13	169
26	5	25	4	16	3	9	3	9	4	16	3	9	22	484
27	2	4	3	9	2	4	3	9	2	4	3	9	15	225
28	3	9	3	9	5	25	2	4	3	9	2	4	18	324
29	5	25	5	25	3	9	5	25	1	1	3	9	22	484
30	4	16	2	4	4	16	4	16	5	25	3	9	22	484
31	5	25	5	25	4	16	5	25	5	25	5	25	29	841
32	5	25	4	16	5	25	4	16	3	9	3	9	24	576
33	4	16	2	4	5	25	3	9	2	4	2	4	18	324
34	4	16	2	4	3	9	2	4	3	9	3	9	17	289
35	3	9	4	16	4	16	4	16	4	16	3	9	22	484
36	4	16	4	16	4	16	3	9	3	9	2	4	20	400
37	4	16	4	16	5	25	4	16	4	16	4	16	25	625
38	3	9	5	25	4	16	3	9	2	4	2	4	19	361
39	5	25	5	25	5	25	3	9	5	25	3	9	26	676
40	4	16	2	4	5	25	3	9	2	4	3	9	19	361
41	5	25	5	25	4	16	5	25	5	25	5	25	29	841
42	5	25	2	4	4	16	4	16	2	4	3	9	20	400
43	3	9	2	4	4	16	3	9	3	9	3	9	18	324
44	1	1	1	1	3	9	1	1	1	1	3	9	10	100
45	4	16	4	16	4	16	3	9	4	16	2	4	21	441
46	5	25	5	25	4	16	4	16	5	25	5	25	28	784
47	3	9	5	25	5	25	5	25	3	9	4	16	25	625
W(sum of 1- 47)	157	570.951	145	503.090	173	651.92	139	443.62	138	461.52	137	429.68	889	17620.01
N	47		47		47		47		47		47		47	
A	5		5		5		5		5		5			
N*A	235		235		235		235		235		235			
Mean	3.340		3.085		3.681		2.957		2.936		2.915			

RII (W/N*A)	0.668		0.617		0.736		0.591		0.587		0.583			
Rank	2		3		1		4		5		6			
Sum of variances of K1 up to K6	570.951+ 503.090+ 651.92+ 443.62+ 461.52+ 429.68=3060.8													
Variance of total test score	17620.01													
K(Number of items)	6													
Cronbach's alpha	α = [6/(6-1)] *[1-(3060.8/17620.01)] = 0.827													

Table E- 2 Sample excel result, RII and chronbach's alpha result of "Market-related challenges" from objective 2

Item No	K1	Variance of K1	K2	Variance of K2	Total (sum of K1 and K2)	Variance of total
1	3	0.147	4	0.089	7	0.007
2	1	5.679	1	7.301	2	25.857
3	4	0.381	3	0.493	7	0.007
4	5	2.615	5	1.685	10	8.497
5	4	0.381	4	0.089	8	0.837
6	3	0.147	4	0.089	7	0.007
7	2	1.913	2	2.897	4	9.517
8	1	5.679	3	0.493	4	9.517
9	3	0.147	4	0.089	7	0.007
10	2	1.913	4	0.089	6	1.177
11	5	2.615	5	1.685	10	8.497
12	2	1.913	3	0.493	5	4.347
13	4	0.381	4	0.089	8	0.837
14	5	2.615	5	1.685	10	8.497
15	4	0.381	4	0.089	8	0.837
16	3	0.147	4	0.089	7	0.007
17	3	0.147	1	7.301	4	9.517
18	4	0.381	4	0.089	8	0.837
19	3	0.147	3	0.493	6	1.177

20	2	1.913	2	2.897	4	9.517
21	3	0.147	2	2.897	5	4.347
22	3	0.147	4	0.089	7	0.007
23	3	0.147	2	2.897	5	4.347
24	2	1.913	2	2.897	4	9.517
25	3	0.147	3	0.493	6	1.177
26	4	0.381	3	0.493	7	0.007
27	4	0.381	5	1.685	9	3.667
28	4	0.381	4	0.089	8	0.837
29	2	1.913	4	0.089	6	1.177
30	5	2.615	5	1.685	10	8.497
31	3	0.147	4	0.089	7	0.007
32	4	0.381	5	1.685	9	3.667
33	5	2.615	5	1.685	10	8.497
34	2	1.913	4	0.089	6	1.177
35	4	0.381	4	0.089	8	0.837
36	4	0.381	5	1.685	9	3.667
37	5	2.615	5	1.685	10	8.497
38	4	0.381	4	0.089	8	0.837
39	5	2.615	4	0.089	9	3.667
40	4	0.381	5	1.685	9	3.667

41	3	0.147	5	1.685	8	0.837
42	3	0.147	4	0.089	7	0.007
43	2	1.913	2	2.897	4	9.517
44	3	0.147	3	0.493	6	1.177
45	2	1.913	3	0.493	5	4.347
46	5	2.615	5	1.685	10	8.497
47	5	2.615	4	0.089	9	3.667
W	159	59.106	174	57.830	333	195.660
N	47		47		47	
A	5		5			
N*A	235		235			
Mean	3.383		3.702		7.085	
RII	0.677		0.740			
Rank	2		1			
Sum of variances of K1 and K2	116.936					
Variance of total test score	195.660					
K(Number of items)	2					
Cronbach's alpha	0.805					

Table E- 3 Sample excel result, RII and chronbach's alpha result of objective 3, showing the result of the total respondents

Item No	K1	K2	K3	K4	K5	K6	K7	K8	K9	Total
1	3	3	4	5	5	5	5	3	5	38
2	4	5	3	4	5	4	4	5	4	38
3	5	3	5	5	4	3	5	5	5	40
4	4	4	4	4	4	4	4	4	4	36
5	5	3	4	5	5	5	4	5	3	39
6	3	3	3	3	3	3	3	3	3	27
7	2	4	5	5	5	5	3	5	5	39
8	4	4	3	5	3	3	3	3	3	31
9	4	4	4	3	5	4	4	4	5	37
10	5	5	5	4	5	3	4	4	3	38
11	4	4	3	4	4	4	4	3	4	34
12	4	3	4	2	4	4	3	2	3	29
13	3	4	4	4	5	4	4	4	3	35
14	5	4	3	3	5	3	5	3	4	35
15	4	4	3	3	4	4	3	3	3	31
16	5	5	3	5	5	5	4	4	3	39
17	4	5	4	4	4	4	4	4	4	37
18	5	4	4	5	5	5	4	4	4	40
19	5	5	3	5	5	4	4	5	4	40

20	4	5	4	4	4	5	4	3	3	36
21	4	4	4	4	4	3	3	3	4	33
22	5	5	5	5	5	5	5	5	5	45
23	4	5	4	3	5	4	3	4	3	35
24	5	3	4	3	5	5	3	3	3	34
25	5	5	5	5	5	5	5	5	5	45
26	5	4	4	4	5	4	5	4	4	39
27	5	4	4	4	4	3	3	4	4	35
28	5	5	5	5	5	4	4	5	4	42
29	5	5	5	5	5	5	5	5	5	45
30	5	5	4	4	5	5	3	4	4	39
31	4	4	4	4	4	3	5	3	4	35
32	4	3	4	4	4	5	4	3	3	34
33	4	5	5	4	5	5	4	5	2	39
34	4	5	5	3	5	5	5	2	3	37
35	4	5	5	4	5	4	4	3	4	38
36	4	4	4	5	4	3	5	3	4	36
37	5	5	4	4	5	5	3	4	3	38
38	5	5	5	5	4	3	5	5	2	39
39	5	5	4	3	5	5	5	3	4	39
40	3	3	3	3	3	3	3	3	3	27

41	4	5	4	4	4	5	5	5	5	41
42	5	5	5	3	4	3	3	4	3	35
43	5	3	4	5	5	4	4	5	3	38
44	4	5	4	4	4	5	5	3	4	38
45	4	3	5	3	4	5	2	2	3	31
46	5	5	5	4	5	5	4	5	3	41
47	4	4	4	4	4	4	4	4	4	36
W	203	200	193	190	211	196	187	180	173	1733
N	47	47	47	47	47	47	47	47	47	
A	5	5	5	5	5	5	5	5	5	
N*A	235	235	235	235	235	235	235	235	235	
Mean	4.319	4.255	4.106	4.043	4.489	4.170	3.979	3.830	3.681	36.872
RII	0.864	0.851	0.821	0.809	0.898	0.834	0.796	0.766	0.736	
Rank	2	3	5	6	1	4	7	8	9	
Variance	24.213	28.94	22.47	29.91	17.74	30.64	30.98	40.64	30.21	757.23
Sum of variances of K1 up to K9	255.743	255.743								
Variance of total test score	757.230									
K(Number of items)	9									
Cronbach's alpha	0.745									