ADOPTION OF GREEN BUILDING PRACTICES IN PAKISTAN: BARRIERS AND MEASURES

A thesis submitted in partial fulfillment of the

requirements for the degree of

Masters of Science

in

Urban and Regional Planning

By

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Islamabad, Pakistan

(2017)

This is to certify that the

Thesis titled

Adoption of Green Building Practices in Pakistan: Barriers and Measures

Submitted by

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has been accepted towards the partial fulfillment

of the requirements for the degree of

Masters of Science in Urban and Regional Planning

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THESIS ACCEPTANCE CERTIFICATE

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This thesis is dedicated to my parents, my family and my respected teachers!

ACKNOWLEDGMENTS

First of all, I am grateful to ALLAH ALM IGHTY who gave me strength to complete my research work and this degree.

Secondly, I would like to express my sincere gratitude to my respected supervisor, Dr. Malik Asghar Naeem for his all-time help, critical appreciation and for providing me an opportunity to perform research on a study area where our country is lagging far behind. Also, I would like to express my deep and earnest appreciation to Dr. Abdul Waheed, for his wholehearted, ever-available help, technical comments, encouragement and guidance throughout the entire period of this research. I also pay my special regards to Dr. Jamaluddin Thaheem for his valuable suggestions and help during this research. I am also very grateful to practitioners who supported my work by responding to surveys and interviews.

Special and heartiest thanks to my Parents and my family for giving me encouragement and support. Without their moral support, I would not have been able to reach at this point.

(Sana Azeem)

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LIST OF ABBREVIATIONS

BREEAM	Building research establishment environmental assessment method
EPA	Environmental Protection Agency
GBCA	Green building council Australia
GBI	Green building index
GBIG	Green building information gateway
GBT	Green building technology
GMP	Green manufacturing practices
GRIHA	Green rating for integrated habitat assessment
HEIs	Higher education institutions
HVAC	Heating Ventilation and Air Conditioning
LEED	Leadership in energy and environmental design
MV	Mean value
PBRS	Pearl building rating system
PGBG	Pakistan green building guidelines
Sq. ft.	Square foot
WGBC	World Green Building Council

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ABSTRACT

From previous researches, it has been observed that buildings are the prime consumer of world's fresh water and energy. The way buildings are designed and constructed today has immense direct and indirect impact on the environment. Perceiving the worldwide impact of buildings and their construction on the environment; international governments and civil society organizations have been investigating approaches to accomplish greater sustainability of the built environment. This made the movement of green building start that also provoked the creation of green building standard, certification and rating systems. This study reviews the evolution of green building concept at national and global level. But, despite the numerous benefits of green building, this approach came across number of issues influencing its widespread adoption in developing as well as in developed countries. This study aims to investigate the potential barriers inhibiting the adoption of green building in Pakistan and important measures needed to promote green building adoption. These barriers and measures were identified and examined by using a combination of research methods, literature review, questionnaire survey and in-depth interviews with the practitioners working in Pakistan construction industry. Ranking technique and factor analysis were used to identify the significant issues associated with the adoption of green building practices. On the basis of data analysis, framework is developed to promote green building approach in the local context. The findings of this study are expected to contribute valuable information to policy-makers for better understanding of key issues that need more attention. The results are based on the perception of local stakeholders, but might also be helpful for policy makers in other countries.

Chapter 1

1 INTRODUCTION

Purpose of this chapter is to highlight the factors that lead to the section of the research topic. Then, the objectives and research questions have been defined on which the research will be based. Moreover, it includes the benefits of the research study and the chapters that makeup the thesis.

Buildings are made to protect human beings from unwanted effects of nature, however, construction also has a large environmental footprint. One sixth amount of world's fresh water is consumed in buildings with one-fourth of the wood harvesting and two-fifth of matter and energy and similar amount of greenhouse gas emissions (Alshuwaikhat et al., 2008; Council, 2008). Global carbon emission is expected to reach 42.4 billion ton by 2035, which is 44.3% increase in the 2007 level (Darko et al., 2017). Methods that are used to design and construct buildings today, have a great impact on their operating cost. This way of building construction will not only have an impact on present patterns of energy consumption and environmental degradation, but it will have immense direct and indirect impacts on our future generations (H. H. Ali et al., 2009).

To overcome this condition, there is a need to construct such buildings which have minimal effects on surrounding environment and on human health. The edge at which we have brought Mother Nature in our blind run of development is enormously critical. Only a complete green solution can save our present and future, which is in form of 'green buildings'. Green buildings help to design and construct buildings, which are healthier as well as resource efficient throughout their life span (Chan et al., 2009). Green building revamps the traditional non-green method of construction by using special building techniques, practices and materials that help to achieve sustainability (Darko et al., 2017). Various environmental, social and economic benefits are observed by going green. The advantages of green building incorporate cost savings from lessened energy, water, and waste; bring down operations and maintenance costs; and upgraded occupant productivity and wellbeing (Kats, 2003). In the construction industry, green building technologies have gained wide acceptance worldwide. Innovative green building technologies such as high efficient HVAC system, green roofs, high efficient double glazed windows, solar shading devices, solar water heaters and gray water treatment have grown over the last decade (Darko et al., 2017). This is because the concern for green building has been increased over the past decade which in turn gave rise to the need of assessment, rating or certification tools. The purpose of green building rating systems is to examine the life cycle performance of a 'whole building' and to compare it with performance standards (Fowler et al., 2006). LEED-USA, BREEAM-UK, Green Star-Australia, GBI-Malaysia, Green Globes etc. are some of most well-known standards used all around the world. LEED is the most recognized rating system mainly used in USA and Canada, and now extended to include Mexico, India, Brazil, Emirates, etc. BREEAM is the Building Research Establishment Environmental Assessment Method that mainly operated in UK and part of Europe including Netherlands, France, Spain, Germany, Sweden, Poland, Norway, Russia, etc. GREEN STAR is the environmental assessment method used to evaluate the life cycle performance of buildings and communities being operated in Australia and New Zealand and south Africa (Mak et al., 2014).

Although in third world countries, this sustainable design approach is quite newer but in the recent years, a considerable success has been observed towards this approach. Unfortunately, Pakistan is in the list of those countries where green building approach is not getting due attention.

Currently, Pakistan is facing a number of environmental challenges. It is going through water scarcity, shortfall of electricity, poor industrial conditions, economic slumps, rapid pace of urbanization, poverty and depletion of natural resources (Sohail and Qureshi, 2010). Pakistan has been a victim of severe energy crisis over the last few years (Ahmed et al., 2014; Javaid et al., 2011). Pakistan has a sunny hot climate as it is situated on latitudes between 24˚N and 35˚N. Due to this weather condition, demand of energy in cooling of buildings is very high (Sohail and Qureshi, 2010). It is in the list of those countries that largely depend on thermal sources and generate most of their electricity from non-renewable sources. This practice is creating severe environmental problems along with the rapid consumption of precious sources of energy (Sohail and Qureshi, 2010). In this shortfall of electricity, there is a need to change traditional construction practices and move towards energy efficient buildings having a potential to save up to 30% (Ahmed & Iftikhar-ul-Husnain, 2014; Zainordin et al., 2012). Green designs help to reduce solid waste generation by 70% and water consumption by 40% along with 39% reduction in carbon dioxide emissions (Aslam et al., 2012).

1.1 Problem Statement

Construction industry has a significant share in the contribution of GDP in the developed as well as developing part of the world (Farooqui et al., 2008). In comparison with any other infrastructural project or product type, building sector alone is the largest consumer of electricity and natural resources. Being a third world country, Pakistan has faced numerous environmental, social and economic challenges. Currently, it is going through water scarcity, shortfall of electricity, poor industrial conditions, economic slumps, rapid paced urbanization, poverty and depletion of natural resources (Sohail and Qureshi 2010). A Green building can help fight battle against these issues. In developing countries including Pakistan, this green development suffers with many market barriers, despite its numerous benefits for the society. The purpose of this research is to investigate the key reasons due to which green buildings approach is not getting due attention in Pakistan. Objectives of this research are to review the evolution of green building concept at global and national level, to observe the dimensions of certified green buildings in Pakistan and to examine the barriers to and measures for adopting green buildings in Pakistan and then suggesting a framework for promoting these practices in our country.

1.2 Advantages

The findings of this research are expected to contribute valuable information to decision-makers for better understanding of key issues that call for more attention in the promotion of efforts of green building practices in Pakistan. It would be helpful for the construction industry-related practitioners working in Pakistan, regulatory authorities, government and public to understand major barriers and measures needed to promote the adoption of this concept. The results are based on the perception of local stakeholders, yet can help policy makers in other countries.

1.3 Research Objectives

1. To review the evolution of green building concept at global and national level
2. To observe the dimensions of certified green buildings in Pakistan
3. To examine the barriers to and measures for the adoption of green building practices in Pakistan
4. To suggest a framework for promotion of green buildings in Pakistan

1.4 Research Questions

1. What are green building rating systems used across the globe and at national level?
2. What are the dimensions of green buildings identified in various rating systems?
3. Which dimensions of green buildings are being observed in Pakistan?
4. What is the perception of key stakeholders about the barriers to and measures for adoption of green building practices in Pakistan?
5. What could be a practical framework for promotion of Green buildings in Pakistan?

1.5 Research/ Thesis Organization

Chapter 1 provides general introduction of green buildings, problem statements, advantages, research objectives and research questions. Chapter 2 presents the literature review in the light of the research study topic and research objectives. Chapter 3 is the research methodology sheds lights on the entire process of the research, selecting the study design, sample size, selection of instrument for data collection and data analysis techniques. Chapter 4 includes data collection and analysis. Chapter 5 includes findings and discussions while Chapter 6 includes conclusion and future research. At the end, references for the research study are provided.

__Chapter 2__

2 LITERATURE REVIEW

Purpose of this chapter is to highlight the concept of green building and green building rating systems along with brief introduction of Pakistan Green Building Council. Worldwide barriers inhibiting the adoption of green building and measures to promote the adoption of green buildings are also discussed in this chapter.

2.1 Concept of Green Building

Studies reflect that buildings have substantial degree of commitment in contaminating the environment. Buildings oversee roughly half of carbon emissions in U.S. along with 65.2% of total electricity consumption, 30% of greenhouse gas emissions, 136 million tons of construction and demolition waste and 12% of potable water (Council, 2008). The edge to which Mother Nature has been brought in our blind run of development is enormously critical. Only a complete green solution can save our present and future which is in the form of ‘green buildings’. For this purpose, there is a need to design such buildings that have minimum impacts on their surrounding environment. “Green buildings” are designed to reduce the overall impact of built environment on human health and the natural environment (Chan et al., 2009).

2.1.1 Definition of Green Buildings

Green building is the foundation of sustainable development. It makes efficient use of natural resources during design, construction, operation, maintenance and demolition phases (Kasai et al., 2014).

Definition of green building is constantly evolving. Environmental Protection Agency (EPA) defines green building as follows:

"The practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or 'high performance' building".

2.2 Sustainable Development and Green Building Nexus

Green building is a key pillar of sustainable development. key principles of green buildings are sustainable site planning, building design optimization, renewable energy utilization, waste and solid waste management, sustainable building material and construction technology, Health, wellbeing and environmental quality (Bowyer, 2008). Green building also has a significant potential in achieving several sustainable development goals (WGBC) shown in Figure 2.1.

Figure 2.1 Green Building and Sustainable Development Goals Nexus

- Green building design ensures healthy lives and promote wellbeing for all at all ages through building life cycle.
- Green building design ensures access to affordable, reliable, sustainable and modern energy for all.
- Promote inclusive and sustainable economic growth, employment and decent work for all.
- Build resilient infrastructure, promote sustainable industrialization and foster innovation.
- Make cities inclusive, safe, resilient and sustainable.
- Ensure sustainable consumption and production patterns.
- Take urgent action to combat climate change and its impacts.
- Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.
- Revitalize the global partnership for sustainable development.

2.2.1 Principle of Sustainable Construction

As green building leads to sustainable environment, therefore, it is important to highlight the key principles of sustainable construction. Seven principles of sustainable construction have been cited in (Kibert, 2016) which are; Reduce resource consumption (reduce), Reuse resources (reuse), Use recyclable resources (recycle), Protect nature (nature), Eliminate toxic materials (toxins), Apply life-cycle costing (economics) and Focus on quality (quality). These principles not only serve as guidelines not only in design and construction phase but also support the decision making process during the life cycle of a building.

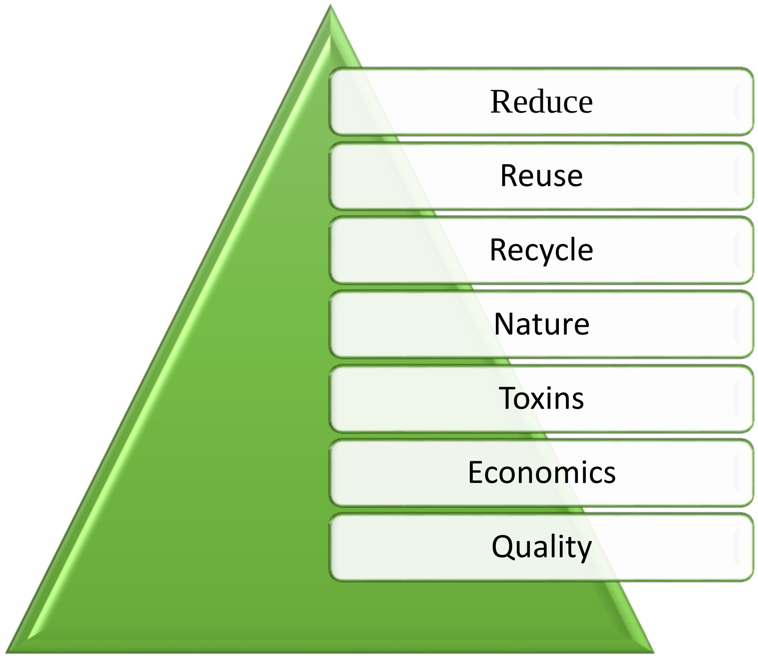

Figure 2.2 Principles of Sustainable Construction

2.3 Green Building Rating System

Due to various climatic and environmental challenges, the concern for green building is being increased worldwide. As a result, there has been a rapid increase in the development of various rating system, assessment tools and methods for sustainable or green development. These rating tools use hierarchical criteria systems to evaluate the sustainability of buildings (Hiete et al., 2011). During the recent years, these building environmental assessment tools have become common and have attracted the construction sector for their numerous benefits (Sev, 2011). As revealed in the literature, environmental assessment tools have become compulsory items in today's construction industry. Researchers used some of the common terms to explain the rating system e.g. building environmental assessment tools, sustainable building assessment systems, building performance assessment methodologies and green building rating systems (WaidyaseNara et al., 2013). Although all the above-mentioned terms have similar meaning but this research is focused on buildings rather than environment and rating system rather than assessment. Therefore, the term “Green Building Rating System” is used in this research.

Many Building Evaluation tools have been established worldwide. These tools focus on various parts of sustainable development and are designed per the project. These tools not only focus on design and construction phase but also include building life cycle assessment i.e. performance evaluation after regular time period, operation and maintenance optimization, indoor environmental quality, energy system design and life cycle costing (WaidyaseNara et al., 2013). The purpose of green building rating systems is to examine the life cycle performance of a ‘whole building’ and to compare it with performance standards (Fowler & Rauch, 2006).

2.3.1 Criteria System Vs. Life Cycle Assessment System

Two types of assessment tools are developed for building sector. One is criteria based system while the other is life cycle assessment methodology.

- In criteria based system point values are allocated according to the scale. LEED; GBTool; BREEAM; EcoProfile (Norway)-Byggforsk (2005) and Environmental status (Sweden)-Miljöstatusföreningen (2005)
- In life cycle assessment tool, weighting method is used. Major aim of this system is to select building design, building material and local utility options during design phase Bees (USA)-OAE (2004); Beat (Denmark)-DBRI (2005); EcoQuantum (Netherlands) and KCL Eco (Finland)-KCL (2005) are included in this category (H. H. Ali & Al Nsairat, 2009).

Although due to increasing understanding of sustainable development many assessment tools have been developed worldwide. However, there are only few evaluation tools that succeeded to set a recognizable standard in this run (Fowler & Rauch, 2006). BREEAM is the world's longest established environmental assessment methodology. It was developed in United Kingdom in 1990 by building research established global ltd (Say et al., 2008). The US Green building council was established as a non-profit organization in 1993. The council is made up of group of stakeholders including engineers, designers, architects, contractors, owners, product manufacturers and environmentalists from construction industry. To change the traditional way of building construction, US green building council established LEED in 1998 under a pilot version (Say & Wood, 2008).

2.4 Green Buildings in Pakistan

According to GBIG, Pakistan contains 10 LEED certified green buildings and 10 registered with US Green Building Council and 1 with achiever award, making a list of 21 total green buildings in country as shown in Table 2.1:

NO	GREEN BUILDING PROJECT NAME	SPACE TYPE	CERTIFICATION TYPE AND YEAR
1.	NCC Karachi , Pakistan	Federal Government / U.S. Department of State Office / 78,600 sq. ft.	LEED for New Construction 2.2 Silver certified on 06/30/2014 (33/69 points)
2.	Artistic Milliners Pvt Ltd, Karachi	Artistic Milliners (Pvt) Ltd Industrial Manufacturing / 483,299 sq. ft.	LEED for New Construction 2009 Gold certified on 10/23/2014 (66/110 points)
3.	Coca-Cola Icecek as Multan Plant	Coca-Cola Icecek AS Industrial Manufacturing / 230,648 sq. ft.	LEED for New Construction 2009 Silver certified on 06/07/2016 (52/110 points)
4.	Artistic Garment Industries Pvt Ltd, Karachi	Artistic Garment Industries (PVT) LTD Industrial Manufacturing / 159,710 sq. ft.	LEED for New Construction 2009 Silver certified on 09/14/2016 (56/110 points)

5.	Citibank Dolmen Karachi	Citibank Pakistan Retail / 14,500 sq. ft.	LEED Commercial Interiors 2009 Gold certified on 07/16/2016 (65/110 points)
6.	SIKA Pakistan Ad-Mix Plant, Lahore	Industrial Manufacturing/ 50,550 sq. ft.	LEED for new construction 2009 Gold certified on 03/23/2017 (65/110 points)
7.	Artistic fabric and garment industries, Karachi	Industrial Manufacturing/ 599,980 sq. ft.	LEED v4 O+M EB Gold certified on 01/03/2017 (72/110 points)
8.	British council library, Lahore	Public Assembly/ 5,121 sq. ft.	LEED for New Construction 2009 Gold certified on 01/13/2017 (65/110 points)
9.	Sapphire Fibres Limited Denim Division, Lahore	Industrial Manufacturing/ 153,146 sq. ft.	LEED for New Construction 2009 Gold certified on 03/02/2017 (63/110 points)
10.	Kohinoor City Hospital, Faisalabad	Kohinoor Planet Constructions Pvt Ltd./ 208,614 sq. ft.	LEED India NC Platinum Certified on 01/01/2009
11.	ASTOLA, Karachi	Industrial Manufacturing / 689,260 sq. ft.	Registered for LEED for New Construction 2009 on 08/31/2016
12.	Mega Corporate Office Tower	Office/ 230,414 sq. ft.	Registered for LEED Core & Shell 2009 on 01/03/2013
13.	TAIGA APPAREL PVT LTD	Industrial Manufacturing / 254,455 sq. ft.	Registered for LEED for New Construction 2009 on 05/23/2016
14.	World Bank Group Country HO, Islamabad	The World Bank Group Office / 55,000 sq. ft.	Registered for LEED v4 BD+C NC on 02/24/2016
15.	Soorty Green Factory in Karachi	Soorty Enterprises (Pvt.) Ltd Industrial Manufacturing / 500,000 sq. ft.	Registered for LEED for New Construction 2009 on 11/14/2014
16.	Soorty Green Factory Unit-13 'Nooriabad'	Soorty Enterprises (Pvt.) Ltd Industrial Manufacturing / 480,000 sq. ft.	Registered for LEED for New Construction 2009 on 03/17/2015

17.	NEC - Islamabad - Master Site	Federal Government / U.S. Department of State - OBO Office / 1,191,846 sq. ft.	Registered for LEED for New Construction 2009 on 03/31/2011
18.	NEC - Islamabad - NOB/NOX	Federal Government Office / 457,260 sq. ft.	Registered for LEED for New Construction 2009 on 03/31/2011
19.	NEC - Islamabad - CSX	Federal Government Office / 147,627 sq. ft.	Registered for LEED for New Construction 2009 on 03/31/2011
20.	NEC - Islamabad - SDA	Federal Government/ Multi-Family Residential/ 586,959 sq. ft.	Registered for LEED for New Construction 2009 on 03/31/2011
21.	Colgate-Palmolive: Pakistan - Karachi	Energy Star Challenge for Industry	Achiever (2010-2014) 11.2% improvement achieved

Table 2.1 Green Buildings in Pakistan

2.5 Worldwide Barriers to the Adoption of Green Building Practices

As one of the critical component, this study reviews the previous literature on green buildings. This review helps to identify barriers and measures to promote green building practices.

Adoption of green building practices, despite its numerous benefits, faces many challenges. Researchers in many countries have conducted studies to identify various potential barriers faced by construction sector in the implementation of green building practices. Samari et al. (2013) surveyed 167 professionals in Malaysian construction industry to investigate the barriers in developing Green building in the country. Top four most important barriers identified in the author's study are: 'lack of credit resources to cover upfront cost, risk of investment, lack of demand as well as higher final price'. Bohari et al. (2016) discovered that the barriers related to early adoption of green building practice in Malaysia are 'low level of awareness/ knowledge, lack of availability of green building codes and guidelines on the execution of green construction. According to Williams et al., (2007), the key barriers include stakeholder having little to no power to enforce sustainable measure, stakeholder either not included or included too late in the development process to implement sustainability measure and also, sustainable measure was allowed by the regulator or statutory undertaker.

One of the most relevant study in this field was conducted by (Ametepey et al., 2015) to identify significant barriers to successful implementation of sustainable construction in the Ghanaian construction industry. Five strongest barriers identified in this study are 'cultural change resistance', 'lack of government commitment', 'fear of higher investment costs', 'lack of professional knowledge', and 'lack of legislation respectively'. AlSanad (2015) conducted a research trying to identify key barriers of sustainable construction in a country like Kuwait, where the green idea is a new model. Barriers revealed in this study are 'no existing rule in Kuwait to adopt green building', 'lack of qualified staff', 'fewer developers undertake green building projects', 'lack of clear benefits of green building', 'risk associated with implementation of new projects and economic condition'. Persson et al. (2015) found that 'fear of hidden costs', 'lack of policy instruments and building codes', 'lack of awareness', 'non-supporting attitude of end users towards energy efficiency', 'lack of life cycle cost perspective' are some of the barriers for the implementation of energy efficient houses in Sweden. A. N. A. Ali et al. (2016) argued that main barriers in Kota Kinabalu construction industry from contractor's perspective are 'lack of availability of codes and standards supporting green construction', 'lack of information and education', 'cost versus benefit issue', 'difficulty in breaking the existing building/construction tradition', 'lack of skill or capacity to carry out work' and 'lack of government support'.

Kasai et al. (2014) studied two Brazilian engineering schools. Main barriers diagnosed in this research are: 'lack of availability of scientific research and literature on green buildings', 'lack of a technical standard for green building in Brazilian HEIs', 'lack of skilled and specialized jobs in green construction', 'cultural barriers and resistance in face of the changes imposed by sustainability requirements at HEIs'. The study conducted by (Richardson et al., 2007) indicated that 'lack of financial incentives for reducing building maintenance costs', 'lack of indicators for evaluating how sustainable a building is', 'high startup capital investment', 'technical level and innovation among architects, designers and engineers is less than desirable in terms of environmental issues' and 'communication breakdown between members of institution' can be considered as the main barriers leading to the failure of green building implementation at HEIs.

Wang et al. (2016) studied some key barriers to the implementation of energy efficient technologies in china's public hospitals and health care facilities. They found that 'High operating costs and maintenance fees for energy-efficient technology', 'A lack of professional staff resources and enterprise for implementing and assessing energy conservation', 'Challenges of new equipment in the design and construction process', 'Incompatibility of the new technologies in the existing buildings', 'Low energy costs, improper pricing methods', 'A lack of awareness of the individual's role in saving energy' and 'A lack of projects with demonstrable success are some main barriers.

Another research was carried out by (Ghazilla et al., 2015) on barriers faced in implementing green manufacturing practices, specifically in Malaysia. Barriers identified in his work are 'Weak organizational structure to support GMP', 'Inadequate design and testing within the organization to support GMP', 'Lack of empowerment to support GMP', 'Restrictive company policies towards products/process stewardship for GMP', 'Limited resources which affect the organization's ability to adopt new GMP practices', 'Lack of flexibility in the manufacturing process with regards to implementing GMP' and 'Supply barriers (difficulties in obtaining green technological information, raw materials and finance)'. Azad et al. (2015) conducted a research to find out "The Impediments in Construction of Sustainable Buildings in Pakistan". Results of author's study shows 'Lack of credit resources to cover upfront cost', 'risk of investment', 'Lack of training/education in sustainable design/construction', 'lack of demand' and 'lack of governmental support and higher upfront cost (new design, technology and construction method)'are the main impediments to sustainable building development in Pakistan.

Tendency to maintain current practices, lack of sustainable material information, perception of higher cost and extra time being incurred and lack of comprehensive tools and data to compare material alternatives are some more barriers identified by (Ahn et al., 2013; Akadiri, 2015; Attaran et al., 2015; Dahle et al., 2001; Hopkins et al., 2016; Timilsina et al., 2016).

2.6 Measures to promote green buildings

As green building approach is facing several impediments in the construction industry, researchers from all over the world conducted number of studies based on the measures and strategies needed to promote green building practices. Awareness among general public and stakeholders towards green technology through discussions, seminars, training and workshop is one of the most substantial measure adopted to promote this concept (AlSanad, 2015; Dahle & Neumayer, 2001; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Samari et al., 2013; Wang et al., 2016). Incentives from government in the form of soft loan, allowances or tax exemption on green building compared to other building is also very important to promote green practices (Ametepey et al., 2015; Dahle & Neumayer, 2001). A wide range of internationally recognized green building rating tools such as LEED, BREEAM, Green star etc. have been developed for the practitioners to get better understanding of green building approach. Easy accessibility of these assessment tools is essential for the promotion of green building practices (Darko et al., 2017). According to (Qian et al., 2010) mandatory regulations and policies along with effective enforcement are also very helpful in promoting green building practices.

3 RESEARCH METHODOLOGY

This chapter describes in brief the research design, types of data collection, sample size, methodology to conduct the research and different types of data analysis techniques to attain the objectives. Figure 3.1 explains the entire procedure

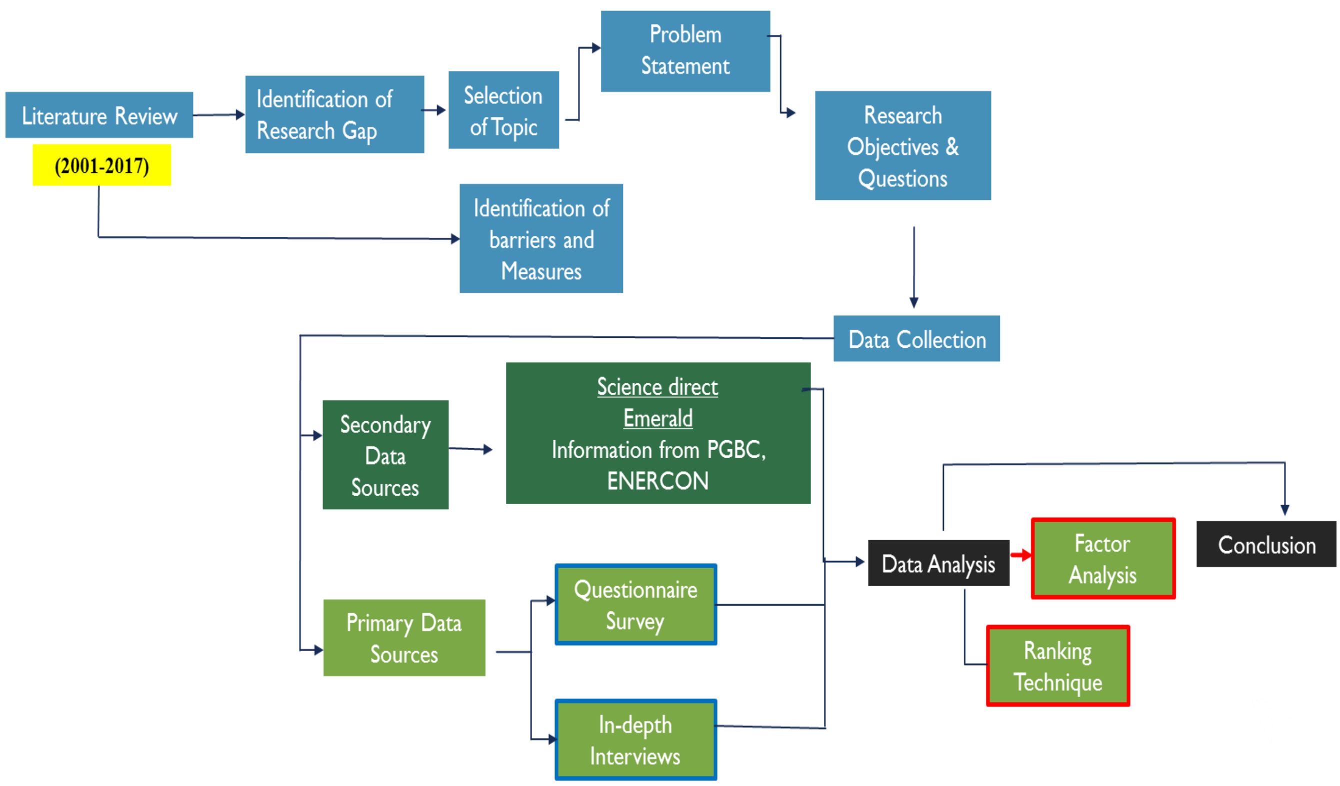

Figure 3.1Research Methodology

3.1 Research Design

Mixed method research design is used for the current study since it is descriptive as well as exploratory research. Descriptive research is applied to describe the features of six internationally recognized green building assessment tools along with the dimensions of certified green buildings observed in Pakistan. Whereas exploratory research is applied to examine the perception of key stakeholders about the barriers to and measures for green buildings in Pakistan. Since the key objective of this research is to understand, what are the barriers to and measures for Green Buildings in Pakistan, it is decided that the most appropriate way to obtain in-depth information is to carry out a quantitative and qualitative method research by collecting empirical data directly from the concerned authorities. The research adopted multi-dimensional design strategy that involves a variety of approaches (qualitative and quantitative). These approaches include questionnaire survey technique and in-depth interviews.

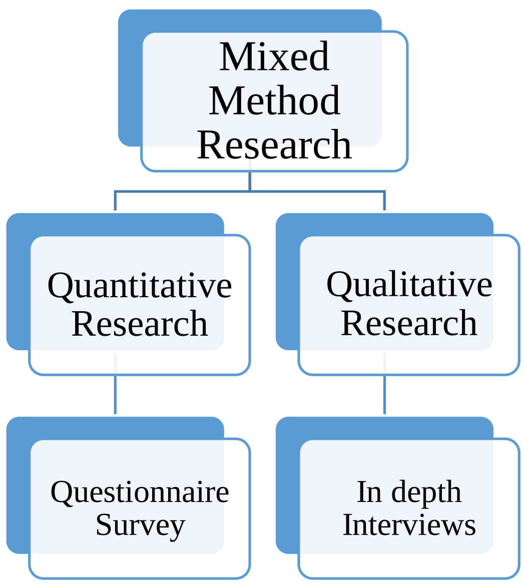

Figure 3.2 Research Approach

3.2 Data Collection

The current study adopts literature review, questionnaire survey technique and in-depth interviews as its main method of data collection.

3.2.1 Secondary Data

Secondary data related to internationally known green building rating tools, certified and registered green buildings in Pakistan and list of worldwide barriers and measures for green buildings is collected from various sources including published reports, articles, papers, journals, manuals, information from concerned departments and from the green building information gateway.

3.2.2 Primary Data

Primary data such as dimensions of green buildings observed in Pakistan is collected from green building information gateway and respective building's management through electronic means. Whereas data related to the perception of key stakeholders about barriers to and measure for green buildings in Pakistan is collected through questionnaire survey technique and in-depth interviews.

3.2.2.1 Questionnaire design

As a systematic method of data collection, questionnaire survey technique has been broadly used to solicit the professional opinions. This questionnaire survey technique has been a popular method in the green building literature as well to examine the issues influencing the adoption of green practices. Thus, to examine the issues related to green building, a questionnaire survey was conducted in the construction industry of Pakistan. Questionnaire prepared for this study consist of three major sections. The first part consisted on the personal information of respondents. Second part was based on potential barriers identified through extensive literature review and third part had list of measures needed to promote green building practices. It had both, closed and open-ended questions. Participants were asked to rank barriers on a scale of 1-5 based on their importance, where 1 is for 'not important' and 5 signifies 'very important'. Measures were also scored on a similar scale shown in Annexure. The five-point Likert scale was selected since it gives explicit results, easy to interpret (Darko et al., 2017). Prior to questionnaire survey, a pilot study was conducted to test the comprehensiveness and relevance of the questionnaire (AlSanad, 2015). The pilot study involved four professors and two postgraduate researchers, who were experienced in this research area. The questionnaire was finalized based on feedbacks received from the pilot study.

3.2.3 Sample Size

The sample size designated for this research consisted of a group of 103 stakeholders working in recognized organizations from different fields; Architecture, Environment, Town planning, Development, Contractors, Interior design, Engineering, Research/Academics and Pakistan green building council. Snowball and purposive or judgmental sampling techniques were used to get data.

Interviewees were selected on the basis of their knowledge and experience in green building approach. Other than questionnaire survey, seven in-depth interviews were carried out with key stakeholders working with Pakistan green building council, National energy conservation center, Atomic energy and a few private organizations working on green projects. The objective of in-depth interviews was to triangulate the questionnaire survey results and to find out the stakeholder’s views regarding barriers to and measures for adoption of green building practices in Pakistan. Every session was started by taking the interviewees response on the questionnaire based on barriers and measures.

3.3 Data Requirements

Extensive literature review is carried out in order to identify significant barriers inhibiting the adoption of green building and measures needed to promote this approach, which varies across globe. On the basis of extensive literature review, a list of 30 barriers was identified as shown in Table 3.1.

Code	**Barriers**	**Key References**
B01	High initial investment, long payback period	(Ahn et al., 2013; Akadiri, 2015; A. N. A. Ali et al., 2016; AlSanad, 2015; Ametepey et al., 2015; Attaran & Celik, 2015; Azad & Akbar, 2015; Bohari et al., 2016; Ghazilla et al., 2015; Hopkins & Hopkins, 2016; Persson & Grönkvist, 2015; Richardson & Lynes, 2007; Samari et al., 2013; Timilsina et al., 2016; Wang et al., 2016; Williams & Dair, 2007)
B02	Lack of incentives from government	(A. N. A. Ali et al., 2016; AlSanad, 2015; Ametepey et al., 2015; Azad & Akbar, 2015; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Samari et al., 2013; Timilsina et al., 2016; Wang et al., 2016)
B03	Lack of green building codes and regulations	(Akadiri, 2015; A. N. A. Ali et al., 2016; Ametepey et al., 2015; Azad & Akbar, 2015; Bohari et al., 2016; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Samari et al., 2013; Wang et al., 2016; Williams & Dair, 2007)
B04	Poor implementation of laws and legislations	(AlSanad, 2015; Ametepey et al., 2015; Azad & Akbar, 2015; Bohari et al., 2016; Ghazilla et al., 2015; Wang et al., 2016)
B05	Disbelief regarding the benefits of green buildings	(Akadiri, 2015; A. N. A. Ali et al., 2016; AlSanad, 2015; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Timilsina et al., 2016; Wang et al., 2016)
B06	Lack of availability of case studies building	(Ametepey et al., 2015; Azad & Akbar, 2015; Ghazilla et al., 2015; Samari et al., 2013; Wang et al., 2016)
B07	Higher functioning costs and maintenance fees for green buildings	(Akadiri, 2015; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Wang et al., 2016)
B08	Lack of awareness among people about the importance & advantages of adopting green building practices	(Ahn et al., 2013; A. N. A. Ali et al., 2016; AlSanad, 2015; Ametepey et al., 2015; Attaran & Celik, 2015; Azad & Akbar, 2015; Bohari et al., 2016; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Samari et al., 2013; Timilsina et al., 2016; Wang et al., 2016)
B09	Lack of professional knowledge	(Ahn et al., 2013; A. N. A. Ali et al., 2016; Ametepey et al., 2015; Azad & Akbar, 2015; Bohari et al., 2016; Kasai & Jabbour, 2014; Samari et al., 2013; Wang et al., 2016; Williams & Dair, 2007)
B10	Lack of end user support	(Bohari et al., 2016; Persson & Grönkvist, 2015; Williams & Dair, 2007)

B11	An unsustainable measure is allowed by the regulator or statutory undertaker	(Williams & Dair, 2007)
B12	Lack of financial resources	(Ametepey et al., 2015; Ghazilla et al., 2015; Richardson & Lynes, 2007; Wang et al., 2016)
B13	Lack of support and guidance from regularity authority on green practices	(A. N. A. Ali et al., 2016; Ametepey et al., 2015; Azad & Akbar, 2015; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Samari et al., 2013; Timilsina et al., 2016; Williams & Dair, 2007)
B14	Lack of availability of environmentally sustainable materials	(A. N. A. Ali et al., 2016; Ametepey et al., 2015)
B15	Lack of indicators for evaluating how sustainable a building is	(Ametepey et al., 2015; Richardson & Lynes, 2007)
B16	Lack of demands for sustainable products	(Ametepey et al., 2015)
B17	Cultural change resistance	(Akadiri, 2015; A. N. A. Ali et al., 2016; AlSanad, 2015; Ametepey et al., 2015; Ghazilla et al., 2015; Kasai & Jabbour, 2014)
B18	Lack of qualified staff	(A. N. A. Ali et al., 2016; AlSanad, 2015; Kasai & Jabbour, 2014; Persson & Grönkvist, 2015; Timilsina et al., 2016; Wang et al., 2016)
B19	Risk associated with implementation of new practices	(AlSanad, 2015)
B20	Weak market demand	(Azad & Akbar, 2015; Ghazilla et al., 2015; Persson & Grönkvist, 2015)
B21	Technical level and innovation among architects, designers and engineers is less than desirable in terms of environmental issues	(Ghazilla et al., 2015; Richardson & Lynes, 2007)
B22	Improper communication structure to support green building practices	(Ghazilla et al., 2015; Richardson & Lynes, 2007)
B23	Challenges of innovative equipment in design and construction method	(Ghazilla et al., 2015; Wang et al., 2016)
B24	Weak organizational structure to support Green building practices	(Ghazilla et al., 2015)
B25	Poor management and/or lack of staff time for implementing green practices	(Akadiri, 2015; Attaran & Celik, 2015; Dahle & Neumayer, 2001; Ghazilla et al., 2015; Hopkins & Hopkins, 2016)
B26	Complexity of design to support green practices	(Azad & Akbar, 2015; Ghazilla et al., 2015)
B27	Lack of technology	(A. N. A. Ali et al., 2016; Ametepey et al., 2015; Azad & Akbar, 2015; Ghazilla et al., 2015; Kasai & Jabbour, 2014; Samari et al., 2013)
B28	Lack of technical expertise	(Azad & Akbar, 2015; Ghazilla et al., 2015; Timilsina et al., 2016)
B29	Lack of technical training/education in green building design and construction	(Azad & Akbar, 2015)
B30	Green building/material is esthetically less pleasing	(Akadiri, 2015)

Table 3.1 Worldwide Barriers in the Adoption of Green Building

A list of 12 potential measures needed to promote the adoption of green building practices has been identified from extensive literature review shown in Table 3.2.

Code	Measures	Key References
M01	Promotion of successful green building practices as case examples	(Ghazilla et al., 2015)
M02	Education on new green technologies should be a part of organizational training	(AlSanad, 2015; Ghazilla et al., 2015; Samari et al., 2013)
M03	Easy accessibility of green building rating/assessment tools	(Darko et al., 2017)
M04	Organizational belief of long term benefits through green building practices	(Ghazilla et al., 2015)
M05	Availability of comprehensive training and education in green building technologies for engineers, developers and policy makers	(Ghazilla et al., 2015; Persson & Grönkvist, 2015)
M06	Availability of green building codes and regulations (Mandatory to apply)	(Ametepey et al., 2015; Darko et al., 2017; Qian & Chan, 2010)
M07	Financial incentives and penalties from the government (e.g. tax, soft loan) for green building practices	(AlSanad, 2015; Ametepey et al., 2015; Bohari et al., 2016; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Samari et al., 2013; Wang et al., 2016)
M08	Creation of public awareness towards green initiatives through seminars, workshops and discussions	(AlSanad, 2015; Dahle & Neumayer, 2001; Darko et al., 2017; Ghazilla et al., 2015; Persson & Grönkvist, 2015; Samari et al., 2013; Wang et al., 2016)
M09	More publicity of green building through television programs, internet, newspaper and radio	(Darko et al., 2017)
M10	Pressure from external and internal stakeholders towards green development	(Ametepey et al., 2015; Ghazilla et al., 2015; Samari et al., 2013)
M11	Government should provide funding and regulatory incentives for green construction development	(Ametepey et al., 2015)
M12	Availability of institutional framework for effective implementation of green building guidelines	(Darko et al., 2017)

Table 3.2 Measures Adopted to Promote Green Building Practices Worldwide

3.4 Data Compilation and Analysis

Collected data was analyzed using Microsoft Office and Statistical Package for the Social Sciences (SPSS). SPSS software was used to perform statistical analysis of the data collected from questionnaires. The methodologies used were Descriptive Statistics, Ranking technique and Factor analysis.

3.4.1 Descriptive Statistics

Descriptive Statistics were used to describe the characteristics of participants and variables. Collected data was analyzed using frequencies, percentages and means. Results of these analyses were presented graphically using tables, bar charts etc.

3.4.2 Ranking Technique

Ranking technique was used to rank barriers and measures based on mean item scores and standard deviation. The mean score ranking technique is very popular and has been broadly used in other green building related studies to rank and determine the key factors among several individual factors (Darko et al., 2017)

3.4.3 Factor Analysis

Factor analysis was performed on barriers. It has been done for better interpretation of factors/barriers, as factor analysis is employed to assemble large number of interrelated variables into comparatively small number of factors through SPSS software (Ametepey et al., 2015). Various tests were performed to examine the appropriateness of factor analysis to the factor extraction. The KMO measure and Bartlett's test of sphericity were conducted in this research.

4 DATA COLLECTION AND ANALYSIS

This chapter describes the data collection, analysis and results obtained from literature review, questionnaire survey and in-depth interviews in detail. In the first stage, key parameters of green building rating systems are analyzed. In second stage, data gathered from certified green buildings observed in Pakistan is discussed. In third stage, perception of key stakeholders about the barriers to and measures for the adoption of green building practices in Pakistan is examined.

4.1 Analysis of key parameters of Green building rating systems

As one objective of this research was ‘to review the evolution of green building concept and rating system’, therefore six internationally recognized rating systems have been selected i.e. BREEAM, LEED, Green Star, Estidama, GBI and GRIHA along with Pakistan green building guidelines. Although, the research identified several other rating systems and those are well-known in construction industry, but due to inconsistency of evaluation criteria and for want of authorization to download, some rating systems could not be considered for the analysis. For example, CASBEE Japan and Green Globes-Canada.

Key parameters of these rating systems are shown in table-4.1.

	BREEAM	LEED	Green Star	Pearl, Estidama	GBI	GRIHA
Background	U.K. Building Research Establishment; 1990	U.S. Green Building Council;1998	Green Building Council Australia; 2002	Abu Dhabi Urban Planning Council;2008	Malaysian Institute of Architects and Association of Consulting Engineers; 2009	TERI and Ministry of New and Renewable Energy;2007
Building Phases	Design, Construction and Operation	Design, Construction and Operation	Design, Construction and Operation	Design, Construction and Operation	Design, Construction and Operation	Design, Construction and Operation
Building types	Courts Eco homes Industrial units Prisons Offices Retail Schools Neighborhood	Offices Homes Neighborhood Development Schools Retail Healthcare	Education Healthcare Industrial Multi-residential Office Office Interiors Retail Center	Offices Retail Multi-residential Schools	Multi-residential Industrial Township Schools Healthcare Interiors	Institutions Commercial Residential
Scope	New construction, Refurbishment, Existing Buildings	New construction, Refurbishment, Existing Buildings	New construction, Refurbishment, Existing Buildings	New Construction, Existing Buildings	New Construction, Existing Buildings	New Construction

Categories	Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use and Ecology, Pollution, Innovation (additional)	Location and Transport, Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation, Regional Priority	Management, Indoor Environmental Quality, Energy, Transport, Water, Materials, Land use & Ecology, Emissions, Innovation	Integrated Development Process, Natural Systems, Livable Buildings, Precious Water, Resourceful Energy, Stewarding Materials, Innovating Practices	Energy Efficiency, Indoor Environmental Quality, Sustainable Site, Planning and Management, Material and Resources, Water Efficiency, Innovation	Site Planning, Building Planning and Construction Stage, Building Operation and Maintenance, Innovation
Rating	**Pass- $\geq$30 Good- $\geq$45 Very Good- $\geq$55 Excellent- $\geq$70 Outstanding- $\geq$85**	**Certified 40-49 Silver 50-59 Gold 60-79 Platinum 80 & Above**	**One Star 10-19 Two Star 20-29 Three Star 30-44 Four Star 45-59 Five Star 60-74 Six Star 75+**	**1 Pearl All mandatory credits 2 Pearl 30+ 3 Pearl 44+ 4 Pearl 57+ 5 Pearl 77+**	**Certified 50 to 65 Silver 66 to 75 Gold 76 to 85 Platinum 86 to 100**	**One Star 50-60 Two Stars 61-70 Three Stars 71-80 Four Stars 81-90 Five Stars 91-100**
International Use	Netherland, France, Spain, Germany, Sweden, Russia etc.	Mexico, Emirates, India, Brazil and Others	New Zealand and South Africa	-	-	-

Table 4.1 Features of Green Building Rating Tools

(Banani et al., 2016; Say & Wood, 2008) (BREEM-2014), (v4-LEED v4), (GBCA), (PBRS version 1.0), (GBI, NRNC V1.0), (GRIHA)

4.1.1 Comparison of Assessment Tools Criteria

A comparison of BREEAM, LEED, Green Star, Pearl Estidama, GBI and GRIHA rating tools is made in this section based on extensive literature review. When comparing these rating tools, there are similarities that sustainability issues are broken down into number of categories and points are assigned to those categories as per their importance. Primary environmental assessment factors considered in these rating tools are: Management, Energy, Transport, Water, Materials, Waste, Land use, Site and Ecology, Pollution and Emissions, Indoor Environmental Quality and Innovation shown in Table 4.2.

Category	BREEAM	LEED	Green Star	Pearl	GBI	GRIHA
Management	✓	✗	✓	✓	✓	✓
Energy	✓	✓	✓	✓	✓	✓
Transport	✓	✓	✓	✓	✓	✓
Water	✓	✓	✓	✓	✓	✓
Materials	✓	✓	✓	✓	✓	✓
Waste	✓	✓	✓	✓	✓	✓
Land use, Site and Ecology	✓	✓	✓	✓	✓	✓
Pollution and Emission	✓	✓	✓	✓	✓	✓
Indoor Environmental Quality	✓	✓	✓	✓	✓	✓
Innovation	✓	✓	✓	✓	✓	✓

Table 4.2 Comparison of Primary Environmental Assessment Factors of Rating Systems

4.1.2 Environmental Categories in Green Building Rating Systems

4.1.2.1 BREEAM UK

BREEAM is broken into several sustainability categories for the assessment shown in figure 4.1. Within each category, there are credits which address specific aspects of sustainable building design, construction or performance.

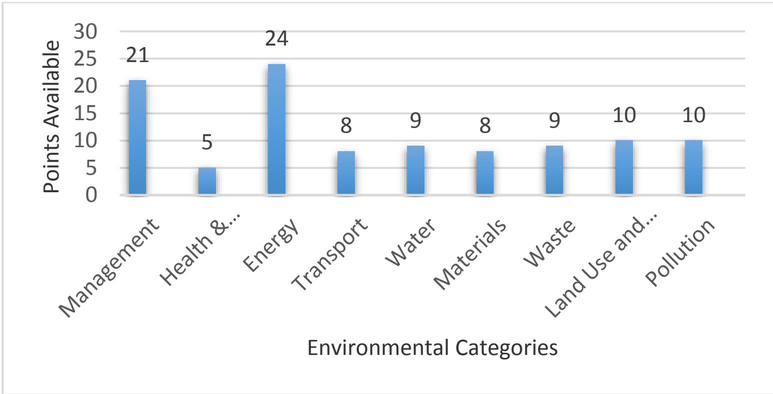

Figure 4.1 Maximum credit points in BREEAM UK (New construction)

4.1.2.2 LEED US

In LEED new construction and major renovation, points are broken down into eight categories with different credits points shown in figure 4.2.

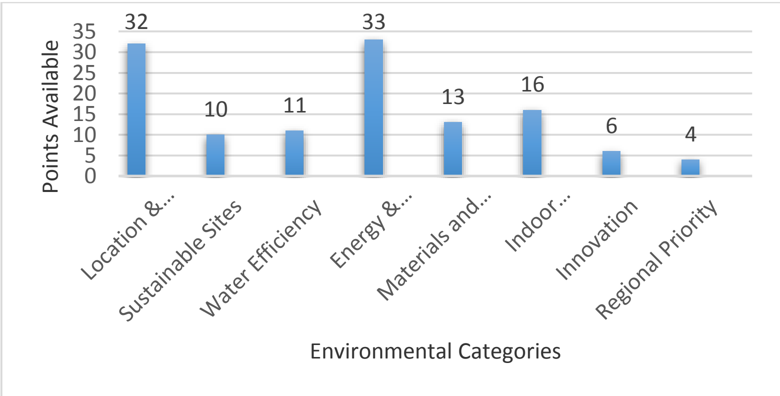

Figure 4.2 Maximum credit Points in LEED (New construction and Major renovation)

4.1.2.3 Green Star Australia

Green star benchmarks projects against eight green star categories shown in figure 4.3. Within each category are credits, which address specific aspects of sustainability.

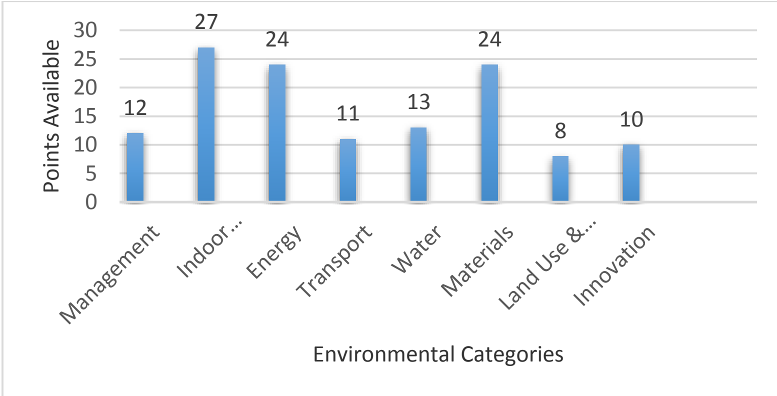

Figure 4.3 Maximum credit Points in Green Star- Design & As Built

4.1.2.4 Pearl Estidama

Pearl is divided into seven environmental sections. Points available for these environmental sections are shown in figure 4.4.

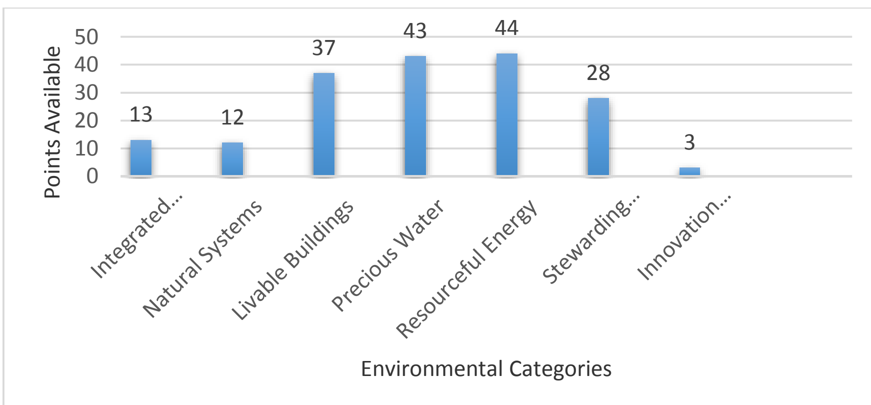

Figure 4.4 Maximum credit Points in Pearl

4.1.2.5 GBI, Malaysia

In GBI, buildings are rated based on six key criteria. Each criterion is further divided into credits, and different points are available for each criterion as shown in figure 4.5.

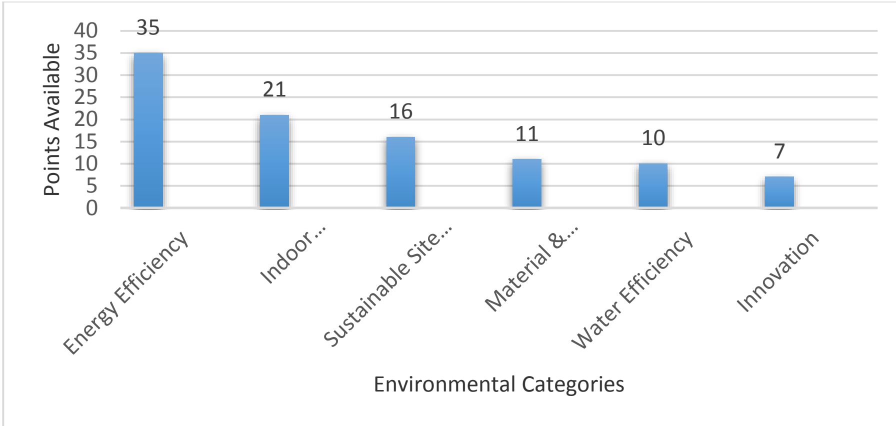

Figure 4.5 Maximum credit Points in GBI-Non Residential New Construction

4.1.2.6 GRIHA, India

GRIHA rating system consists of 34 criteria categorized in four different sections shown in figure 4.6 below.

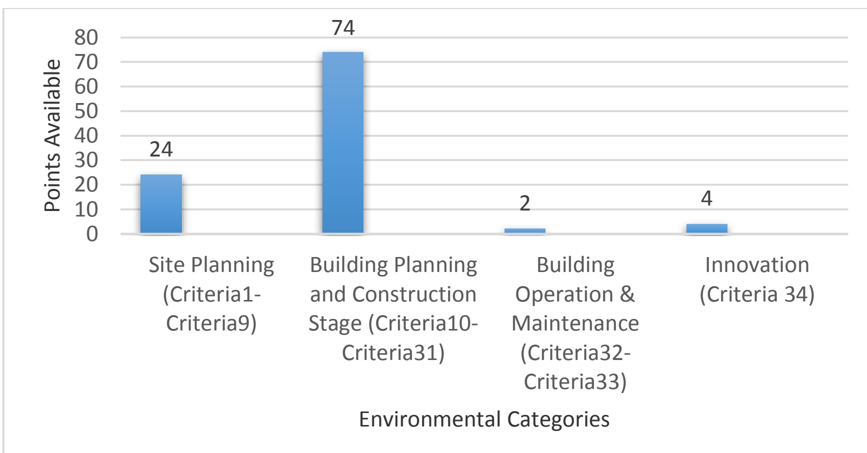

Figure 4.6 Maximum credit Points in GRIHA

Energy is considered as the most important category and maximum points are allocated for this environmental section in all green building rating systems. In GRIHA criteria 13- criteria 19 is for energy and out of 74 points, 40 points are allocated for them.

4.1.3 Pakistan Green Building Council

Pakistan Green Building Council was founded in 2013. In Pakistan green building practices are getting in stream of Pakistan construction industry through foreign industrial benefits or requirements. However, Pakistan Green Building Council took this initiative and provided a platform for national, international and government bodies and organizations to gather on a single platform. Now, PGBC with the collective effort of 9 bodies shown in Figure 4.7 has developed country's first green building guidelines and the draft version of PGBG V-1.

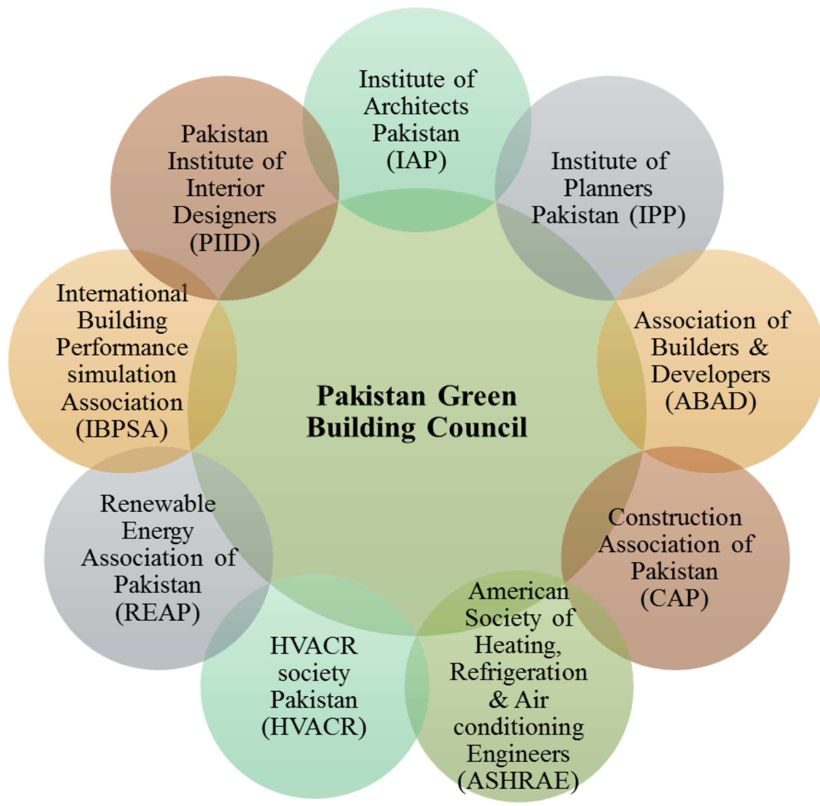

Figure 4.7 Professional bodies of Pakistan

Currently, these practices are voluntary but believed to set sustainable building practices, standards and awareness among masses. On the regulatory side, Pakistan has building code of Pakistan Energy Provision 2011 developed by ENERCON in collaboration with Pakistan engineering council.

4.1.4 Pakistan Green Building guidelines

In Pakistan Green Building guidelines, sustainability issues are break down in several environmental categories, further divided into key-categories and different credit points are allocated to these sections as shown in Figure 4.8.

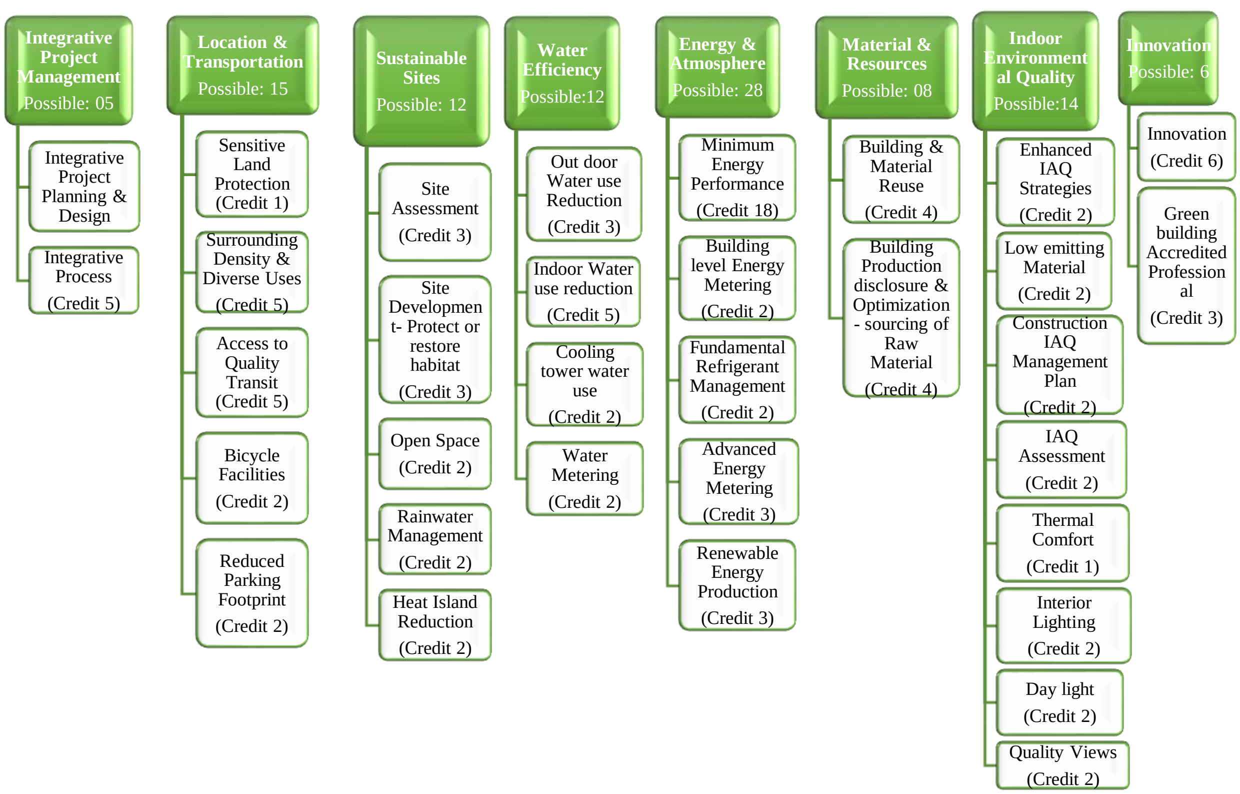

Figure 4.8 Sustainability categories in PGBG

In Pakistan Green Building guidelines, Energy and Atmosphere section also got maximum points i.e. 28 possible points.

4.2 Dimensions of Green Buildings observed in Pakistan

As, second objective of this study is to examine the dimensions of Green Buildings observed in Pakistan. For this purpose, five certified Green Buildings were selected i.e. Artistic Garment Industries Pvt Ltd Karachi; Citibank Dolmen Karachi, Coca-Cola Icecek as Multan Plant, British Council Library Lahore and Artistic Fabric and Garment Industries Karachi. Five certified buildings were selected i.e. Artistic Garment Industries Pvt Ltd, Karachi; Coca-Cola Icecek as Multan Plant; NCC Karachi and Citibank Dolmen Karachi. All five buildings with their intelligent features are explained in this section.

The data obtained from the building managers of all five buildings is briefly discussed in Table 4.2.

Characteristics		**Artistic Garment Industries (PVT) LTD**	**Cola Iceck Multan**	**British Council Library Lahore**	**Citibank Dolmen Karachi**	**Artistic Fabric and Garment Industries Karachi**
Location		Karachi	Multan	Lahore	Karachi	Karachi
Rating system		LEED-NC-2009	LEED-NC-2009	LEED-NC-2009	LEED-CI-2009	LEED v4 O+M-EB
Certification type		Silver	Silver	Gold	Gold	Gold
Year of Certification		2016	2016	2017	2016	2017
Space Type		Industrial Manufacturing	Industrial Manufacturing	Public Assembly	Retail	Industrial Manufacturing
Total Floor Area		159,710 sq. ft.	230,648 sq. ft.	5,121 sq. ft.	14,500 sq. ft.	599,980 sq. ft.
Green Buildings Features						
Categories	**Sub-categories**	**Points Achieved**	**Points Achieved**	**Points Achieved**	**Points Achieved**	**Points Achieved**
Energy and Atmosphere	EAc1 Optimize Energy Performance	4/19	5/19	9/19	6/5	10/20
	EAc2 On-site Renewable Energy	0/7	1/7	0/7	4/3	0/5
	EAc3 Enhanced Commissioning	0/2	0/2	0/2	5/5	2/2
	EAc4 Enhanced Refrigerant Mgmt	0/2	2/2	0/2	4/14	yes

	EAc5 Measurement and Verification	3/3	2/3	3/3	3/5	-
	EAc6 Green Power	0/2	0/2	0/2	0/5	-
	EAp1 Fundamental Commissioning	Yes	Yes	Yes	Yes	-
	EAp2 Minimum Energy Performance	Yes	Yes	Yes	Yes	-
	EAp3 Refrigerant Management	Yes	Yes	Yes	Yes	-
Total EA Points		**7/35**	**10/35**	**12/35**	**22/37**	**20/38**
Materials & Resources	MRc1.1: Building Reuse - Walls/Floor/Roof	0/3	0/3	0/3	No	Credit points are not available for this section
	MRc1.2: Building Reuse - Interiors	No	No	0/1	0/2	
	MRc2: Construction Waste Management	2/2	2/2	2/2	1/2	
	MRc3: Building Materials Reuse	0/2	0/2	2/2	0/2	
	MRc4: Recycled Content	1/2	2/2	2/2	0/2	
	MRc5: Regional Material Sourcing	2/2	2/2	2/2	0/2	
	MRc5: Rapidly Renewable Materials	No	No	1/1	No	
	MRc7: Certified Wood	No	No	0/1	No	
	MRp1: Recycling Collection / Storage	Yes	Yes	Yes	yes	
Total MR Points		**5/14**	**6/14**	**9/14**	**1/14**	**8/8**

Indoor Environmental Quality	EQc1: Outdoor Air Delivery Monitoring	No	No	No	No	No
	EQc2: Increased Ventilation	Yes	Yes	No	No	No
	EQc3.1: Construction IAQ Mgmt Plan	Yes	Yes	Yes	Yes	Yes
	EQc3.2: Flush Out / IAQ Test	No	Yes	Yes	No	Yes
	EQc4.1: Low-Emitting Adhesives / Sealants	Yes	Yes	Yes	No	Yes
	EQc4.2: Low-Emitting Paints / Coatings	Yes	Yes	Yes	Yes	Yes
	EQc4.3: Low-Emitting Flooring Systems	Yes	No	Yes	No	No
	EQc4.4: Low-Emitting Composites / Laminates	No	No	Yes	No	No
	EQc5: Indoor Pollutant Source Control	No	No	No	No	No
	EQc6.1: Controllability - Lighting Systems	Yes	Yes	No	No	No
	EQc6.2: Controllability - Temp / Ventilation	No	No	Yes	No	No
	EQc7.1: Thermal Comfort - Design	No	Yes	Yes	yes	yes
	EQc7.2: Thermal Comfort - Verification	No	Yes	Yes	Yes	Yes
	EQc8.1: Daylight / Views - 75% of Spaces	No	No	Yes	Yes	Yes

	EQc8.2: Daylight / Views - 90% of Spaces	No	No	Yes	yes	yes
	EQp1: Minimum IAQ Performance	Yes	Yes	Yes	Yes	Yes
	EQp2: Eliminate Tobacco Smoke	Yes	Yes	Yes	Yes	Yes
Total IEQ points		**6/15**	**8/15**	**11/15**	**6/17**	**7/17**
Sustainable Sites	SSc1: Site Selection	1/1	No	1/1	1/5	Credit points are not available for this section
	SSc2: Density/ Connectivity	5/5	No	5/5	6/6	
	SSc3: Brownfield Redevelopment	0/1	No	0/1	No	
	SSc4.1: Public Transportation Access	6/6	6/6	6/6	6/6	
	SSc4.2: Bicycle Storage/Locker Room	0/1	Yes	1/1	2/2	
	SSc4.3: Low-Emissions Vehicles	3/3	3/3	0/3	No	
	SSc4.4: Parking Capacity	2/2	2/2	0/2	2/2	
	SSc5.1: Protect/Restore Habitat	0/1	No	0/1	No	
	SSc5.2: Maximize Open Space	0/1	No	1/1	No	
	SSc6.1: Storm water Quantity Control	0/1	No	1/1	No	
	SSc6.2: Storm water Quality Control	1/1	Yes	1/1	No	
	SSc7.1: Heat Island-Non-Roof	1/1	Yes	1/1	No	

	SSc7.2: Heat Island-Roof	0/1	Yes	1/1	No	
	SSc8: Light Pollution Reduction	0/1	No	0/1	No	
	SSp1: Construction Pollution Prevention	No	Yes	No	No	
Total SS points		**19/26**	**15/26**	**18/26**	**17/21**	**17/25**
Water Efficiency	WEc1: Water Efficient Landscaping	4/4	0/4	0/4	No	5/6
	WEc2: Wastewater Technologies	2/2	2/2	2/2	No	2/2
	WEc3: Water Use Reduction	4/4	4/4	4/4	11/11	4/4
	WEp1: Water Use Reduction	Yes	Yes	Yes	Yes	Yes
Total WE points		**10/10**	**6/10**	**6/10**	**11/11**	**11/12**
Innovation	IDc1: Innovation in Design	4/5	2/5	4/5	3/5	
	IDc2: LEED® Accredited Professional	Yes	Yes	1/1	Yes	
Total ID points		**5/6**	**3/6**	**5/6**	**4/6**	**5/6**
Regional Priority		**4/4**	**4/4**	**4/4**	**4/6**	**4/4**

Table 4.3 Dimensions of Five LEED Certified Green Buildings in Pakistan.

4.2.1 Summary of Five Certified Green Buildings in Pakistan

- **Artistic Garment Industries (PVT) LTD** is an Industrial Manufacturing having an area of 159,710 sq. ft. It followed LEED for new construction 2009 version and got "Silver certification" in 2016 by scoring 56 points out of 110. This building achieved 20% improvement in building performance by scoring 7 out of 35 points in energy and atmosphere section along with 5 out of 14 points in materials & resources, 6 out of 15 points in indoor environmental quality section, 19 out of 26 points in sustainable sites category, 100% points i.e. 10 out of 10 points in water efficiency, 5 out of 6 points in innovation and 4 out of 4 points in regional priority section.

- **Coca-Cola Icecek** is also an Industrial Manufacturing. This building has the largest covered area among all four buildings i.e. 230,648 sq. ft. It followed LEED for new construction 2009 version and got "Silver certification" in 2016 by scoring 52 points out of 110. This building scores 10 out of 35 points in energy and atmosphere section with 20% Improvement on baseline building, 6 out of 14 points in materials and resources, 8 out of 15 points in indoor environmental quality section, 15 out of 26 points in sustainable sites category, 6 out of 10 points in water efficiency with half of reduction in total waste water generation, 3 out of 6 points in innovation section and 4 out of 4 points in regional priority section.
- **British Council Library Lahore** is a Public assembly building having an area of 5,121 sq. ft. It followed LEED new construction 2009 guidelines and got "Gold Certification" in 2017 by scoring 65 points out of 110 total possible points. This building scores 12 out of 35 points in Energy and atmosphere with 30% Improvement on baseline building performance rating, 9 out of 14 points in Material and Resources with 2.5% Rapidly renewable materials, 11 out of 15 points in Indoor Environmental quality (2/3rd part of building has accessed to day lighting with quality views), 18 out of 26 points in Sustainable Sites, 6 out of 10 points in Water Efficiency, 5out of 6 in Innovation and 4 out of 4 in Regional Priority sections.
- **Citibank Pakistan** having an area of 14,500 sq. ft. It followed LEED Commercial Interiors 2009 version and got "Gold certification" in 2016 by scoring 65 out of 110 points. This building scores 22 out of 37 points in energy and atmosphere section, 1 out of 14 points

in materials and resources, 6 out of 17 points in indoor environmental quality, 17 out of 21 points in sustainable sites, 11 out of 11 points in water efficiency, 4 out of 6 points in innovation section and Regional Priority respectively.

- **Artistic Fabric and Garment Industries Karachi** is Pakistan's First LEED Existing Building and Highest LEED point scorer. It scores 72 total points out of 110 and got Gold certification in 2017. This building having an area of 599,980 sq. ft. and it followed LEEDv4 Operation and Maintenance for exiting building guidelines. This building scored 20/38 points in Energy and Atmosphere, 8/8 points in Material and Resources, 7/17 in Indoor Environmental Quality, 17/25 in Sustainable Sites, 11/12 in Water Efficiency, 5/6 in Innovation and 4/4 in Regional Priority section. This building able to achieve 39.01% overall saving from baseline by analyzing the building performance in relation to Envelope, Lighting, Process Equipment, Occupancy and HVAC systems by using Energy Star Portfolio Manager.

4.3 Examination of Barriers and Measures in Adoption of Green Building Practices in Pakistan

The third objective of this study is to examine the barriers and measures in adoption of green building practices in Pakistan. For this purpose, questionnaire survey technique and in-depth interviews were conducted. Questionnaire forms were distributed to local construction stakeholders associated with Pakistan construction industry to get their perception towards barriers faced in the implementation of green building practices and measures needed to promote green building in Pakistan. A total of 120 questionnaires were distributed and 103 completed questionnaires were received with the response rate of 85.8% from the practitioners. Interviewees were selected on the basis of their knowledge and experience in green building approach. Other than questionnaire survey, seven in-depth interviews were also carried out with key stakeholders working with Pakistan.

4.3.1 Characteristics of the Respondents- Frequencies and Percentages

Respondents to this survey belonged to different industrial sectors. In Table 4.4, the characteristic of respondents has been shown. 19.4% (20) of the respondents were Architects, 6.8% (7) were Environmentalists, 9.7% (10) were Town planners, 6.8% (7) were Developers, 7.8% (8) were Contractors, 4.9% (5) were Interior designers, 28.2% (29) were Engineers, 9.7% (10) belonged to academics (Researcher/ Professor) and 6.8% (7) of the respondents belonged to PGBC.

Respondents	No of questionnaires Returned	Percentage	Cumulative Percentage
Architects	20	19.4	19.4
Environmentalist	7	6.8	26.2
Town Planner	10	9.7	35.9
Developer/ Builder	7	6.8	42.7
Contractors	8	7.8	50.5
Interior Designer	5	4.9	55.3
Engineer	29	28.2	83.5
Researcher/ Professor	10	9.7	93.2
Pakistan Green Building Council	7	6.8	100.0
Total	103	100.0	

Table 4.4 Respondents Characteristics

4.3.2 Education Level of Participants

Education level of sampling area is shown in Figure 4.9. Educational status of sample respondents ranged from 12 years of education to above Masters level. Of the total respondents, 2.90% were having 12 years of education, 5.80% were having 14 years of education, 55.30% were having 16 years of education and 35.90% were having 18 years or above level of education.

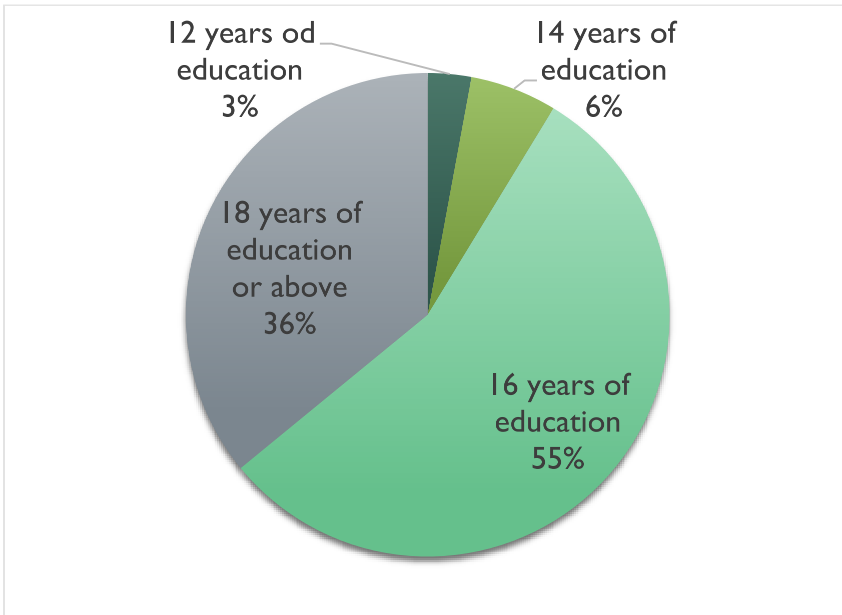

Figure 4.9 Highest level of Education of Participants

4.3.3 Stakeholders Experience in Pakistan Construction Industry

The respondents having more than 16 years of experience were 6.8% (7), 12.6% (13) had experience of 11-15 years, 25.3% (26) had experience of 6-10 years and 55.3% (57) had less than 5 years of construction experience. Experiences of stakeholders are shown in Figure 4.10.

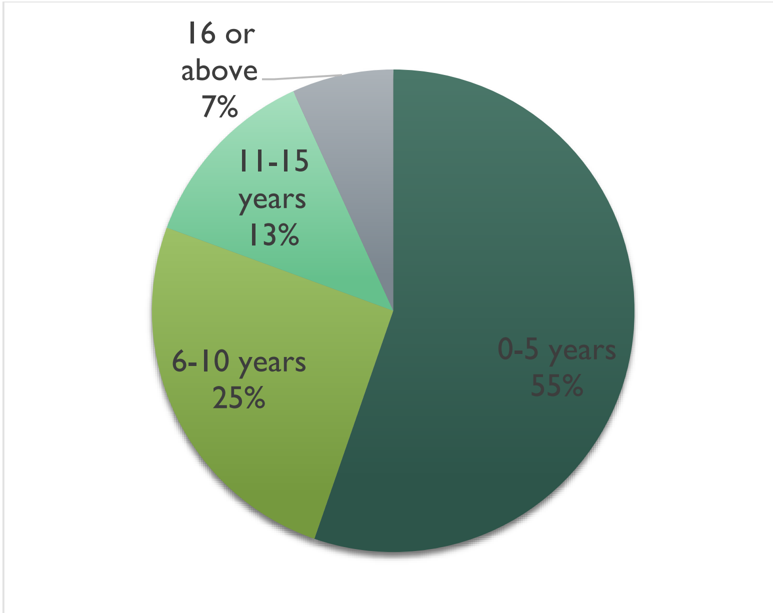

Figure 4.10 Experiences of stakeholders in Pakistan construction industry

4.3.4 Statistical Analysis

Reliability of categorized data was calculated using Cronbach's Alpha method. Cronbach's Alpha is used to measure the internal consistency among various factors. Values of reliability coefficient vary between 1 and 0, with '1' denoting perfect internal reliability and '0' denoting lack of internal reliability. The values of Cronbach's alpha coefficient for this study were 0.836 for barriers and 0.774 for measures. As values of test are greater than threshold of 0.7, which means data of this study using five point Likert scale was reliable at the 5% significance level (Darko et al., 2017).

Barriers and measures were ranked based upon mean item scores and standard deviation. The mean score ranking technique is very popular and has been broadly used in other green building related studies to rank and determine the key factors among several individual factors (Darko et al., 2017). For a better interpretation of barriers and to condense them into small manageable number of components, Factor analysis was performed. Principal component analysis with Varimax rotation and Kaiser Normalization was used in this analysis. Factor retention was by the eigenvalue 1.0 criterion, suggesting that only factors that account for variances greater than one should be included in factor extraction. Number of factors to be extracted was fixed to 5.

4.3.5 Survey Results

4.3.5.1 Descriptive Statistics of Barriers

The experts were requested to rate the importance of 30 barriers that were identified through literature review. Results are shown in Table 4.5.

Code	Statements (N=103)	Mean	Not important		Slightly important		Moderately important		Important		Very important	
			Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
B01	High initial investment, long payback period	3.97	1	1.0	8	7.8	13	12.6	52	50.5	29	28.2
B02	Lack of incentives from government	4.32	0	0	2	1.9	13	12.6	38	36.9	50	48.5
B03	Lack of green building codes and regulations	4.20	1	1.0	6	5.8	15	14.6	30	29.1	51	49.5
B04	Poor implementation of laws and legislations	4.19	0	0	3	2.9	14	13.6	46	44.7	40	38.8
B05	Disbelief regarding the benefits of green buildings	3.51	2	1.9	8	7.8	17	16.5	40	38.8	36	35.0
B06	Lack of availability of case studies building	3.97	2	1.9	20	19.4	25	24.3	35	34.0	21	20.4
B07	Higher functioning costs and maintenance fees for green buildings	3.25	7	6.8	25	24.3	21	20.4	35	34.0	15	14.6
B08	Lack of awareness among people about the importance & advantages of adopting green building practices	4.52	0	0	1	1.0	6	5.8	34	33.0	62	60.2

B09	Lack of professional knowledge	3.92	1	1.0	10	9.7	11	10.7	55	53.4	26	25.2
B10	Lack of end user support	3.88	0	0	13	12.6	11	10.7	54	52.4	25	24.3
B11	An unsustainable measure is allowed by the regulator or statutory undertaker	3.31	1	1.0	9	8.7	59	57.3	25	24.3	9	8.7
B12	Lack of financial resources	3.96	1	1.0	4	3.9	15	14.6	61	59.2	22	21.4
B13	Lack of support and guidance from regularity authority on green practices	4.10	1	1.0	1	1.0	14	13.6	58	56.3	29	28.2
B14	Lack of availability of environmentally sustainable materials	2.92	9	8.7	36	35.0	23	22.3	24	23.3	11	10.7
B15	Lack of indicators for evaluating how sustainable a building is	3.50	3	2.9	19	18.4	20	19.4	46	44.7	15	14.6
B16	Lack of demands for sustainable products	3.51	3	2.9	16	15.5	24	23.3	45	43.7	15	14.6
B17	Cultural change resistance	3.78	3	2.9	12	11.7	19	18.4	40	38.8	29	28.2
B18	Lack of qualified staff	3.79	0	0	16	15.5	15	14.6	47	45.6	25	24.3
B19	Risk associated with implementation of new practices	3.45	4	3.9	22	21.4	20	19.4	38	36.9	19	18.4
B20	Weak market demand	3.60	4	3.9	13	12.6	21	20.4	47	45.6	18	17.5

B21	Technical level and innovation among architects, designers and engineers is less than desirable in terms of environmental issues	3.57	4	3.9	17	16.5	15	14.6	50	48.5	17	16.5
B22	Improper communication structure to support green building practices	3.80	0	0	11	10.7	17	16.5	57	53.3	18	17.5
B23	Challenges of innovative equipment in design and construction method	3.60	1	1.0	15	14.6	23	22.3	49	47.6	15	14.6
B24	Weak organizational structure to support Green building practices	3.85	1	1.0	11	10.7	15	14.6	51	49.5	25	24.3
B25	Poor management and/or lack of staff time for implementing green practices	3.62	1	1.0	14	13.6	26	25.2	44	42.7	18	17.5
B26	Complexity of design to support green practices	3.04	6	5.8	30	29.1	30	29.1	28	27.2	9	8.7
B27	Lack of technology	3.50	6	5.8	15	14.6	20	19.4	45	43.7	17	16.5
B28	Lack of technical expertise	3.81	3	2.9	14	13.6	12	11.7	45	43.7	29	28.2
B29	Lack of technical training/education in green building design and construction	4.11	1	1.0	6	5.8	12	11.7	46	44.7	38	36.9
B30	Green building/material is esthetically less pleasing	2.08	40	38.8	31	30.1	19	18.4	10	9.7	3	2.9

Table 4.5 Statements for Examining Barriers to Successful Implementation of Green Buildings in Pakistan

4.3.5.2 Ranking of Barriers to the Implementation of Green Buildings in Pakistan

Results based on the perception of local stakeholders are shown in Table 4.6 and figure-4.11.

Code	Mean values	Std. Deviation	Ranking
	Statistics	Statistics	
B08	4.52	0.654	1
B02	4.32	0.770	2
B03	4.20	0.964	3
B04	4.19	0.780	4
B29	4.11	0.896	5
B13	4.10	0.735	6
B01	3.97	0.902	7
B06	3.97	1.004	8
B12	3.96	0.779	9
B09	3.92	0.915	10
B10	3.88	0.921	11
B24	3.85	0.944	12
B28	3.81	1.085	13
B22	3.80	0.856	14
B18	3.79	0.987	15
B17	3.78	1.075	16
B25	3.62	0.961	17
B23	3.60	0.943	18
B20	3.60	1.042	19
B21	3.57	1.072	20
B16	3.51	1.018	21
B05	3.51	1.083	22
B15	3.50	1.047	23
B27	3.50	1.110	24
B19	3.45	1.135	25
B11	3.31	0.792	26
B07	3.25	1.178	27
B26	3.04	1.075	28
B14	2.92	1.169	29
B30	2.08	1.109	30

Table 4.6 Ranking of Barriers based on Mean values and Standard Deviation

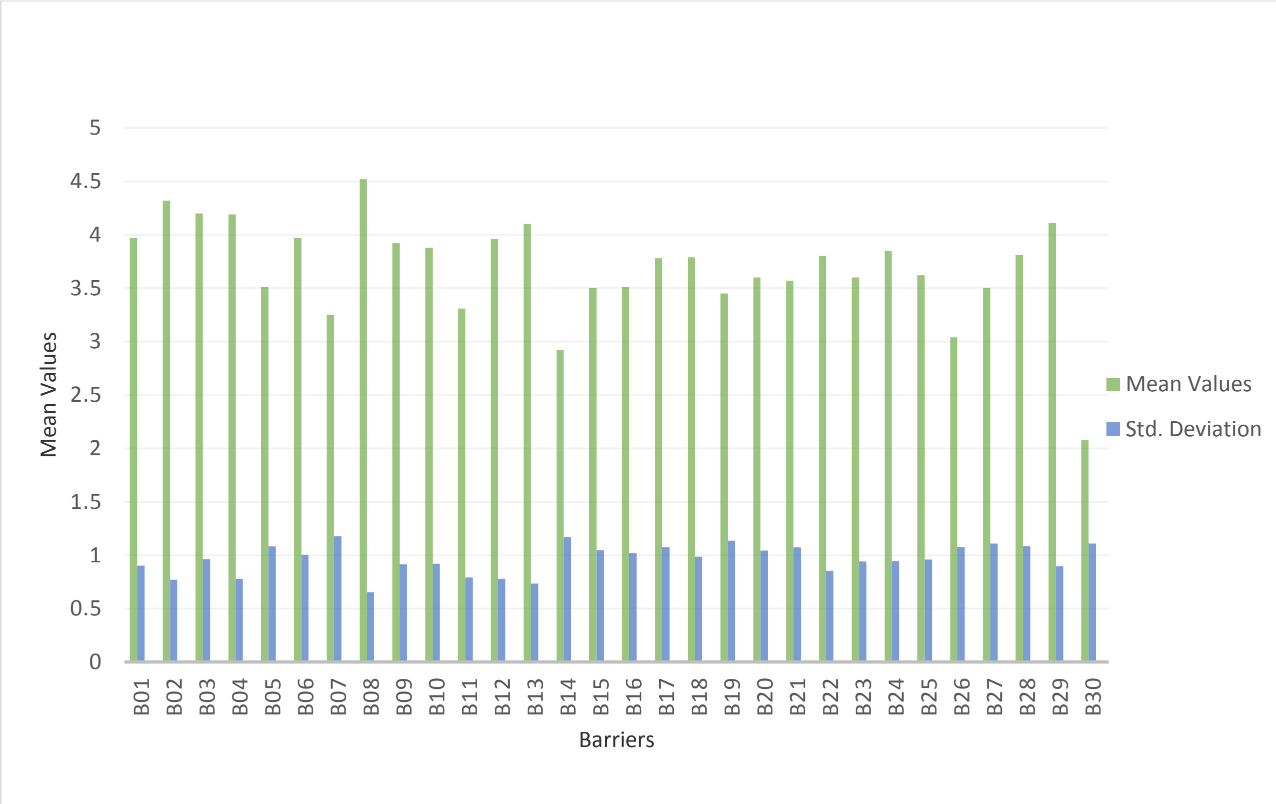

Figure 4.11 Bar graph of Barriers based upon Mean values and Standard Deviation

Ranking of identified barriers was made as per the perception of local stakeholders. It has been done based on their Mean values (MV) and Standard Deviation (SD). The results from empirical analysis revealed that the five top most important impediments to the successful implementation of green building practices in Pakistan are; Lack of awareness (MV= 4.52; SD=0.654), Lack of incentives from government (MV= 4.32; SD=0.770), Lack of green building codes and regulations (MV= 4.20; SD=0.964), Poor implementation of laws and regulations (MV=4.19; SD=0.780) and Lack of technical training/education in green building design and construction (MV=4.11; SD=0.896). It is also noted that "B01: High initial investment, long payback period" and "B06: Lack of availability of case studies building" have same mean scores. However, the standard deviation of B01 is 0.902, which is lower than that of B06 which is 1.004. Therefore, B01 is ranked as seventh and B06 is ranked as eighth. B20, B23 and B15, B27 are ranked on similar basis as they also have same mean item scores.

4.3.5.3 Factor Analysis

Outcome of factor analysis was based on the condition that a factor is substantial to the study, if it has a mean value greater than 2.00. All 30 factors were included in factor analysis because they have mean values greater than 2.00. The KMO value was found to be 0.674 (indicating that the data set is adequate for factor analysis). The chi-square value in Bartlett's test was found to be large (946.263), and the associated significance level is small (p=0.000). Therefore, it was appropriate to use factor analysis. Factors extracted through principal component analysis, having Eigen values greater than 1, accounting for 65.46% of the variance and the factor loading value exceeded 0.50. The result of factor analysis revealed that factor 1 accounted for 18.856% of the total variances in the correlation matrix including 4 statements (B4, B13, B23, B24). The second factor explained 15.88% of the total variances including 4 statements (B2, B6, B17, B20), Factor 3 accounted for 14.094% of total variances representing 4 statements (B7, B14, B26, B27), Factor 4 explained 9.150% of total variances representing 3 statements (B9, B18, B28) and the Factor 5 accounted for 7.480% of total variances in the correlation matrix representing 2 statements (B11, B12) as shown in Table 4.7.

Code	**Statements**	**Factor Loadings**				
		Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
B04	Poor implementation of laws and legislations	0.647				
B13	Lack of support and guidance from regularity authority on green practices	0.547				

B23	Challenges of innovative equipment in design and construction method	0.586				
B24	Weak organizational structure to support Green building practices	0.699				
B02	Lack of incentives from government		0.654			
B06	Lack of availability of case studies building		0.626			
B17	Cultural change resistance		0.594			
B20	Weak market demand		0.618			
B07	Higher functioning costs and maintenance fees for green buildings			0.716		
B14	Lack of availability of environmentally sustainable materials			0.570		
B26	Complexity of design to support green practices			0.524		
B27	Lack of technology			0.599		
B09	Lack of professional knowledge				0.669	
B18	Lack of qualified staff				0.681	
B28	Lack of technical expertise				0.717	
B11	An unsustainable measure is allowed by the regulator or statutory undertaker					0.736
B12	Lack of financial resources					0.624

Table 4.7 Factor Matrix for Barriers

4.3.5.4 Descriptive Statistics of Measures

The experts were requested to rate the importance of 12 barriers identified through the literature review. Results are shown in Table 4.8.

Code	Statements (N=103)	Mean	Strongly Disagree		Disagree		Uncertain		Agree		Strongly Agree	
			Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**	**Frequency**	**%**
M01	Promotion of successful green building practices as case examples	4.24	0	0	2	1.9	13	12.6	46	44.7	42	40.8
M02	Education on new green technologies should be a part of organizational training	4.20	0	0	4	3.9	8	7.8	54	52.4	37	35.9
M03	Easy accessibility of green building rating/assessment tools	4.35	0	0	1	1.0	9	8.7	46	44.7	47	45.6
M04	Organizational belief of long term benefits through green building practices	4.17	0	0	2	1.9	12	11.7	55	53.4	34	33.0
M05	Availability of comprehensive training and education in green building technologies for engineers, developers and policy makers	4.44	0	0	3	2.9	6	5.8	37	35.9	57	55.3
M06	Availability of green building codes and regulations (Mandatory to apply)	4.48	0	0	1	1.0	8	7.8	35	34.0	59	57.3
M07	Financial incentives and penalties from the government (e.g. tax, soft loan) for green building practices	4.47	0	0	3	2.9	3	2.9	40	38.8	57	55.3
M08	Creation of public awareness towards green initiatives	4.63	0	0	0	0	2	1.9	34	33.0	67	65.0

	through seminars, workshops and discussions											
M09	More publicity of green building through television programs, internet, newspaper and radio	4.09	1	1.0	4	3.9	14	13.6	50	48.5	34	33.0
M10	Pressure from external and internal stakeholders towards green development	4.23	0	0	7	6.8	11	10.7	36	35.0	49	47.6
M11	Government should provide funding and regulatory incentives for green construction development	4.10	0	0	5	4.9	15	14.6	48	46.6	35	34.0
M12	Availability of institutional framework for effective implementation of green building guidelines	4.43	2	1.9	0	0	8	7.8	35	34.0	58	56.3

Table 4.8 Statements for Examining Measures needed to Promote the Adoption of Green Buildings in Pakistan

4.3.5.5 Ranking of Measures to Promote Green Buildings in Pakistan

Results on the relative importance of measures needed to promote green building practices are shown in Table 4.9 and Figure 4.12.

Code	**Mean Values**	**Std. Deviation**	**Ranking**
	Statistics	Statistics	
M8	4.63	0.524	1
M6	4.48	0.684	2
M7	4.47	0.698	3
M5	4.44	0.737	4
M12	4.43	0.800	5
M3	4.35	0.682	6
M1	4.24	0.747	7
M10	4.23	0.899	8
M2	4.20	0.746	9
M4	4.17	0.706	10
M11	4.10	0.823	11
M9	4.09	0.841	12

Table 4.9 Ranking of Measures to Promote Green Building Practices

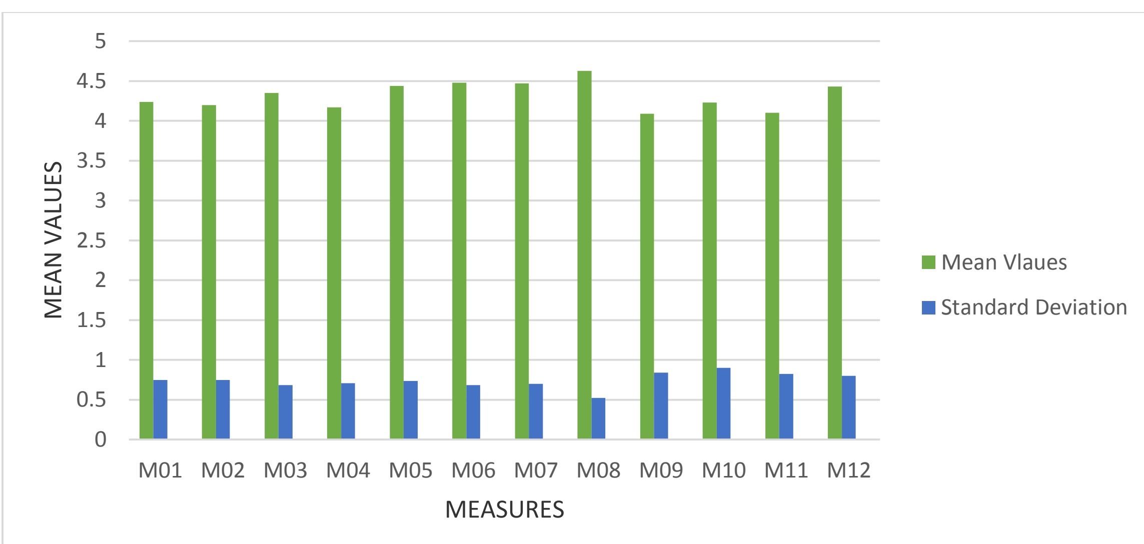

Figure 4.12 Bar graph of Measures based upon Mean values and Standard Deviation

The mean values of all 12 measures are above 4, which indicates that all measures have significant importance. As per the results, five top most substantial measures are; Creation of public awareness towards green initiatives through seminars, workshops and discussions (MV= 4.63), Availability of green building codes and regulations (Mandatory to apply) (MV= 4.48), Financial incentives and penalties from the government (e.g. tax, soft loan) for green building practices (MV= 4.47), Availability of comprehensive training and education in green building technologies for engineers, developers and policy makers (MV=4.44) and Availability of institutional framework for effective implementation of green building guidelines (MV=4.43).

5 FINDING AND DISCUSSIONS

Green building brings numerous environmental, economic and social benefits for the construction industry and society. In order to accelerate the adoption of green building practices, this research identifies and examines key barriers in its successful implementation and measures needed to promote this concept by analyzing the professional views from Pakistan Construction Industry. Ranking of barriers and measures would provide valuable information to decision-makers. It will help them to understand the key areas that need more attention in future green building policy/initiatives. The following sections discuss the findings of the study. Due to the word limitation, five top ranked factors give priority in the discussion identified from the previous sections.

5.1 Barriers

Currently, there exist significant barriers in the adoption of green buildings in Pakistan. The survey results indicate that, one of the most critical barriers to the adoption of green buildings in Pakistan is 'lack of awareness among people about the importance and advantages of adopting green building practices'.

The same barrier has been highlighted as the most crucial barrier in the construction industries of Ukraine, Kuwait and Malaysia (AlSanad, 2015; Sohail and Qureshi, 2010; Bohari et al., 2016). Additionally, the outcome of interviews indicates that majority of the stakeholders and public is not aware with the long-term benefits of green buildings. Although, green building technology has a rapid growth in global construction industry, however, the local stakeholders are not updated yet with the wide range of benefits associated with green building practices. As per the results, lack of efforts to create awareness programs that specifically target green building technologies, market opportunities among stakeholders have been highlighted as a main reason by the interviewees.

‘Lack of incentives from government for implementing green building practices’ has been ranked as second most significant barrier by the experts, as they see insufficient support from government in the development of green building practices in Pakistan. Local stakeholders have a firm belief that green building practices can only be encouraged provided the government is devoted to do so. As government is a main stakeholder in the industry, it must play a vital role in providing such environment which can help in effective implementation of green building practices. Interviewees said that construction industry of Pakistan has run in its traditional way hence it is extremely difficult to change construction practices and building material used. Due to lack of availability of financial incentives and higher initial investment of green buildings, people are very hesitant to change their old and traditional construction habits. Due to this change resistance, there is a lack of demand for green products by clients and stakeholders.

‘Lack of green building codes and guidelines’ has also been identified as one of the barriers continuously highlighted by the interviewees and got third in rank as per the survey result. Stakeholders found it difficult to start project without the help of green building codes and guidelines. Interviewees highlighted that in order to go green, worldwide recognized green building guidelines/ rating systems need to be imported, which creates higher cost to the client and becomes a hurdle for stakeholder of Pakistan in this struggle.

Another significant barrier is the ‘Poor implementation of laws and legislations’ (ranked fourth). Management and leadership of an organization play a pivotal role in achieving the successful implementation of advanced strategies. Interviewees indicated that the accomplishment of the execution of green building practices lies in the commitment of leader and managers in developing and executing an efficient plan. Due to inefficient law system, market interest for green buildings is further reduced. Therefore, to make implementation a law in only way, people of Pakistan will implement it. This is because, sometimes things must be imposed rather than dictating them.

The fifth ranked barrier is ‘Lack of technical training/education in green building design and construction’. This barrier is also highlighted as the most crucial barrier is previous researches. Interviewees believed that green building approach is newer in our industry and stakeholders who have experience and technical knowledge are limited. Therefore, there are shortages of platforms that provide technical training/education on green practices. As green building technologies are getting more innovative and advanced, therefore, technically competent stakeholders are needed to move forward with the application of green building practices. One of the interviewee said that our country is lacking behind in the advancement of technology due to number of constraints due to which our local stakeholders could not be able to fulfill green building requirements during design, construction and implementation phases.

5.1.1 Factor Analysis

Factor analysis enabled 17 barriers out of 30 barriers to be placed under five components shown in Table 4.6. On the basis of the inherent relationship among the factors, following points are made according to underlining phenomenon linking the factors.

5.1.1.1 Factor 1: Management/ Leadership Barriers

- Poor implementation of laws and legislations
- Lack of support and guidance from regularity authority on green practices

- Challenges of innovative equipment in design and construction method
- Weak organizational structure to support Green building practices

5.1.1.2 Factor 2: Governmental and Socio-cultural Barriers

- Lack of incentives from government
- Lack of availability of case studies building
- Cultural change resistance
- Weak market demand

5.1.1.3 Factor 3: Economic Barriers

- Higher functioning costs and maintenance fees for green buildings
- Lack of availability of environmentally sustainable materials
- Complexity of design to support green practices
- Lack of technology

5.1.1.4 Factor 4: Technical Barriers

- Lack of professional knowledge
- Lack of qualified staff
- Lack of technical expertise

5.1.1.5 Factor 5: Regulations Barriers

- An unsustainable measure is allowed by the regulator or statutory undertaker
- Lack of financial resources

In order to identify the most essential factor to the successful implementation of green building practices in Pakistan, average of the mean values for each variable was calculated. Results indicated that Management/Leadership barriers (mean= 3.935) is the top most important factor followed by Governmental and socio-cultural barriers (mean=3.8175), Technical barriers (mean= 3.84), Regulations and Resource related barriers (mean=3.635), and Economical and innovative related barriers (mean= 3.1775).

5.2 Measures

Various measures are needed to eliminate potential barriers and to promote the adoption of green building practices. This study has examined the measures needed to promote green construction in Pakistan. The survey results indicate that 'Creation of public awareness towards green initiatives through seminars, workshops and discussions' is the most substantial measure. The outcome of the interviews indicated that initial cost of green building may be higher than a conventional building but when it is evaluated against benefits, it is a worthwhile deal. Therefore, increasing awareness among end-users about long term benefits of green buildings and to acknowledge them, as well as, how their incorporation can help in saving the environment for present and future generations is very important.

The second rank of 'Availability of green building codes and regulations (Mandatory to apply)' shows that experts devoted great importance to this measure. The results of this measure is consistent with Chan et al., (2009), who claimed that mandatory government policy is the most substantial measure to promote green building practices. As per the interviewees, introduction of green building regulations and bylaws in the present planning system of Pakistan can play a very important role in promoting this practice. Experts highlighted that the mandatory governmental policies on green building practices can also act like a driving factor for external and internal stakeholders to take relevant actions for the adoption of this practice. Outcome of the interview with Pakistan green building council indicates that with the collective efforts and hard work

Pakistan GBC has been successful in developing the draft of country's first green building guidelines. Currently, these practices are voluntary and believed to set sustainable building practices and standards and awareness among masses.

'Financial incentives and penalties from the government (e.g. soft loan, tax) for green building practices' was ranked as the third most important measure. Interviewees believed that financial and market-based incentives are the greatest opportunity to increase the adoption of green building practices in Pakistan. These incentives increase the motivation level of stakeholders towards green approach as they provide compensations to them. As higher initial investment, lack of financial incentives and resistance to change due to cost are some of the barriers to the adoption of green buildings. Therefore, policy makers/ government should pay more attention to the incentives programs. Moreover, government should also develop a mechanism to penalize the non-compliers in the form of higher tax rates etc. If these measures are not taken seriously, then it would be a challenge in the widespread adoption of green practices highlighted by the interviewee.

The results of this study indicate that 'Availability of comprehensive training and education in green building technologies for engineers, developers and policy makers' ranked fourth. This measure is essential for the continuous promotion of green building practices in the local context. Interviewees emphasized that educating our young generation and helping them in understanding that, how a simple step towards green building can help in saving energy and environment. Establishment of research centers that work on the innovative processes of green technology and help in preparing the guidelines for the professional is another measure suggested by one of the interviewee. Dedicated course on green building technologies should be taught at university level so that our future engineers/ designers are aware with long lasting benefits of green buildings.

The fifth ranked barrier identified by this research is 'Availability of institutional framework for effective implementation of green building guidelines'. Efficient legal framework is a strong factor in the adoption of green building practices underlined by the interviewees. According to the experts, along with playing its part in the creation of policies the government also has a great influence on the effective implementation of those regulations through regular monitoring and assessment.

5.3 Framework for the Promotion of Green building

After all the data has been tabulated, various analysis and tests have been applied to identify and highlight the main issues and constraints in the adoption of green buildings in Pakistan. On the basis of data analysis, literature review and stakeholder's perception, the framework for the promotion of green building has been developed. The framework shows issues, dimensions and measures to promote this concept at local level.

Framework for promotion of Green building in Pakistan

Issues	**Dimensions of Green building**	**Barriers**	**Measures**		
			Institutional Support	Monitoring and Evaluation	Construction and Development
-Environmental footprints of built environment -Environmental degradation Climatic challenges -Depletion of natural resources	-Sitting and Structure design efficiency (sustainable design) -Energy Efficiency (low-energy house & zero-energy building) -Water Efficiency (water conservation) -Materials Efficiency (Sustainable architecture) -Indoor Environmental Quality enhancement (indoor air quality) -Operations and Maintenance optimization -Waste reduction -Reduce impact onto electricity network	-Management & Leadership Barriers -Governmental and Socio-Cultural Barriers -Economic Barriers -Technical Barriers -Regulatory Barriers	-Creation of public awareness towards green initiatives through seminars, workshops & discussions. -More publicity of green building through television programs, internet, newspaper and radio. -Education on new green technologies as a part of organizational training -Establishment of research centers that work on the innovative processes of green technology and help in preparing the guidelines for the professional -Dedicated course on green building technologies should be taught at university level -Promotion of successful green building practices as case examples -Regularity/ financial incentives, funding or penalties for green construction from government -Institutional framework for effective implementation of green building guidelines	-Supervision of development/ construction as per standards & approved plans/designs	-Availability of comprehensive training and education in green building technologies for engineers, developers and policy makers. -Easy accessibility of green building rating/ green building rating/ assessment tools -Availability of green building codes and regulations (Mandatory to apply) -Environment friendly materials

6 CONCLUSION

The objectives of present study were to review the evolution of green building concept and rating systems, dimensions of certified green buildings observed in Pakistan, to examine the barriers to and measures for promoting green building in Pakistan and to suggest a framework.

Green building is one of the key pillars of sustainable development. It has numerous environmental, social and economic benefits for the society and surrounding environment. Due to various climatic and environmental challenges, the concern for green building is being increased in worldwide. There has been a rapid increase in the development of various rating systems, assessment tools and methods for sustainable or green development. Six internationally recognized rating tools have been briefly discussed along with first draft version of Pakistan green building guidelines developed by Pakistan green building council. These rating systems have similarities and differences when compared with each other and highest priority category is common in all of them i.e. ENERGY. Maximum points are allocated to this environmental category.

In Pakistan, there are only seven certified green projects. Data from four certified green buildings were gathered and discussed.

This study also investigated the major issues influencing the adoption of green building practices from the perception of local stakeholders in Pakistan. A wide range of potential barriers and measures were identified and examined by using a combination of research methods, including literature review, questionnaire survey and in-depth interviews. The results were further analyzed by using factor analysis and ranking technique. These techniques are used for the better understanding of key issues that are worthwhile to pay more attention in the promotion efforts of green building practices in Pakistan.

This study examined 30 barriers and 12 measures. Out of 30 barriers, factor analysis enabled 17 barriers to be placed under five components; 1) Management/Leadership barriers, 2) Governmental and socio-cultural barriers 3) Economical and innovation related barriers, 4) Technical knowledge/Awareness barriers 5) Regulation and resource related barriers. As per the survey results, the most critical barrier in the successful implementation of green buildings in Pakistan is 'lack of awareness', followed by 'lack of incentives from government' and 'lack of green building codes and regulations' respectively. All of the 12 measures were recognized as significantly important measures with the most substantial being 'Creation of public awareness towards green initiatives through seminars, workshops and discussions', followed by 'Availability of green building codes and regulations (Mandatory to apply)' and 'Financial incentives and penalties from the government (e.g. tax, soft loan) for green building practices' respectively.

The findings of this study would contribute in the understanding of major barriers and measures needed to promote the adoption of green building practices in Pakistan. The results are expected to contribute valuable information to policy making in construction industry and in the implementation of green building practices in future. The results are based on the perception of local stakeholders, but might also be helpful for policy makers in other countries.

6.1 Limitations and Future Research

There are some limitations of this study that warrant future research attention. First, although the sample size was adequate to conduct statistical analysis, it is appreciated that it is nevertheless a relatively small sample. Future research is required to employ a larger sample to see whether the results would differ from what have been reported in this study. Furthermore, future research could use more advanced statistical analysis techniques, e.g., structural equation modeling, to verify the exact influences of the specific factors on the adoption of GBTs.

Lastly, future study could compare the views of GB experts from different countries on the GBTs adoption issues to observe market-specific differences.

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ANNEXURE