EVALUATION AND EVOLUTION OF GREEN BUILDING RATING SYSTEMS: A POLICY PROPOSAL FOR PAKISTAN

FINAL YEAR PROJECT UG-2012

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ABSTRACT

The construction industry in Pakistan is mounting promptly. Now it is inescapable to becoming cognizant of sustainability and its implication for persistence of our resources. This research and literature mainly emphasis on how sustainability can be integrated in buildings, but till now, there is no research specifically related to the development of a rating system for evaluating the sustainability of green buildings. This thesis presents a rating system for green buildings. It is presented in three parts; the first part presents the extensive and comprehensive literature review of prevailing and effective Rating systems of developed countries in which sustainability measures are considered firmly in construction industry i.e. LEED, BREAM, DGNB and PEARL.

The second part is conducting field survey (Questionnaire). This form was developed to acquire the data from experienced field personals. Questionnaire consisted of number of questions related to sustainability measures (Energy, water, site selection, socio-economic effects etc.). We acquired data in term of percentage assigned to each sustainability criteria. Every person had to assigned particular percentage to each criteria by keeping in mind the importance of each criteria.

The third part was to analyze the data we collected. We sort out the factors according to their significance and percentage assigned by experienced field personnel's. On the basis of these data we developed a policy draft for Pakistan Green Building Rating system.

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We are grateful to Almighty Allah, the most merciful and the beneficent, for giving us the strength to plod on despite our conscience wanting to give up. Thank you so much Dear Allah.

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CHAPTER 1

INDRODUCTION

1.1 General

In last few decades the terms like sustainability and green buildings have gained worldwide recognition. The primary reason for this is an alarming threat that various factors pose to the global environment. Consequently, there is an effort to reduce the effect of these hazardous factors by creating awareness and taking necessary measures accordingly. Concepts like sustainability and green buildings came to the surface, as an offshoot of an overall effort that was initiated few decades back.

In their report *"Our common future"* (1988), World Commission on Environment and Development defines sustainability as, *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"*. So, apparently sustainability is about utilizing the non-renewable resources in a manner that they aren't depleted quickly and maximizing the use of renewable resources. Sustainability is aimed at benefitting from the resources in a way that future generations aren't affected by our activities, and they are left with a better world. Environmental Protection Agency (EPA) of USA defines green buildings as, *"Green building is the practice of building structures and using processes that are environmentally friendly and resource-efficient throughout a building's life-cycle from siting to design, operation, construction, renovation, maintenance, and deconstruction".*

The Intergovernmental Panel on Climate Change (IPCC) in 2001 reported that the drastically changing climatic conditions will increase *"threats to human health, particularly in lower income countries, predominantly within tropical/subtropical countries"* and ability to meets our present and future needs are threatened by that the environmental degradation.

Pakistan is one of the most adversely affected countries; owing to the climatic changes. Despite being a comparatively lower contributor to carbon emissions, it is still in the category of those countries that are considered to be affected the most. A possible way forward is to draft a strategy that can make the implementation of green building codes feasible. Sustainability and green buildings are well-considered and talked about concepts in developed parts of the world. Adequate research and policies have been crafted and above this, modern societies have moved a step

forward by making more practical and tangible efforts. Contrary to this, Pakistan has not seen significant progress in this regard. The progress and research done in this regard are of very basic nature, and need adequate efforts to witness tangible changes.

Construction industry utilizes substantial amount of resources and thus, have a significant contribution towards social, economic and environmental expenses of any country. Resources utilized include monetary investments, material and energy. According to the U.S. Department of State Building, most of the buildings were categorized as structurally deficient and functionally obsolete. It is therefore, imperative to integrate sustainable practices in Building design, construction and maintenance, which will result in building a healthier environment and efficient use of resources and investment. Until now construction industry and professional engineers have been unable to develop any type of rating system for the sustainable Buildings and there is a dire need to describe explicit ways and procedures to define and measure sustainability in buildings. This very part is necessary before any further progress can be made, based upon initial findings and research.

In an effort in this regard, the Construction Engineering Management (CEM) Department of National Institute of Transportation (NIT, NUST) took a step forward to develop a sustainable building rating system, which can be utilized to categorize green buildings. CEM Department supervised this research project to develop a framework for assessing the sustainability in building design, construction and maintenance and provide a set of sustainable guidelines.

1.2 Need Statement

Usage of certain internationally developed green building certification systems in Pakistan without being modified to adjustments with respect to local context leads to a situation where the results of an evaluation does not reflect the reality of site of construction and does not remain effective. Firstly, there is a need to identify which key factors or criteria's would play an important role in developing a green building rating system for Pakistan. Secondly, those criteria's need to be given weightage according to their importance.

1.3 Specific Objectives

The general intent of this study is to give a basic framework for development of Pakistan's green building rating system keeping in mind the construction industry practices of Pakistan. It would be in form of a proposal which can be carried forward for a fully developed and working rating system. The main goals and objectives of this study are:

a. Study and evaluate already existing green building rating systems.
b. Analyze these rating systems and convert them for local context.
c. Give a policy proposal of green building rating system for Pakistan.

1.4 Research Methodology

The study consists of four major phases 1) Literature review, 2) Development of rating system, 3) Conduct survey, 4) Policy proposal. The methodology take on to achieve these phase are illustrated in figure 1. Detail steps involved in these phases are shown on right side of the figure.

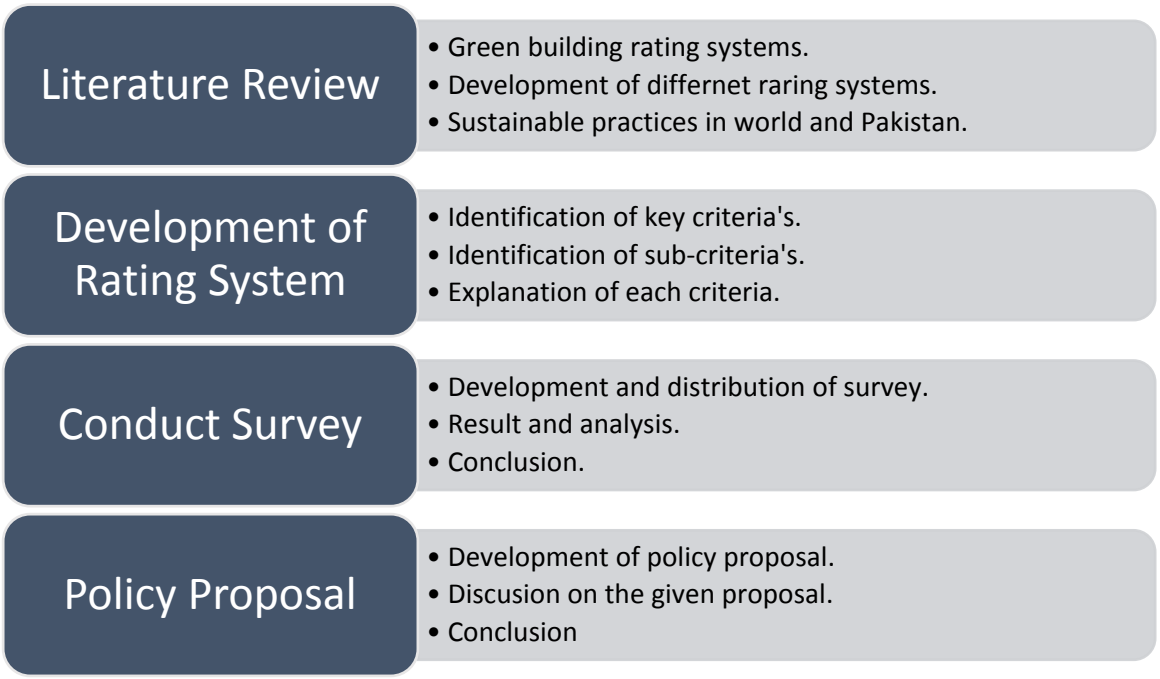

Figure 1: Detail Steps of Research Methodology

Phase 1: Literature Review

In this phase different existing green building rating systems are reviewed and their detailed working is understood.

Phase 2: Development of Rating System

After reviewing the existing green building rating systems different categories for Pakistan were defined keeping in mind the local construction practices and context. Different criterias selected are given in figure 2.

Phase 3: Conduct Survey

Survey was used to collect responses of different construction industry experts. Results from this survey was used to assign weights to all categories. Figure 3 describes the survey phase.

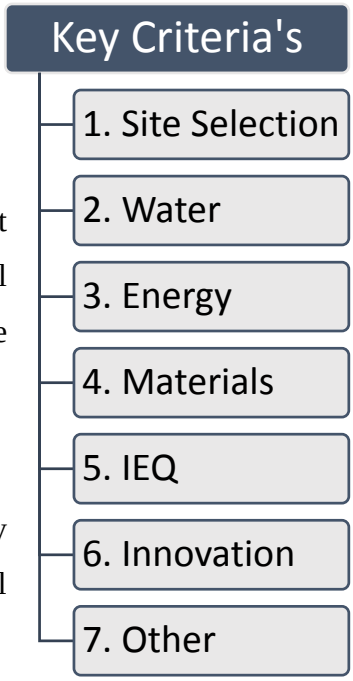

Figure 2: Key Criteria's

Figure 3: Survey Phase

Phase 4: Policy Proposal:

Based on the already developed categories and survey weights a policy proposal for Pakistan is given which defines different criteria's and its respective score.

1.5 Conclusion

This chapter outlines the research need, goals and objectives, methodology, limitations, and research contribution. Green building rating systems are used for measuring sustainability in buildings, but the Pakistan construction industry lacks such specifications and standards. This research study is an effort to develop a rating system which can be used as a constructive tool to define and measure sustainable buildings in Pakistan.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This Chapter deals with the literature review, which encompasses two main categories: sustainability concept, different green building rating systems. Figure 4 illustrates the overall composition of the literature review.

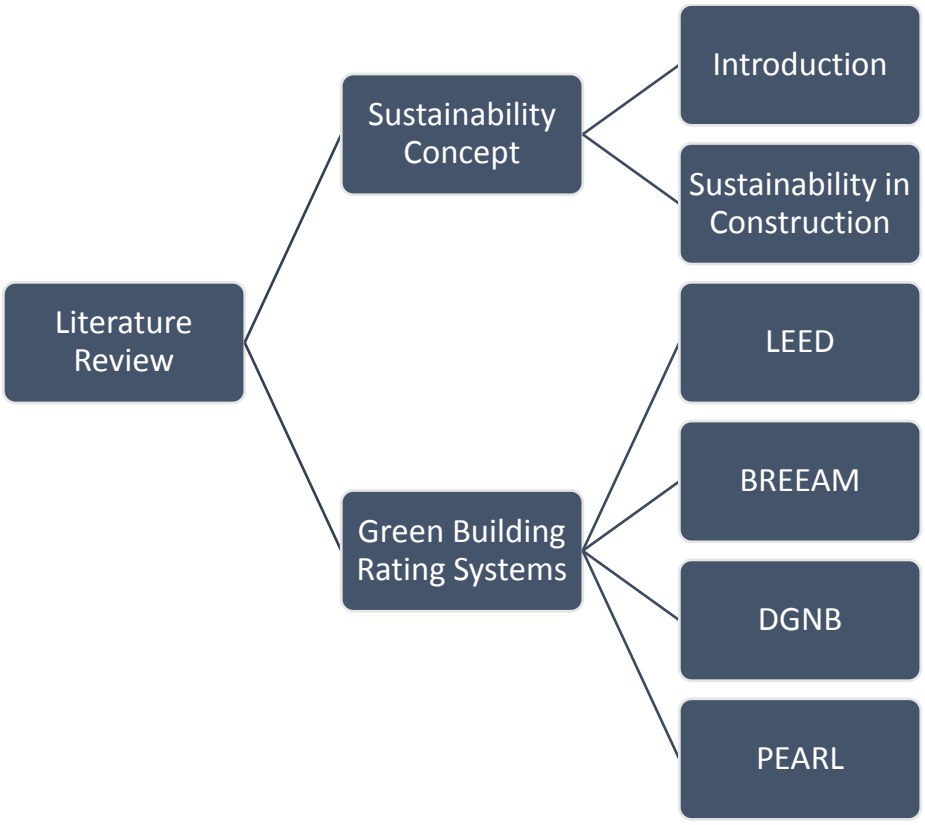

Figure 4: Systematic Diagram of Literature Review

The first category of sustainability mainly composes of three different type of components i.e. environmental, economic and social aspects. A sustainable construction is one which meets all these criteria of sustainability. In second category we learned all that we could about the existing rating systems which would help us in our proposal. How these rating systems evolved and there stages of evolution was studies.

2.2 Sustainability Concept

2.2.1 Introduction to Sustainability

Sustainability, in simpler terms, refer to usage of natural resources in such a balanced state that they do not reach decline, exhaustion and unrenewable point and passing down the succeeding generations by evolving them. In this background, sustainability appears to be a notion labelling to every field extending from global development strategy to use of energy resources and from planning to design in construction.

The notion sustainability has become prevalent in strategy leaning researches as a countenance of what public policies should strive to achieve. Talks about the sustainability started after the Burndtland report in 1987. Subsequently the notion has loosened its meaning. The report states that the change is unfortunate but disguises the conflict which occurs between long-term sustainability and short-term welfare. Furthermore, the difference between three 'pillars' of sustainability is abstractly vague.

Sustainable development has three pillars i.e. economic, social and environmental components and sustainable development cannot be achieved without having a balance between these three. Ecological and social sustainability cannot be presented without taking into economic effects of the sustainability, it is generally accepted that social sustainability is the prerequisite of economic sustainability. These three pillars should be taken into attention as necessary parts of the sustainable development because of their full integrations with each other. Figure 5 shows the relation between sustainable development and its components.

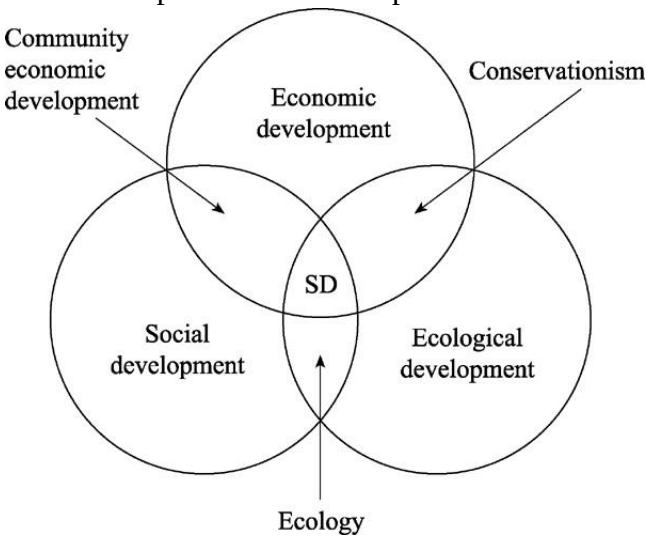

Figure 5: Relation between Sustainable Development and its Components

Leaving a better world for the future generation then what was given to us defines environmental sustainability, guarding the ecological equilibrium and natural systems from annihilation. It is essential to take into attention ecological equilibrium and decrease in consumption of unrenewable energy or other resources.

Sustainability of a resource is reliant on the ability of renewing itself at the equivalent rate. For instance; major process in water cycle is rise of water by evaporation and then dropping again on the earth as rain. One precondition of this process is that water and the air is kept pollutant free, because if the water is polluted by different sources i.e. pesticides or chemicals and the air by emission of carbon particles and gases it would adversely disturb sustainable cycle of water. In another way environmental sustainability is defined as passing onto the natural resources to forthcoming generations without annihilation. For that reasons when deciding levels of natural resources it is imperative to keep in mind that it should not be beyond the renewal rates of that resource and also the rate at which these resources are cleared of any impurities.

In the present modern economic growth strategies, it is presumed that economic action will surge by increasing the buying power of persons and due to which there would be an increase in Gross National Product which will then contribute to individuals. It is assumed from its meaning, this development model depends on unlimited production and consumption. If we see this from ecological perspective this model threats the resources as unlimited but it has been proven that resources which provide basic need of humans are limited and are decreasing by every moment and are not be renewed at the rate of their consumption. Instead it is evident that there are environment problems as a consequence of wastes which are the results of these consumption rage.

The common description of social sustainability is the capability of a social system, such as a country, to function at a distinct level of social wellbeing forever. Social Sustainability which is most significant target of sustainable development emphases on certain basic right and freedom just associated to being a human. The most protuberant one of basic right and freedom is fairness and equilibrium among generations. Resources should be passed onto the next generation to withstand their survival.

2.2.2 Sustainability in Construction

A lot of buildings are needed by peoples for civilization sustainment and these buildings are the responsible for environmental degradation through their construction, operation, maintenance and demolition phase. They also are responsible for consumption of humongous amount of energy and natural resources which have a hazardous impact on climate by disturbing quality of air and water. A study conducted in 2010 showed that construction industry is responsible for consumption of 50% of water, 45% of energy and also responsible for generating 50% of greenhouse gases, 23% of air contamination, 40% of water contamination, and 40% of solid waste in cities are produced by buildings. These environmental degradation caused by construction industry can be significantly reduced by changing the obsolete methods. Furthermore the most obvious or quantifiable consequence of industry is on the environment, socio-economic effects are also among the leading reasons.

Exhaustive use of natural resources because of actions of construction industry, solid and liquid wastes and gas emissions during and at the end of construction and demolition activities have a lot of undesirable effects on the environment. These undesirable effects can be abridged as rapid usage of unrenewable resources, obliteration of forest areas, harm to agricultural areas, air, water and soil contamination, annihilation of natural green areas, and global warming.

Construction industry which is effective in economic respect, it cannot maintain environmental sustainability because of generation of tones of wastes products and not effective utilization of resources proficiently. It has a potential to increase life class of lower class people through job opportunities because of its manual labor concentrated nature of job.

On the other hand construction industry is known for its old techniques and not working towards solution to sustainable development due to which there is a general perception that construction industry never tries for sustainable solution and employs old non-sustainable traditional methods.

Some of the general barricades to achieve sustainable construction are:

a. The absence of awareness from different project participants. A survey revealed that around 60% of construction industry professional never even tried for a green project and a surprising only 32% of clients showed interest in following green standards
b. The absence of training and education in sustainable design and construction.
c. The slow or very slow recovery of high upfront cost in sustainable construction.

d. The high upfront cost of alternatives i.e. sustainable buildings.

Enlist are few of the technical barricades to achieve sustainable construction:

a. Absence of a definite set of sustainable construction standards that can be essentially engineered in construction projects. Though some best practice guidelines are there which covers diverse environmental performance aspects, there are very less properly organized set of rules about procedures related with the including of these environmental problems into the construction.
b. The necessity for an established framework for sustainable practices in construction. Although positive struggles have been continuing to control and enhance distinct features of the environmental qualities of built, but the comprehensive methods that incorporate these separate research strands have generally been lacking. This obstructs the ability of diverse industry stakeholders to collaborate in an identical and productive way.
c. The difference about an optimal project delivery structure to achieve sustainability.

2.3 Green Building Rating Systems

It is creation of a building by using processes which environment friendly and resource effecting from selection of site to demolition phase. They are characterized by usage of recycled material, effective water and energy usage, and minimalized susceptibility to climatic changes; minimalized contaminating to water, air and soil and reducing noise and light contamination thereby minimizing adversarial effect on the environment. Subsequently, this environmental friendly construction process involves social and economic benefits. Socially, they increase the living and working environment standards for people. Economically, they offer life cycle cost benefits to owners and inhabitants.

Building rating systems are eco-friendly and administration tools that helps in concentrating on the construction sector and achieving sustainability, by incorporating economic and social benefits. Rating systems have combined the skills and knowledge from environmental practices, decision making and management tools, which were being used in other prolific sectors and were thus inclined by those. So it’s reasonable to state that a mainstream of the rating systems are grounded on the notion of life cycle analysis (LCA) practice and demonstrates resemblances with the Environmental Management Systems. It’s justified to say that, rating systems are scoring systems

intended to assess new and existing buildings centered on a particular standard of evaluating environmental performance.

Building assessment systems intent to initiate criteria for green buildings by assessing performance beside essentials of these systems. A green building rating system is characterized by elements of a checklist, from which few can be optional. Points are assigned to each criteria based on the weightage of each section and importance to sustainability.

The decisions about which criteria to be include in a system and the assignment of point values are particular to each rating system, though some criteria's can be confirmed accurately, such as by gauging water reduction. Finally, a structure obtains total points to reflect its sustainability. Often, the points are used to allocate a level in ranking, such as platinum, gold, or silver.

Few of the prominent green building rating system are:

2.3.1 Leadership in Energy and Environmental (LEED)

Leadership in Energy and Environmental Design (LEED) is an autonomous verification rating system that offers techniques of formulating and over sighting the environmental standards intended for new and existing commercial, residential and, institutional buildings.

LEED is developed through a consensus-based process that emphasizes the role of technical committees composed of volunteer experts organized into Technical Advisory Groups (TAGs) and other committees under the guidance of the LEED Steering Committee (LSC). TAG members represent diverse perspectives and contribute to the development of requirements and language for prerequisites and credits. Each TAG focuses on ensuring that the technical requirements in LEED are accurate and represent best practices and high achievement levels for its credit category. A Technical Committee, composed of TAG Chairs and other experts, reviews the TAG recommendations to ensure consistency and integration across all credit categories.

Since that time, LEED has been extended to address a diverse types of building and has been modernized and revised to incorporate new concerns and elevate performance standards. LEED 2009, the current version, now includes a family of rating systems that address diverse building types in different stages of development. LEED presently comprises the following:

- New Construction.
- Commercial Interiors

- Existing Buildings: Operations & Maintenance
- Neighborhood Development
- Core and Shell
- Homes and Residential.

There are also specific rating system variants for Schools, Retail, and Healthcare, with additional specifications for data centers, hotels and warehouses/distributions centers under development.

All LEED rating systems are composed of prerequisites and credits. Prerequisites are mandatory elements required for certification. In addition, projects must obtain additional points through achievement of elective credits. The number of credits achieved governs the project certification level as Certified, Silver, Gold or Platinum being the highest level. LEED 2009 for NC certifications are presented according to the following scale:

Certification	Points
Certified	40-49
Silver	40-59
Gold	60-79
Platinum	80+

Table 1: Certification for LEED-NC

The LEED rating systems included in this study contain prerequisites and credits in eight categories (LEED-NC):

Location and Transport: This criteria encourages to ponder over decide about location of the project, and credits points given to projects with public transport and amenities.

Sustainable Sites: This inspires approaches that diminish the influence on ecosystems and water bodies and addresses location.

Water Efficiency This recommends efficient use of water, inside and out of the structure, to decrease potable water intake.

Energy and Atmosphere: This encourages improved building energy performance by innovative approaches and incorporates facility commissioning, on site renewable energy production.

Materials and Resources: This promotes usage of sustainable building materials and reduction of waste, encourages materials reuse.

Indoor Environmental Quality: This encourages better indoor air quality, comfort, and access to view and daylight, it also states minimum IAQ standards.

Innovation in Design: This states innovative approaches, exemplary standards and presence of a LEED Accredited Professional on the project team.

Regional Priority: To deliver an incentive for the attainment of credit points that encourage geographically related environmental significance.

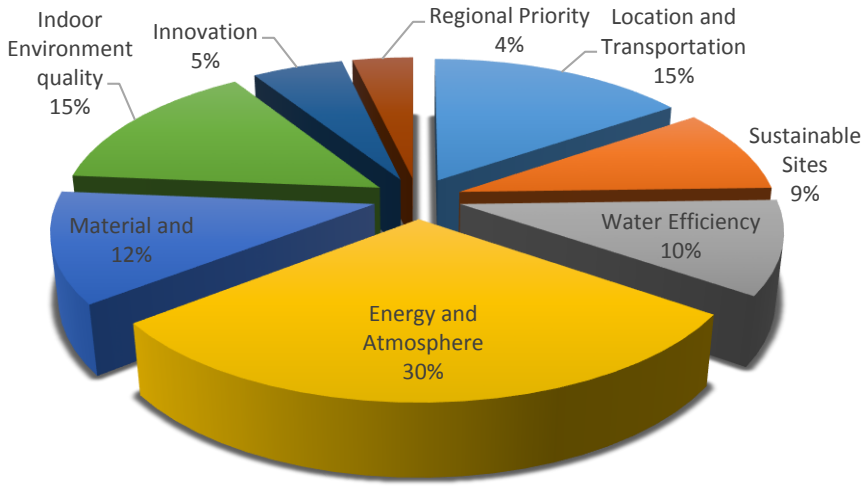

Figure 6: Weights of Each Section

2.3.2 Building Research Establishment Environmental Assessment Method (BREEAM)

BREEAM was the world's first mainstream sustainability rating system for the construction environment and has added much to the tough emphasis in the United Kingdom on sustainability in building design, construction and usage. Now BREEAM has evolved into an international standard that is locally adapted, operated and applied by a system of international operatives,

evaluators and industry professionals. From its application and use BREEAM helps customers quantify and reduce the environmental effects of their structures and in parallel creating higher value and lower risk assets. Together with LEED they are the most prevalent systems.

Efforts on forming BREEAM started in 1989 at the Building Research Establishment, and the introductory version for evaluating new office buildings was launched in 1990. This was trailed by versions for other structures including industrial units, superstores, and existing offices. In 1998 there was a key facelift of the BREEAM Offices standard. The expansion of BREEAM then augmented with yearly updates and versions for other structure categories such as retail premises.

In 2000 EcoHomes was launched which is a version of BREEAM for new homes and this system was advanced for development of Code for Sustainable Homes. An extensive apprise of all BREEAM versions in 2007 resulted in the introduction of obligatory post construction standards, minimum credits and innovation credits. International versions for BREEAM were also launched in the same year. Additional update in 2011 saw the introduction of BREEAM New Construction, which is now being used in UK for accessing and certifying buildings.

BREEAM has extended from its original attention on separate new structures at the construction phase to incorporate the whole life cycle of structures from development to in-use and maintenance. Its consistent amendments and updates are determined by the continuing need to improve sustainability, respond from the industry as feedback and support the UK's sustainability policies. Extremely supple, the BREEAM standard can be used to access nearly any building and location, with variations for new buildings, existing buildings, and refurbishment projects.

BREEAM is accessed five different categories:

- **BREEAM New Construction:**
- **BREEAM International New Construction**
- **BREEAM In-Use**
- **BREEAM Refurbishment**
- **BREEAM Communities**

The BREEAM assessment standards for projects evaluated by the use of BREEAM International New Construction 2016 scheme are shown in table 2,

BREEAM Rating	% Score
Outstanding	≥ 85
Excellent	≥ 70
Very Good	≥ 55
Good	≥ 45
Pass	≥ 30
Unclassified	< 30

Table 2: BREEAM Rating Benchmark

BREEAM evaluates the whole performance of structures using environmental features such as energy efficiency, water consumption, internal environment, pollution, transport and materials, awarding credits points in each category according to buildings' performances.

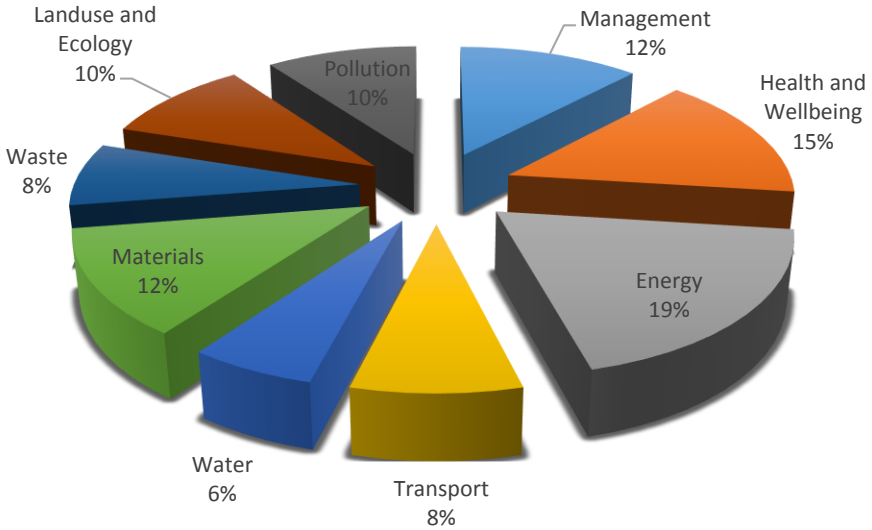

Figure 7: Weights of Each Section in BREEAM

2.3.3 German Sustainable Building Council (DGNB)

DGNB roughly translates to German Sustainable Building Certificate established in 2009 under the collaboration of German Sustainable Building Council and Federal Transport Ministry and Urban Affairs as a system to provide planning and assessment of structures. On a deeper level DGNB was put forward as a second generation green building assessment system in compliance with the European Standards for sustainable structures.

Economy, ecology and social features are the classic three pillars of sustainable development and DGNB is based on these columns. Two multidimensional topics or categories i.e. technical and process quality of a construction are also part of DGNB. The site or location is evaluated separately and acts as mandatory criteria. As of now there are six topics under which DGNB evaluates a building Economical Quality, Ecological Quality, Functional Quality, Process Quality, Socio-cultural Quality, and Quality of Location furthermore these topics are segmented in criteria groups and sub-criteria's. These sub-criteria's are accessed either by quality or quantity depending upon the sub-criteria. DGNB is a flexible evaluation system due to which each criteria has a weights from 0 to 3 and adjusted according to type of the building. Overall there are presently 49 from 63 criteria's activated.

Those who wants there projects to get certified by DGNB should necessarily hire a certified DGNB auditor who would help the design team during this whole process. First step is to get your project registered online at DGNB's website then work closely with the auditor and design the project according to his recommendations as he identifies the potentials where building could be improved. Once the design is completed auditor gives suggestions in construction phase as well and after the completion of building all the documentation is send to DGNB, and the process of determining the certification level is undertaken.

Once the auditor is hired and design phase is carried a pre-certification can be received but it's not a guarantee to final certification. This pre-certification is issued in same certification levels for which building is targeting its final certification. Pre-certification is generally used for marketing and has no other such use to it.

There are five topics under which DGNB assesses or evaluates a green building, and under these topics there are different criteria's and sub-criteria's each having different percent weight

according to their importance. Figure 8 shows the interconnection between these five topics of DGNB and basic framework:

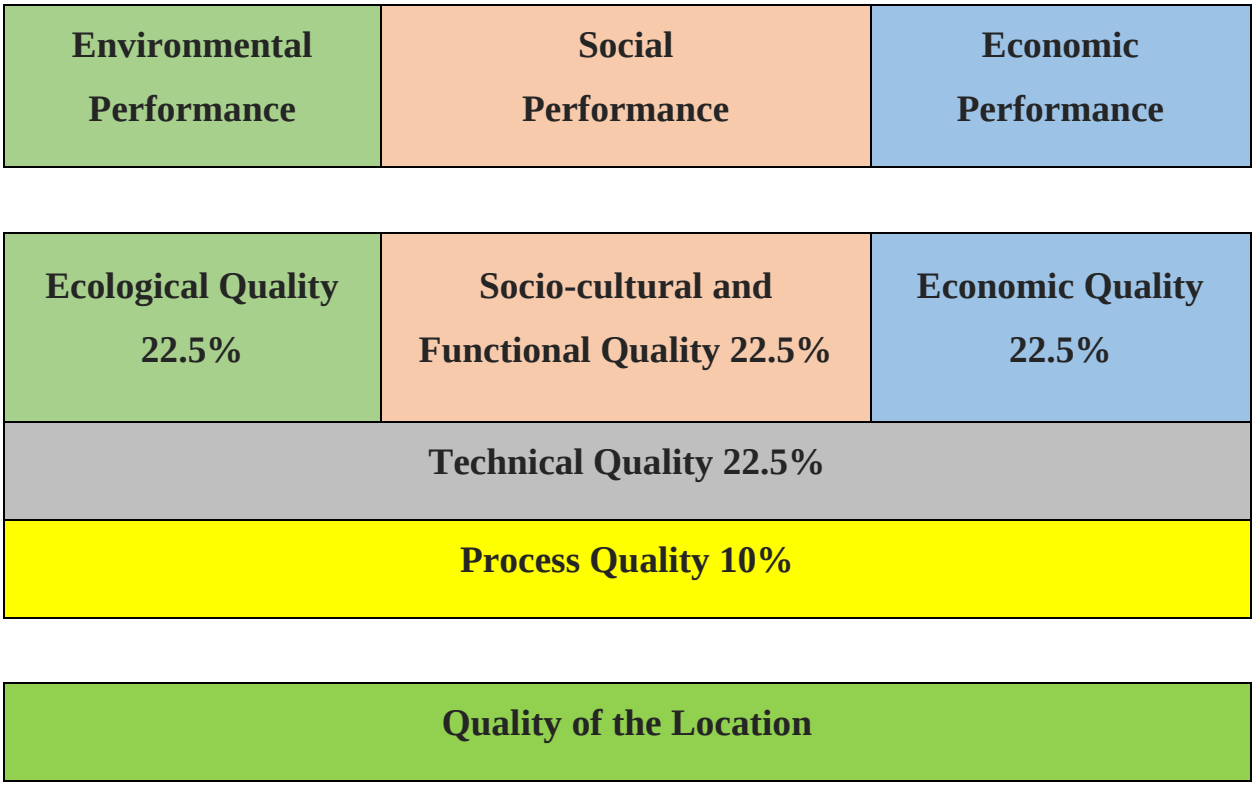

Figure 8: DGNB Scoring Framework

DGNB is a complex credit impact factors and percentage created evaluation and certification scheme. The highest number that can be attained by a project is 100. The assessment system is distributed into four certification groups i.e. Platinum, Gold, Silver and Bronze. Weightage is given in the scheme by weightage of single assessment criteria and impact factors for criteria.

Award	Total Performance Index
Platinum	≥ 80%
Gold	≥ 65%
Silver	≥ 50%
Bronze	≥ 35%

Table 3: DGNB Award Criteria

2.3.4 PEARL Rating System for Estidama

The Pearl Rating System is the sustainable rating system developed by the Urban Planning Council of Abu Dubai as part of their sustainable development vision, Estidama. Currently Pearl is applicable to buildings, communities and villas with different standards for each. It is somewhat comparable to LEED, it has several certification ranging from one pearl to five pearls being the highest certification. Pearls has maximum of 180 points across 7 sections further divided into sub sections. A minimum certification of one pearl is mandatory for all new projects within Abu Dhabi and for government buildings a least of two pearl certification is compulsory. This different levels of certification requirement was authorized by the Executive Council of Abu Dhabi and become part of building by laws in second quarter of 2010.

The Pearl Rating System intentions are to encourage the sustainability of a project during its lifecycle from designing phase to construction and operation phase. The Pearl Rating System offers design direction and thorough standards for evaluating a project potential in relative to the four pillars of Estidama.

The Pearl Rating System is systematized into seven criteria's that are essential to sustainable development. These seven criteria's of the Pearl Rating System are:

- Integrated Development Process
- Natural Systems
- Livable Buildings
- Precious Water
- Resourceful Energy
- Stewarding Materials
- Innovating Practice

The sum of credits obtainable in a given criteria regulates the weighting of that criteria. Diverse building usage might have a different sum of credits for a specific module. This is envisioned to strengthen the serious issues that should be addressed for a specific building usage. For a mixed use structure, the total sum of credits obtainable will differ dependent on the different uses present.

Credit Section	Maximum Credit Points
Integrated Development Process	13
Natural Systems	12
Livable Buildings	37
Precious Water	43
Resourceful Energy	44
Stewarding Materials	28
Innovating Practice	3
Total	100

Table 4: Maximum Credit Points in Pearl

Within every criteria there are both compulsory and discretionary credits points and credits are granted for each discretionary credit attained. To attain a 1 Pearl rating, all the compulsory credit requirements should be full filled. To attain an advanced Pearl rating, all the compulsory credit requirements should meet beside a least number of points.

Requirement	Pearl Rating Achieved
All mandatory credits	1 Pearl
All mandatory credits + 60 credit points	2 Pearl
All mandatory credits + 85 credit points	3 Pearl
All mandatory credits + 115 credit points	4 Pearl
All mandatory credits + 140 credit points	5 Pearl

Table 5: Pearl Rating Levels

2.4 Comparison

Comparison of few leading rating system was done by studying and understanding the technical document of all the rating system. Categories of LEED was taken as a benchmark and every other rating system was compared. This comparison has been shown in tabular form in table 6:

	LEED	BREEAM	DGNB	PEARL
Management	✓	✓	✓	-
Energy Efficiency	✓	✓	✓	✓
Transport	✓	✓	Included in environmental Aspect	Included in livable buildings: Outdoors
Sustainable Site	✓	✓	✓	✓
Indoor Environmental Quality	✓	✓	Included in sociocultural and functional quality	✓
Water Efficiency	✓	✓	✓	✓
Materials	✓	✓	✓	✓
Socio-economic aspects	-	-	✓	-
Innovation	✓	✓	✓	✓
Environmental impacts	✓	Included in assessment criteria	Included in ecological quality	Included in natural system

Table 6: Comparison of Green Building Rating Systems

This study shows that DGNB as only rating system which gives emphasis on social and economic aspect of the building. Other than that all of the rating system has same major objectives to be met, with different percent of emphasis on these categories. The percent emphasis was also compared four different rating system named LEED, BREEAM, DGNB and PEARL by studying the

technical manual and its credit points for every green building rating system. It has been tabulated in table 2-7:

	LEED	BREEAM	DGNB	PEARL
Site selection	24.5%	20.5%	Separate Evaluation	16%
Water	5.5%	2.5%	2.5%	25%
Energy	33%	33%	6%	25%
Materials	13.5%	13.5%	9%	16%
Indoor environmental quality	14%	13%	22.5%	20%
Innovation	6.5%	6.5%	4.5%	2%
Other	4% (Regional Priority)	12% (Facility Management)	23% Economic Quality 10% Process Quality 22% Technical Quality	7% (Integral Design Process)

Table 7: Percent Emphasis

2.5 Conclusion

The chapter summarizes the research in two main categories i.e. sustainability concepts and green building rating systems. After going through all the documentation of above green building rating system and different research papers we came to fully understand the working of all these rating system and there development phases over years which would be help full for us in developing Pakistan's own green building rating system.

CHAPTER 3

FRAMEWORK FOR ASSESSING SUSTAINIBILITY IN BUILDING

3.1 Overview

Based on the detailed content analysis discussed in the previous chapters, the framework is divided into seven sections: 1) Site Selection, 2) Water, 3) Energy, 4) Materials, 5) Indoor Environment Quality, 6) Innovation, and 7) Others.

Site selection deals with selecting sites that does not have impacts on the environment due to its location. Water section emphasizes on increased water efficiency inside and outside of buildings to decrease the load on public water supply and wastewater systems. Energy section emphasis on ways and methods to rely less on the conventional electric generation and encourages sustainable ways for electric consumption. Materials section inspires designers and developers to consider complete life cycle when choosing and acquiring materials, with a broader need to improve the social and environmental results associated with their transport, manufacture, disposal, and installation. Indoor environmental quality establishes minimum indoor air quality standards to enhance indoor air quality and comfort within the buildings, thus contributing to the comfort and wellbeing of the dwellers. Innovation provides the design teams and project owners with an opportunity to achieve unique performance above the standards. Other section consists three individual criteria's not related to each other's, Regional priority, Life cycle cost analysis and socio-economic effects.

The description, aim, and requirements have been established for each criterion by consulting various references such as LEED-NC, BREEAM, DGNB, Pearl, Environmental Protection Agency (EPA), World Green Building Council (WGBC), and European Standards (ENs).

Next few pages enlists and define seven sections and there criteria's put forward after careful consideration and review.

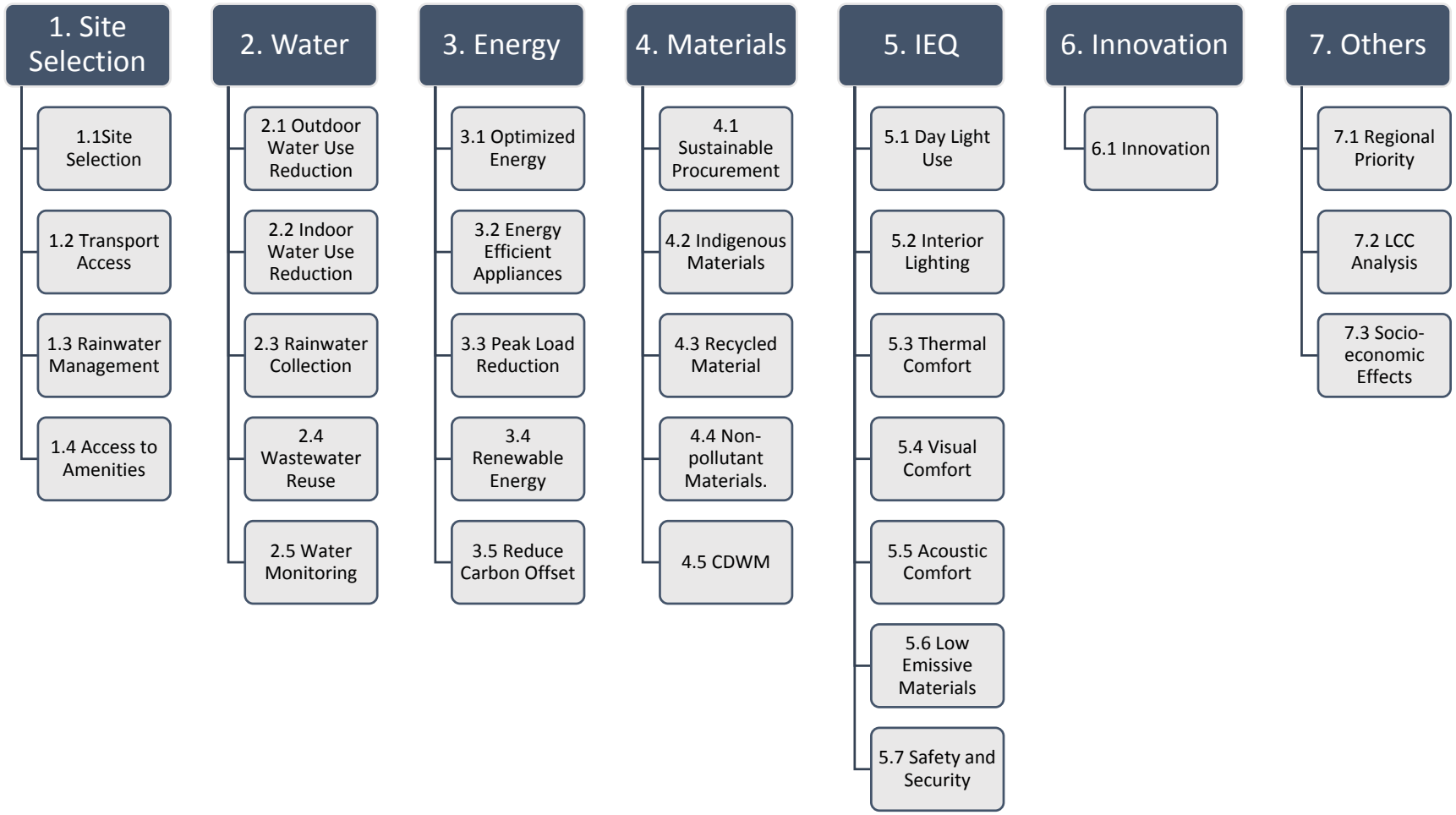

Figure 9: Key Criteria's and Sub-criteria's

1. Site Selection

Site selection deals with selecting sites that does not have impacts on the environment due to its location.

1.1 Site Selection

Description

Site selection plays a vital role towards sustainability. Preference should be given to already develop sites, as further environmental damage is limited due to lesser construction activities. Selecting the site wisely preserve natural habitats; avoids encroachment of sites on water bodies and agricultural lands.

Aim

Discourage the use of inhabitant land thus reducing the environmental impact of site due to its location.

Requirements

Do not select site for a new building, roads or parking lots on portions of land that come in conflict with any of the following conditions:

- Land which was previously undeveloped and its height is lower than 3 meter above the height of 1 century flood levels.
- Land which has been identified as a breeding place for any threatened or endangered species.
- Land which is less than 35 meter away of any marshlands or areas of distinct distress as identified by state or local rule, OR is in the setback distances from marshlands suggested by state or local authorities.
- Land which was previously undeveloped and is within 15 meter of a water body i.e. tributaries, streams, rivers, lakes and seas which support marine life, recreational activities or industrial usage.
- Land that preceding to procurement for the project was Public Park, exception can be given if land of equal or greater value as Public Park is accepted in trade by the public authorities.

1.2 Transport Access

Description

Minimum use of personal vehicles and usage of alternate transport like bicycles as they reduce the pollution caused by the auto vehicles.

Aim

Encouraging the new owners to develop building which is in close proximity to a public transport system.

Requirements

- The project site is should be within 350 meter of safe walking distance, measured from main entrance of building to the usable public transport stop.
- Exception can be given to the public transport stop which are under construction or in planning phase if they are to open with 1 year of completion of the project.

1.3 Rainwater Management

Description

Rainwater runoff is the major source for water body pollution, as runoff is generated after a rain it washed out the pollutants into the water body and also the stagnant water after rain caused many diseases and public discomfort.

Aim

To reduce the rainwater discharge and protect the water bodies from receiving pollutant load after the rain fall.

Requirements

- Establish a storm water controlling system that infiltrate the storm water, and develop a sustainable drainage systems.
- Show that peak runoff developed is less than the rainwater carrying capacity of the convince system using the data from previous 2 year 24 hour design storm.

1.4 Access to Amenities

Description

Easy access to different amenities is the prominent problem in high density urban development which increases the reliance on personal vehicles to reach these places which contributes to the pollution and road congestions.

Aim

To reduce dependence on individual car use by selecting the site of the new buildings within the area having a mix use and amenities.

Requirements

Newly constructed building should lie within 350 meter of safe walking distance from the building entrance to any publicly approachable building entrance of any six of the following:

- Grocery Store or Market
- School
- Library
- Mosque
- Daycare
- Gymnasium or Swimming pool.
- Police station
- Hospital/ Medical Services / Pharmacy.
- Public playgrounds and/or shaded picnic areas

2. Water

Water section emphasizes on increased water efficiency inside and outside of buildings to decrease the load on public water supply and wastewater systems.

2.1 Outdoor Water Use Reduction

Description

Unmonitored outdoor water consumption is one of the biggest source of water wastage and can be controlled by few preventive measure thus saving the precious potable water.

Aim

To emphasis on providing the water metering devices on all exterior water uses aiding in effective management of outdoor water use and preventing the leakage.

Requirements

Exhibit easily manageable and visibly labelled water meters are provided and they are capable of monitoring the water use, at a minimum of the following exterior water uses:

- Swimming pools
- Gardening hose.
- Water features.
- Irrigation systems.
- Swimming pools.

2.2 Indoor water use reduction

Description

Reducing the indoor water use has many implications it negates the need of large water supply facilities and systems. Which in turn reduces the wastewater generation this reducing the cost of treatment of waste water and saving energy.

Aim

To promote the reductions of indoor potable water consumption by using water efficient appliances and fixtures and reuse of recycled water.

Requirements

- Using approaches that use less water than the baseline calculated for the building, not including irrigation usage.
- Water baseline for the building is calculated based on average occupant usage and must include following fixtures and fittings, urinals, showers, water closets, faucets, lavatory, and spray valves.

2.3 Rainwater Collection

Description

Rain water is a big source of water where underground water is not easily available but rain water is not utilized to its maximum which results in runoff and wastage of water source.

Aim

To collect rainwater using different techniques and let minimum amount of rainwater to be wasted.

Requirements

- Harvesting of at least 50% of rain water.
- Minimizing the rainwater runoff to go into sewage

2.4 Wastewater Reuse

Description

Gray water from taps constitutes of more than 50% of total household consumption this water which is not polluted to the extreme could be used again before discharging back into the sewage.

Aim

To reuse wastewater back in water cycle thus decreasing the demand of potable water.

Requirements

- Total demand of the building potable should be reduced by 50% by suing water saving fixtures or through the reuse of non-potable water i.e. rainwater, and/or gray water.

- At least 50% of the wastewater should be treated on site and reused for purposes like gardening and/ or in urinals

2.5 Water monitoring and leakage detection

Description

As the trend of underground and in wall water fitting has increased so has the unmonitored water leakage which causes the precious water to be wasted.

Aim

To ensure there is not water leakage in system through different checks.

Requirement

The water leak detection system must be:

- Able to locate and identify leakage and its rate.
- Flexible enough to meet the requirements of occupiers water consumption conditions.
- Flow control regulators should be installed for each WC areas and adjustable to demand to minimize water wastage from leakage.
- Valves for isolation should be in place allowing isolation of cold and hot water by hand for the following supplies.
    - Taps.
    - Showers.
    - Incoming pipeline.
    - Outgoing pipeline.

3. Energy

Energy section emphasis on ways and methods to rely less on the conventional electric generation and encourages sustainable ways for electric consumption.

3.1 Optimize Energy Performance

Description

Household is one of the major consumer of electricity and a major portion of it could be conserved by usage of energy conservation recommendations.

Aim

To encourage the decreases in the projects energy intake and thus sinking the carbon emissions linked to structure operation.

Requirements

- Exhibit a significant improvement in the planned structure performance rating with respect to standard structure performance rating.
- Fulfill the requirements of the ASHRAE Advanced Energy Design Guide suitable to the scope. Project teams should fulfill the all appropriate standards as recognized in the Advanced Energy Design Guide for the climate zone where structure is situated.

3.2 Energy Efficient Appliances

Description

Usage of obsolete and conventional energy appliances i.e. incandescent bulb are non-sustainable but also the major source of cost increases.

Aim

To identify and boost usage of energy efficient appliances to warrant optimum standards and energy efficiency in operation building.

Requirements

- Establish the structure's equipment energy and approximation its impact to the entire yearly equipment energy intake of the structure, presuming a typical design.
- Establish the systems or procedures that intake a substantial percentage of the entire yearly equipment energy intake of the development and its operation.
- Exhibit a significant decrease in the entire yearly equipment energy intake of the structure.

3.3 Peak Load Reduction

Description

Usage of electricity during peak hours not only cause production of more harmful gases but also cause problems especially in energy deprived countries.

Aim

To decrease energy consumption and consequential increased structure consumption to accommodate for loads at peak usage time by use of innovative building and services design and also on site renewable energy generation.

Requirements

- Exhibit that the peak electrical consumption is below 80% than the structure’s design annual mean electrical consumption.

3.4 Renewable Energy Production

Description

Production of electricity from non-sustainable sources not only produces harmful gases but are also the source of harm to human health.

Aim

To establish and identify increasing number of site renewable energy generation to decrease environmental and economic effects related with fossil fuel energy usage.

Requirements

- Exhibit that the site based renewable energy analysis study has been endeavored, and that suitable technologies have been nominated for usage on site as an outcome of the study.
- Site based renewable energy systems should be used to decrease structure's energy costs. Performance of the on-site renewable energy generation should be exhibited as a percent decrease in buildings annual energy cost.

3.5 Reduce Carbon Offset

Description

Carbon based materials are the most prominent source of environmental degradation and emission of harmful carbon dioxide and greenhouse gases.

Aim

To boost the usage of design actions which reduce carbon emissions and minimalize dependence on active building service system.

Requirements

- Study should be undertaken by the end of design stage with help of energy specialist to identify the most suitable local low or zero carbon energy sources for the structure and its construction.
- A local low zero carbon technology should be quantified for the structure and its construction identified in the study.

4. Materials

Materials criteria motivates engineers and designers to study whole lifecycle when selecting and obtaining materials, with a broader necessity to develop the social and environmental consequences related with their conveyance, production, discarding, and fitting.

4.1 Sustainable Procurement

Description

Meet the requirements for materials not based on cost benefit investigation, but with an understanding to maximize net interests of the world.

Aim

To identify and inspire the identification and obtaining of conscientiously obtained building products.

Requirements

- At the end of design phase, there should be a written strategy and process that show procurement obligation for all vendors and traders to follow these protocols.
- The standard strategy and process must be spread to all applicable internal and external workforces.
- The strategy and technique must encourage the requirement of goods with responsible obtaining authorization over parallel goods without authorization.

4.2 Indigenous Material

Description

Materials procurement from far away sources not only increases cost but also decreases the chances of local community development.

Aim

To inspire the selection of construction resources that have low transportation effects and endorses local economies.

Requirements

- Prove that the distance traveled by good, is not more than 500 km from the farthest point of source to the construction site.
- Any goods sent by air transport during their transportation do not qualify for this point.
- Price of local goods should be equal to at least 10% of Total Goods Cost.

4.3 Recycled Material

Description

With a lot of demolition of old structures handling of demolition waste has become a problem and there usage again in construction process help mitigate this problem.

Aim

To incorporate the recycled material during design and construction phase, helping in reducing the environmental impacts from extracting new materials.

Requirements

- Use recycled material in a manner that the total cost of recycled material should be 10%-20% of total material cost of the project.

4.4 Non-pollutant Material

Description

Pollutant materials which are banned in EU countries degrades the human health and are a constant risk to human environment.

Aim

To endorse the choice of resources that do not pose a long-term harmful effects on human well-being or contaminate natural ecology.

Requirements

- Insulating materials used for thermal protection should have a small Global Warming Potential of less than five and Ozone Depleting Potential of zero.
- Usage of chlorine based goods like PVC, CPE, and CPVC should be banned or minimized in favor of more sustainable substitutes.
- Eradicate goods or building material comprising elements or composites with harmful health effects.

4.5 Construction and Demolition Waste Management

Description

With more and more construction and ever increasing demolition of old structures its becoming problematic for management of these wastes.

Aim

To redirect building and demolition wreckage from dumping in junkyard and incineration units back into construction process.

Requirements

- Reutilize and recover harmless construction and demolition wreckage.
- Improve and device a waste managing strategy that classifies the materials to be redirected from dumping site and whether the materials will be fixed on-site or commingled.
- Prove that the contractor executed monthly observing of the building and demolition left-over management strategy, and attained a least final salvage rate of 30% of building and demolition waste.

5. Indoor Environment Quality

Indoor environmental quality forms least indoor air quality values to improve indoor air quality and ease within the structure, thus increasing the health of the inhabitants.

5.1 Day Light Use

Description

In countries like Pakistan day light is around more than 12 hours daily which can be utilized for saving energy and cost.

Aim

To endorse structure designs that exploit the usage of natural day light inside of a building.

Requirements

- Equip the building with day light sensors for the lighting system.
- Equip occupancy sensors all around the building for automated controlling of lighting systems.
- Automatic or physically controlled interior or exterior glare controller devices to all windows.
- Automatic glare controller devices must be linked to the building managing system.
- All physically controlled interior glare controller devices must not be wider than 4 m and be manageable by inhabitants.

5.2 Interior Lighting

Description

Interior lighting system should provide comfort to the inhabitants.

Aim

To stimulate interior visual ease through by the usage of high end lighting fixtures.

Requirements

- No incandescent lights may be fitted in the indoor environment, and all interior and permanently fitted fluorescent light fittings must include high end electronic ballasts.

5.3 Thermal Comfort

Description

Without the thermal comfort a structure cannot fulfill its basic criteria and the needs of the inhabitants i.e. providing protection against weather changes.

Aim

To guarantee suitable thermal comfort done through design, and controls are designated to preserve a thermally calm atmosphere for inhabitants within the structure.

Requirements

- Local thermal comfort standards must be used to govern the level of thermal comfort in the structure, in specific interior winter and summer temperature ranges should be in line with the suggested comfort standards.
- If the thermal comfort standards are not being met for the predictable weather change, the project team must establishes how the structure has been modified, or designed to be effortlessly modified in the future using passive strategy solutions to meet conditions.

5.4 Visual Comfort

Description

Usage of max daylight through the building provide comfort to inhabitants and also the building should be well lit.

Aim

To guarantee day lights, artificial lights and resident controls are well thought out at the design phase to guarantee best practice in visual standards.

Requirements

- The possibility for restricting glare has been planned for all applicable building zones using a glare control plan, either through structure form and plan or building design procedures.
- Attain a straight line of sight to the outside atmosphere via vision glazing between 20 inches and 80 inches above the FFL for building occupants in 80% of all frequently occupied zones.

5.5 Acoustic Comfort

Description

Providing dwellers comfort against unnecessary acoustic levels from outside and inside the sound sources.

Aim

Deliver acoustic comfort that are appropriate with the acoustic privacy necessary for the planned intent of building.

Requirements

- A appropriately trained acoustician is hired by the client at the suitable phase in the procurement procedure to deliver early design advice on:
    - Outside causes of sound impacting the chosen location.
    - Location layout and zoning of the structure for respectable acoustics.
    - Acoustic standards for users with special hearing requirements.
    - Acoustic management of dissimilar regions.
- Establish that interior ambient noise levels do not exceed 40 dB, in rooms and do not surpass 45 dB in other zones.

5.6 Low Emissive Material

Description

Using materials with high VOC causes long term ill effects on human health and severe problems for the dwellers.

Aim

To decrease the extent of interior air pollutants that are aromatic, irksome and damaging to the comfort and health of installers and inhabitants.

Requirements

- All epoxy and sealants used on the inner side of the structure should be inside Volatile Organic Compound Limits.
- Exhibit that the inner surface area enclosed by paints in the structure meet or are lower than the upper limit of VOC.
- Exhibit that 100% of all surface areas concealed by carpets, cushion, hard floor and related surfaces fulfill the Indoor Air Quality Requirements.

5.7 Safety and Security

Description

Providing safety and security to the inhabitants is of paramount importance and should be able to provide them effectively.

Aim

To deliver a safe and secure atmosphere for structure inhabitants and invitees.

Requirements

Exhibit suitable safety & security risk extenuation for the progress, through one of the next two tactics:

- Application of risk extenuation actions decided in discussion with the Safety & Security Team as part of the Development Review Process.
- Where discussion with the Safety & Security Team is not directed as part of the Development Review Process, develop the following plans to validate safety:
    - Safety & Security Risk Assessment.
    - Safety & Security Strategy.
    - Safety & Security Layout Plan.

6. Innovation

Innovation delivers the project teams and vendors with a chance to attain exclusive performance overhead the criteria's.

6.1 Innovation

Description

Construction industry is perceived as one of the least innovative industry which may be true because of the centuries old methods still in place with little modernization.

Aim

To sustain innovation within the construction industry by acknowledgement of sustainability associated advantages which are not compensated by typical green building rating system.

Requirements

- Attain noteworthy, and quantifiable environmental achievement using an approach not tackled in the rating system.
- Accomplish exemplary achievement in current prerequisite or points that permits exemplary execution. An exemplary credits may be achieved by acquiring double the point requirements.

7. Others

7.1 Regional Priority

Description

Many of the commercial and domestic building does not fulfill their purpose effectively because the priority and requirement of public was not kept in mind while design phase which results in loss of capital.

Aim

Offer an inducement for the accomplishment of points that tackle geographically related environmental significances.

Requirements

- Originate an approach for including architectural and technical results that are encouraged by cultural and regional models, and validate their influence to energy productivity, water preservation or enhanced indoor or outdoor well-being.

7.2 Life Cycle Cost Analysis

Description

Life cycle cost analysis is an important technique, which assist in making investment decisions. They are principles and procedures for comparing present and future prices to reach at most cost-effective solution for assuring that a structure would deliver the service for what it was envisioned.

Aim

Permit operational and lasting judgments about structure design and construction for exploiting maximum productivity over the entire lifespan of the development.

Requirements

- Quantify the lifecycle effect of the structure by using lifecycle assessment tools.

7.3 Socio-economic Effects

Description

It accesses the impact of development has on communities social and economic wellbeing.

Aim

Study and incorporate the social and economic effects of a building

Requirements

- Undertake a comprehensive study to find the social and economic effects of the building on the public and society.

CHAPTER 4

SURVEY, DATA COLLECTION AND ANALYSIS

4.1 Overview

This Chapter deals with the survey methodology adopted to obtain weights for the categories Site Selection, Water, Energy, Indoor Environmental Quality, Innovations, and others by awarding points to various criteria to rate sustainable buildings based on the professionals opinion. The questioner approach was chosen to obtain quantitative results for this research study and consisted of one round of survey. The surveys were conducted from the professionals and experts working in construction industry and educational institutes in Pakistan.

4.2 Phases in Survey

The overall survey was segmented into four phases. This includes development, distribution, Analysis and Results, and Conclusion of survey. These four survey phases can be summarized in the Figure 10.

Figure 10: Phases in Survey

4.2.1 Phase 1: Development of Survey Form

In phase 1, survey form was developed using the already developed framework which can be referred in Appendix A, five questions about the participants background were asked with name

being optional, other being qualification, nature of job, experience, and previous knowledge of sustainability. Each criteria with their sub-criteria's were written under a different section and participants to provide there percent weights out of 100 for each section, a column for describing each sub-criteria was provided for facilitating the participants and comment section in front of each sub-criteria was provided for any suggestions. At the end weights for each criteria's as a whole were asked again giving a total score of 100 which would be used to find percent weights of each criteria and there sub-criteria's.

4.2.2 Phase 2: Distribution of Survey Form

Phase 2 consisted of distribution of the already formed survey questioner, it was emailed, hand delivered and sent through Google Forms to around 300 people from every part of construction industry and also educational institutes.

4.2.3 Phase 3: Analysis and Results

Out of 300 delivered survey form, 68 responses were received thus achieving a respectable response rate of 22% was achieved. After the collection of received responses they were put into an excel sheet and different analysis were carried onto them.

4.2.3.1 Demography

Of the five background question asked four of them were used to develop demography of the respondent's i.e. their qualification, nature of job, experience, and previous knowledge.

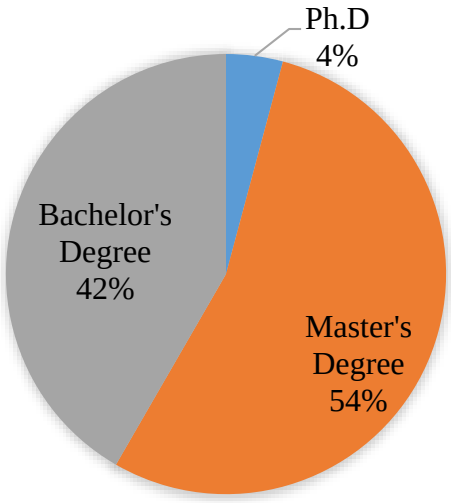

Figure 11: Qualification of Respondents

Out of 68 respondents more than 50% has a master's degree 54% to be exact, 42% has a bachelor's degree, and a small chunk of 4% has a Ph.D. as shown in figure 11.

Second demography shows than our respondents covers all 4 domains i.e. educational institute, client, architect, and contractor with one fifth of them holding an educational institute job, and one fourth of them working in field with the contractors, while 37% of them were working with the clients and was the most dominant field. A relatively smaller portion of 17% of them were working as an Architect.

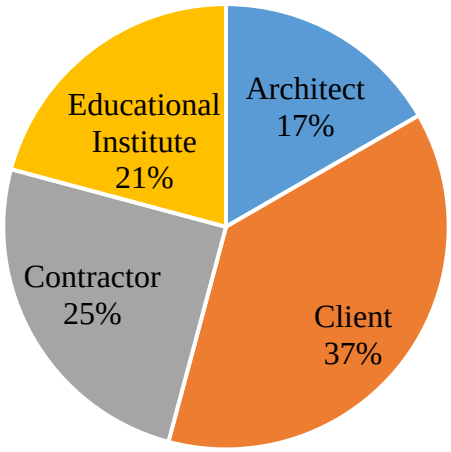

Figure 12: Nature of Job of Respondents

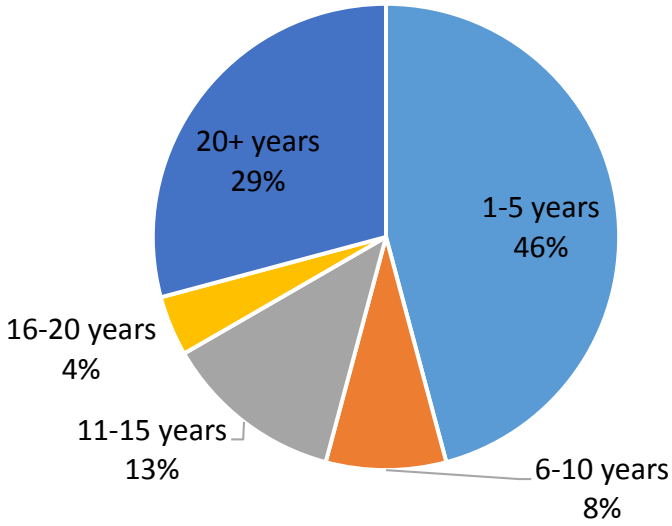

Figure 13: Years of Experience of Respondents

Most of our respondents i.e. 46% had an experience between 1-5 years, but a good chunk of 29% had an experience of above 20 years, and one fourth of the respondents had an between experience of 6-20 years.

An encouraging 42% of our respondents had a previous knowledge of sustainability or green buildings, ranging from attending seminars/workshops to first hand on project experience.

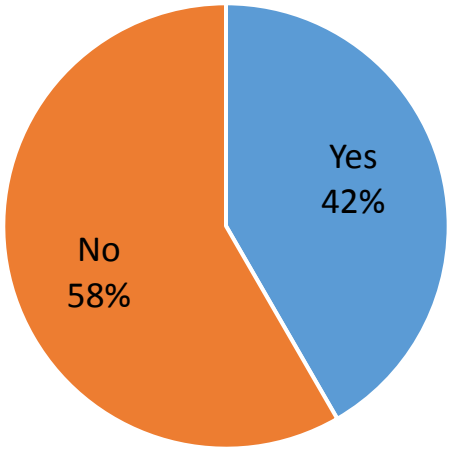

Figure 14: Previous Knowledge on Sustainability of Respondents

4.2.3.2 Credit Points for Criteria's

Mean of the weights given by respondents to the criteria's were calculated and rounded off to zero decimal place for obtaining credits in whole numbers.

Energy criteria received the maximum credits i.e. 22 this is mainly due to awareness among masses to save energy in Pakistan as it has been hit with worst energy crisis over the last decade.

Site Selection and Water both have somewhat same credits finishing at second and third most weighted section with 18 and 17 credits respectively.

Materials criteria had 15 credits to it and Indoor Environmental Quality got 12 credit points. Innovation received 10 credits which was a bit higher than we expected, some comments even suggested that our main focus should be innovation because Pakistan lags behind in this matter. The remaining sic credit point were given to the others section containing three sub-criteria's.

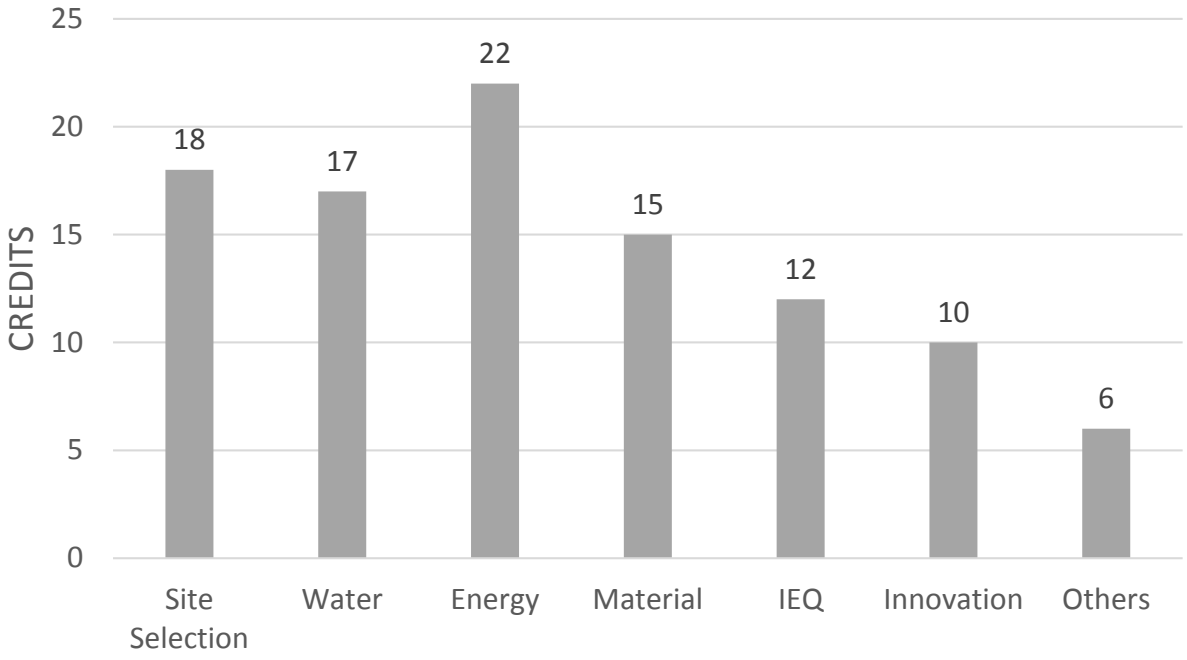

Figure 15: Credit Points for Criteria's

4.2.3.3 Credit Points for Sub-Criteria's

Total 18 points of Site Selection were fairly distributed among the four sub-criteria's, sub-criteria site selection and rain water management receiving 5 credit points each. With 4 points allotted to transport access and access to amenities.

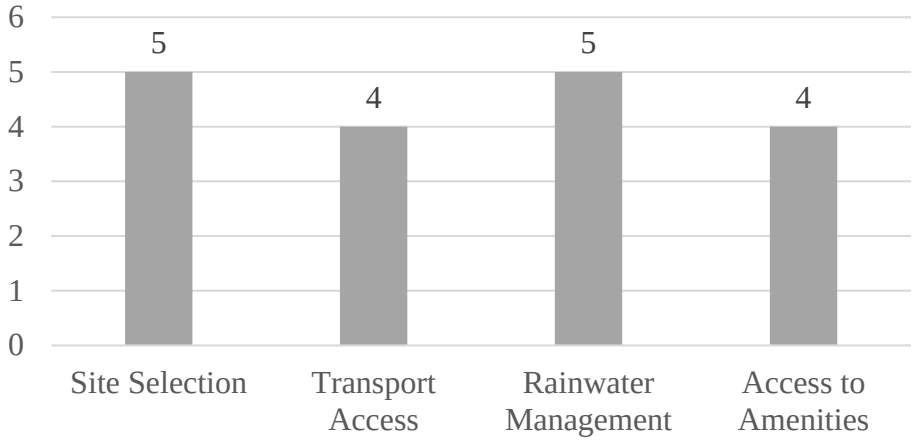

Figure 16: Credit Points for Site Selection

Out of total 17 credit point for water, indoor water use reduction and rainwater collection both received 4 credit points, and rest of them i.e. outdoor water use reduction, wastewater reuse and water monitoring got 3 credit points.

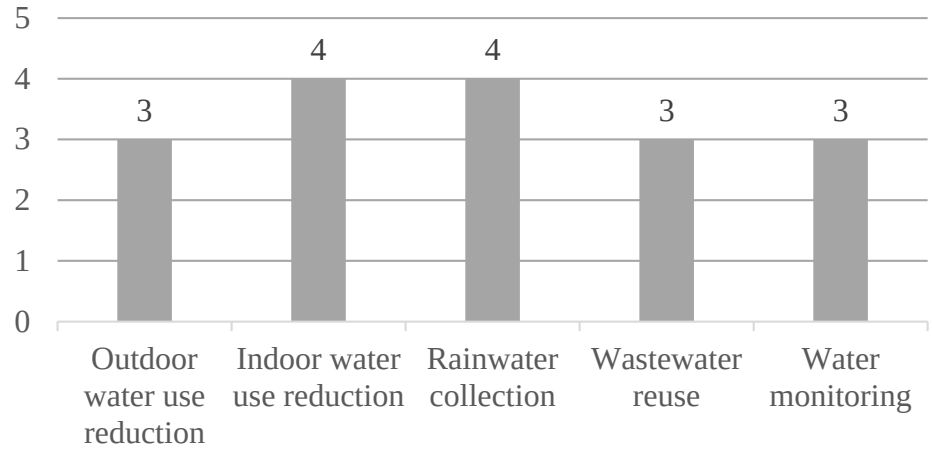

Figure 17: Credit Points for Water

Of the maximum of 22 credit point assigned to energy, optimized energy performance, peak load reduction and renewable energy production all achieved 5 credit points. 4 credit points went to use of energy efficient appliances and 3 to reduce carbon offset.

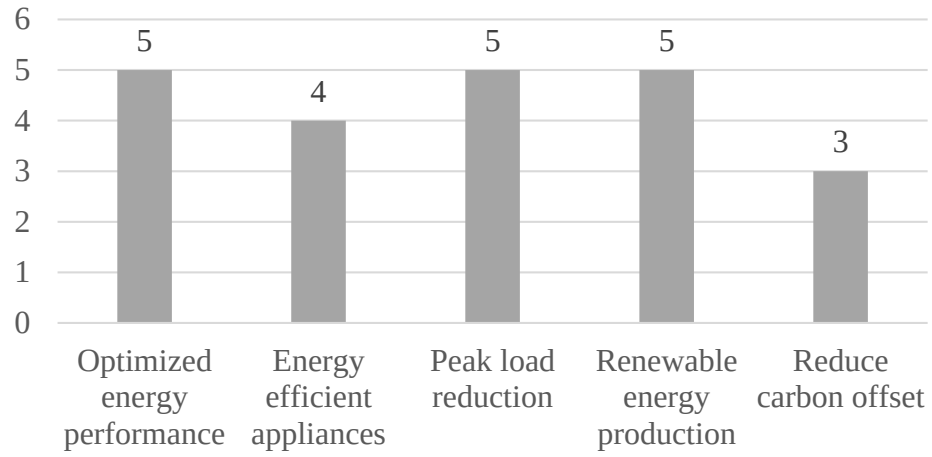

Figure 18: Credit Points for Energy

Materials which received 15 credit point, divides 4 points for use of recycled material, 3 point each to sustainable procurement, indigenous material, and construction and demolition waste management remaining 2 points were awarded to use of non-pollutant materials

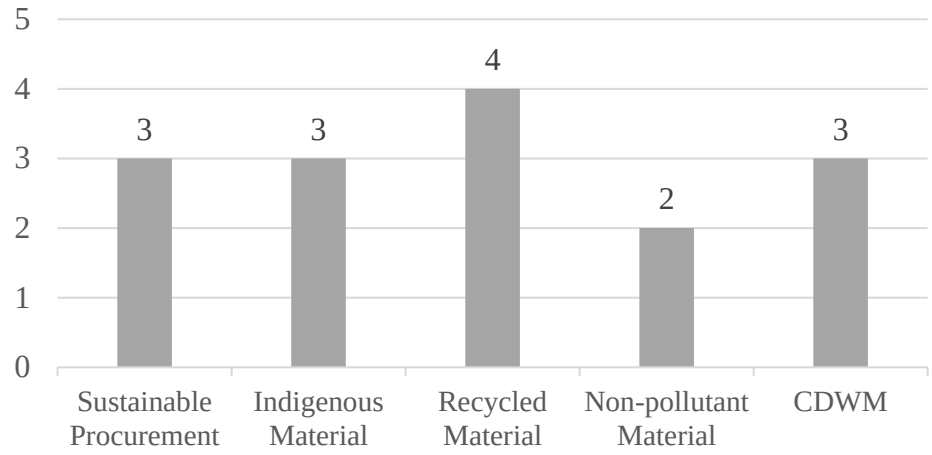

Figure 19: Credit Points for Materials

Indoor Environment Quality having seven sub-criteria's received a total of 12 credit points, 3 credit points for day light use, 2 each for interior lighting, thermal comfort, and visual comfort. Remaining 3 points were divided among acoustic comfort, use of low emissive materials, and safety and security receiving 1 credit each.

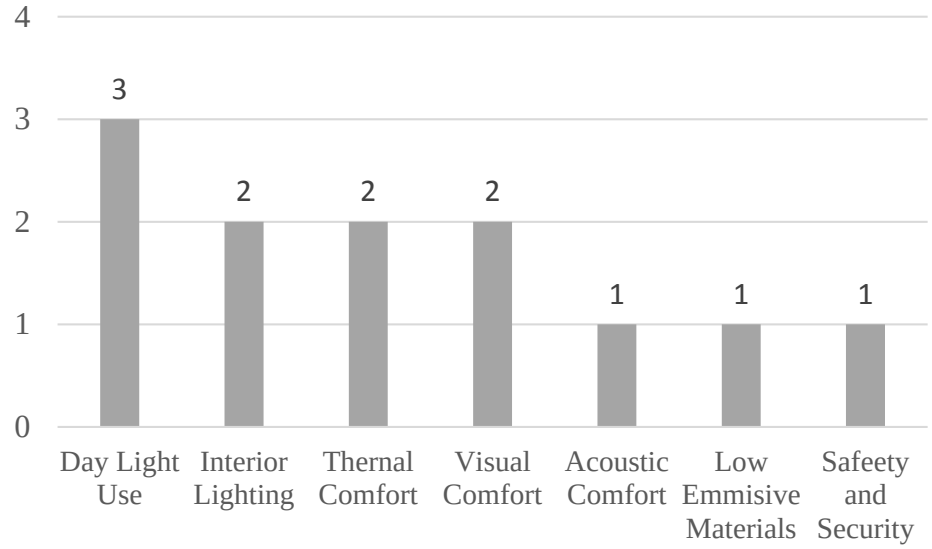

Figure 20: Credit Points for IEQ

Other section comprising of regional priority, life cycle cost analysis and socio-Eco mimic effects got 6 credit points, with life cycle cost analysis receiving maximum of the three i.e. 3 credit points, socio-economic effects received 2 credit points and regional priority got minimum of 1 point.

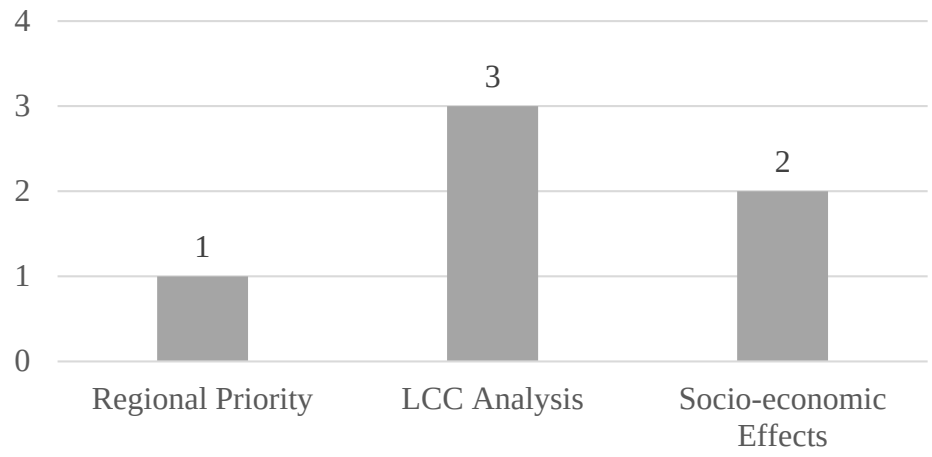

Figure 21: Credit Points for Others

4.3 Shortcomings of Survey

Although our best effort went into conduction of this survey but still there was room for improvement which would have resulted in better outcome of the survey and its results. Few of the shortcoming of the survey are enlisted below:

- It was relatively a small sample size and many professional couldn't be engaged.
- There were not many respondents with firsthand experience of sustainable construction.
- Standard deviation was quite high and could have been reduced using a follow up survey method but it was not possible because of time and scope constraints.

4.4 Summary

The chapter provided a discussion survey, data analysis, results and findings. In this Chapter, after the successful development of sustainable framework for green building, the survey process was conducted in one rounds to allocate the weights to each criteria in Selection, Water, Energy, Indoor Environmental Quality, Innovations, and others section. The conclusion of the survey process also marks the establishment of the objective 2.

CHAPTER 5

RECOMMENDATIONS AND CONCLUSION

5.1 Comparison

After the conclusion of survey weights of our survey results were compared to already existing green building rating systems i.e. LEED, BREEAM, DGNB and PEARL.

This comparison is shown in table 8:

	LEED	BREEAM	DGNB	PEARL	Pakistan's GBS
Site selection	24.5%	20.5%	Separate Evaluation	16%	18%
Water	5.5%	2.5%	2.5%	25%	17%
Energy	33%	33%	6%	25%	22%
Materials	13.5%	13.5%	9%	16%	15%
Indoor environmental quality	14%	13%	22.5%	20%	12%
Innovation	6.5%	6.5%	4.5%	2%	10%
Other	4% (Regional Priority)	12% (Facility Management)	22.5% Economic Quality 10% Process Quality 22.5% Technical Quality	7% (Integral Design Process)	1% Regional Priority 3% LCC Analysis 2% Socio-economic effects

Table 8: Comparison of Results with Existing Rating System

In site selection we our results between BREEAM and PEARL with 18 % weightage compared to 20.5% and 16%. Water has the second highest weightage of all the four rating systems i.e. 17%. Energy gets the second lowest of all only above DGNB with 22%, it should have got more weightage as Pakistan suffers from energy crisis. Materials get 15% which is second highest only lower to PEARL. Indoor Environmental Quality gets 12% which is lowest of all four rating systems. Innovation received 10% weightage which is maximum of all, others are compared in the last section.

5.2 Recommendations

After development of framework and assigning of weights to criteria's we proposed a three stage process for better and effective, implementation and adoption of green building rating system in Pakistan. These three stages are as:

1) **Voluntarily Adoption**

   In this stage it would be up to the construction industry for adopting the standards of green buildings and those who would be volunteering for adoption these standards would be given incentives in for of property tax relaxation, and/or electricity bill compensation.

2) **Feedback**

   Feedback and recommendation for improving the green building rating system would be collected from the user who have already volunteered for adoption, based on the users feedback improvements would be made for better implementation.

3) **Mandatory Adoption**

   In third stage green building standards would be introduced in building bylaws as mandatory and without following these standards no building would be issued certificate for construction by municipal authorities

5.3 Areas of Future Research

This section provides a list of several future research areas. It includes proposing a suitable certification level, inclusion of more professional in survey, usage of Delphi survey for better results. The details of each future research areas are explained below:

a) Certification Level: In order to distinguish green bridge and award an appropriate certification to a building project, there is a need to develop a certification level. This can be done by

evaluating various building projects and developing a distribution curve to choose different award levels.

b) Inclusion of more professionals: The research was able to collect data from only small size of sample, better results could have been achieved by inclusions of more professional having prior experience in working on sustainable development and green buildings.
c) Usage of Delphi survey: Instead of using a one way questioner, a two round Delphi survey would have not only decreased the standard deviation but also help in achieving more accurate result by giving respondents an option to change their weights in follow up survey.

5.4 Conclusion

This framework is just an initial step towards development of a sustainable rating system for Pakistan, we still have many miles to go. Implementation of these standards would help Pakistan to become a greener country and overcome its energy crisis. It's a small contribution from our side for a **BETTER and BRIGHTER PAKISTAN.**

APPENDICES

APPENDIX A

SURVEY FORM

EVALUATION AND EVOLUTION OF GREEN BUILDING RATING SYSTEM: A POLICY PROPOSAL FOR PAKISTAN

We students of BE Civil Engineering at NUST, Islamabad are doing a final year project on the above topic in which we aim to give a framework for Pakistan's own green building rating system.

This survey aims to gather expert opinion on the development of policy proposal for green building rating system in Pakistan. The results will be used to assign weights to all criteria in site selection, water, energy, materials, indoor environment quality, innovation, and other. The results of this surveys will be used in prospective analysis.

Project Advisor Name and Department: Dr. Muhammad Jamaluddin Thaheem, HOD Construction Engineering and Management. **Email:** jamal.thaheem@nit.nust.edu.pk **Phone:** +92-51-90854164

This surveys is anonymous, and do not include any personal questions. The survey will likely take about 15 minutes of your time.

Participation is voluntary; you may choose to discontinue your participation at any time without consequence.

In case of any further information, please contact:

Abdullah Zafar
Mobile: +92-300-8733849
Email: azafar1994@hotmail.com

1. Background Information

Mark the appropriate answer.

1. Name (Optional)

   _____

2. What is your qualification?

   ☐ College

   ☐ Bachelor's Degree

   ☐ Master's Degree

   ☐ Ph.D.

3. How would you describe best the nature of your job?

   ☐ Client

   ☐ Architecture

   ☐ Contractor

   ☐ Educational Institute

   ☐ Other, Specify _____

4. How many years of work experience do you have?

   ☐ 1 - 5 years

   ☐ 6 - 10 years

   ☐ 11 - 15 years

   ☐ 21 - Above.

5. Have you ever worked on a project which used sustainable practices?

   ☐ No

   ☐ If yes, please briefly describe the nature of your involvement/s.

2. Individual Criteria Ranking

Please rank the criteria within the sections and assign relative percentages and to what extent do you agree with each statement. Please provide comments wherever needed.

1. Site Selection

Criteria	Title	Description	Rank	%	Comment
1.1	Site selection	Discourage the use of inhabitant land thus reducing the environmental impact of site due to its location.			
1.2	Transport access	Encouraging the new owners to develop building which is in close proximity.			
1.3	Rainwater management	To reduce the rainwater discharge and protect the water bodies from receiving pollutant.			
1.4	Access to amenities	To reduce dependence on individual car use by selecting the site of the new buildings within the area having a mix use.			
1.5	Other				
	Total			**100**	

2. Water

Criteria	Title	Description	Rank	%	Comment
2.1	Outdoor water use reduction	To emphasis on providing the water metering devices on all exterior water.			
2.2	Indoor water use reduction	To promote the reductions of indoor potable water consumption by using water efficient appliances.			
2.3	Rain water Collection	To collect rainwater using different techniques and let minimum amount of rainwater to be wasted.			
2.4	Waste water reuse	To reuse wastewater back in water cycle thus decreasing the demand of potable water.			
2.5	Water monitoring and leakage detection	To ensure there is not water leakage in system through different checks.			
2.6	Other				
	Total			**100**	

3. Energy

Criteria	Title	Description	Rank	%	Comment
3.1	Optimize energy performance	To encourage the decreases in the projects energy intake and thus sinking the carbon emissions linked to structure operation.			
3.2	Energy efficient appliances	To identify and boost usage of energy efficient appliances to warrant optimum standards and energy efficiency in operation building.			
3.3	Peak load reduction	To decrease energy consumption at peak usage time by use of innovative building and services design.			
3.4	Renewable energy production	To establish and identify increasing number of site renewable energy generation to decrease environmental and economic effects related with fossil fuel energy usage.			
3.5	Reduce carbon offset	To boost the usage of design actions which reduce carbon emissions and minimalize dependence on active building service system.			
	Total			**100**	

4. Materials

Criteria	Title	Description	Rank	%	Comment
4.1	Sustainable procurement	Meet the requirements for materials not based on cost benefit investigation.			
4.2	Indigenous material	To inspire the selection of construction resources that have low transportation effects.			
4.3	Recycled material	To incorporate the recycled material during design and construction phase, helping in reducing the environmental impacts.			
4.4	Non-pollutant material	To endorse the choice of resources that do not pose a long-term harmful effects on human well-being or contaminate natural ecology.			
4.5	Construction & demolition waste management	To redirect building and demolition wreckage from dumping in junkyard and incineration units back into construction process.			
4.6	Other				
	Total			**100**	

5. Indoor Environment Quality

Criteria	Title	Description	Rank	%	Comment
5.1	Day light use	To endorse structure designs that exploit the usage of natural day light inside of a building.			
5.2	Interior lighting	To stimulate interior visual ease through by the usage of high end lighting fixtures.			
5.3	Thermal comfort	To guarantee suitable thermal comfort done through design, and controls.			
5.4	Visual comfort	To guarantee day lights, artificial lights and resident controls are well thought out at the design phase.			
5.5	Acoustic comfort	Providing dwellers comfort against unnecessary acoustic levels.			
5.6	Low emissive materials	To decrease the extent of interior air pollutants that damaging to health.			
5.7	Safety and security	To deliver a safe and secure atmosphere for structure inhabitants and invitees.			
	Total			**100**	

6. Innovation

Criteria	Title	Description	Rank	%	Comment
6.1	Innovative practices	To sustain innovation within the construction industry by acknowledgement of sustainability associated advantages which are not compensated by typical green building rating system			
	Total			**100**	

7. Others

Criteria	Title	Description	Rank	%	Comment
7.1	Regional priority	Offer an inducement for the accomplishment of points that tackle geographically related environmental significances.			
7.2	Life cycle cost analysis	Permit operational and lasting judgments about structure design and construction for exploiting maximum productivity over the entire lifespan of the development.			
7.3	Socio-economic effects	Study and incorporate the social and economic effects of a building			
	Total			**100**	

3. Relative Category Percentage

Based on your professional experience and Pakistan's local context, please indicate the relative percentages for the following categories out of a total 100% **e.g.** Site selection 10%, Water 20%, Energy 25%, Material 10%, Indoor environment quality 20%, Innovation 5%, Other 10%

Category	%
1. Site Selection	
2. Water	
3. Energy	
4. Materials	
5. Indoor environment quality	
6. Innovation	
7. Other	

4. Comments

General thoughts or comments regarding survey or project:

_____

_____

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