

## **EVALUATION OF MOST EASILY ACHIEVABLE FACTORS IN CONSTRUCTION OF GREEN BUILDING IN LEED RATING SYSTEM**

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*Abstract: Green building which is also known as Green construction, refers to both a structure and the use of processes that are environmentally responsible and resource efficient throughout a building's life cycle: from siting to design, renovation, and demolition. Green building design involves finding the balance between homebuilding and sustainable environment. This research work is to find the easily implemented factors which earn credit with little efforts to make construction Green. Main factors considered are sustainable sites, water efficiency, energy and atmosphere, Green material and resources, etc. to study the importance of each factor sequentially by interview with experts, questionnaire survey and cost consumption and with less efforts.*

**Key words:** LEED rating system, sustainable development, renewable energy, rain water harvesting.

### **I. INTRODUCTION**

A Green building is an environmentally sustainable building design, constructed and operated to minimise the total environmental impact. LEED is the organization connected with USGBC (United States Green Building Council) which gives certification of Green building concept to applied construction. Green building refers to both a structure and using of process that are environmentally responsible and resource efficient throughout a building's life cycle: from sitting to design, construction, operation, maintenance, renovation and demolition. Certification of LEED helps to improve the value of the building. Various factors related to sustainable development are considered to design the building. After that the building is constructed, it is applied to get certificate of green construction. There are main 69 points which are to be achieved are mentioned in the rating system already. With respect to the requirements of each credit and submittals, the credits are rated. After summation of credits, the certificate is given as per the criteria satisfied. There are different certification levels like silver certificate, golden and platinum certificate.

**II. NEED OF THE STUDY**

This study intends to promote green building concept. This survey study will help in finding most easily achievable factors which are crucial for green building concept. There are 64 credits/factors mentioned in LEED rating system which are considered for certification of green building concept. It is not possible to make any building which is 100% green. Further the construction cost or initial cost of the project is very high. This will help to prioritise factors to be implemented first on any proposed construction project. This will help to estimate optimum cost of the project.

**Objectives:**

To achieve the aim, the main objectives of this study are outlined as follows:

- To analyse the relevant factors to LEED rating.
- To segregate the most affected factors to LEED rating system.
- To find most easily implemented factors to rate the construction as Green building.

**Main factors in LEED rating system:**

Main factors to be considered are site selection, water efficiency, energy and atmosphere materials and resource, indoor environment quality and innovation and design process.

**List of factors:**

Code No.	Perspective	Factors to be implemented	Description
A1	<b>Sustainable Sites</b>	Site Selection	Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.
A2		Development Density	Protect green fields and preserve habitat and natural resources.
A3		Brownfield Redevelopment	Reducing pressure on undeveloped land.
A4		Alternative Transportation	Reduce pollution and land development impacts from automobile use.
A5		Reduce Size Disturbance	Conserve existing natural areas and restore damaged areas
A6		Storm water Management	Limit disruption and pollution of natural water flows
A7		Heat Island Effect	thermal gradient differences between developed and undeveloped areas
A8		Light Pollution Reduction	Eliminate light trespass from the building and site
B1	<b>Water Efficiency</b>	Water Efficient Landscaping	Limit or eliminate the use of potable water for landscape irrigation
B2		Innovative Wastewater Technologies	Reduce generation of wastewater and potable water demand
C1	<b>Energy &amp; Atmosphere</b>	Fundamental Building System Commissioning	Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended
C2		Minimum Energy Performance	Establish the minimum level of energy efficiency for the base building and systems

C3		CFC Reduction in HVAC&R Equipment	Zero use of CFC-based refrigerants in new base building HVAC&R systems	
C4		Optimize Energy Performance	to reduce environmental impacts associated with excessive energy use	
C5		Renewable Energy	Reduce use energy generated by fossil fuel	
C6		Additional Commissioning	Verify and ensure that the entire building is designed, constructed and calibrated to operate as intended	
C7		Ozone Depletion	Reduce ozone depletion	
C8		Measurement & Verification	optimization of building energy	
C9		Green Power	Encourage the development and use of renewable energy technologies	
D1		<b>Materials &amp; Resources</b>	Storage & Collection of Recyclables	Facilitate the reduction of waste generated
D2			Building Reuse	Extend the life cycle of existing building stock, conserve resources
D3	Construction Waste Management		Redirect recyclable recovered resources back to the manufacturing process	
D4	Resource Reuse		Use salvaged, refurbished or reused materials, products and furnishings	
D5	Recycled Content		use materials which contains recyclables	
D6	Local/Regional Materials		supporting the regional economy and reducing the environmental impacts resulting from transportation	
D7	Rapidly Renewable Materials		Use rapidly renewable building materials and products	
D8	Certified Wood		Encourage environmentally responsible forest management	
E1	<b>Indoor Environmental Quality</b>		Minimum IAQ Performance	Establish minimum indoor air quality (IAQ) performance
E2	<b>Indoor Environmental Quality</b>	Environmental Tobacco Smoke(ETS) Control	Prevent exposure of building occupants and systems to Environmental Tobacco Smoke (ETS).	
E3		Carbon Dioxide(co2) Monitoring	Install a permanent carbon dioxide (CO2) monitoring system	
E4		Ventilation Effectiveness	effective delivery and mixing of fresh air	
E5		Construction IAQ Management Plan	Prevent indoor air quality problems resulting from the construction/renovation process	
E6		Low-Emitting Materials	Reduce the quantity of indoor air contaminants that are odorous, potentially irritating	
E7		Indoor Chemical & Pollutant Source Control	Avoid use of harmful chemicals	

E8		Controllability of System	Provide a high level of thermal, ventilation and lighting system
E9		Thermal Comfort	Provide a thermally comfortable environment
E10		Day Light & Views	a connection between indoor spaces and the outdoors
F1	<b>Innovation &amp; Design Process</b>	Innovation in Design	Innovative building design than regular practise
F2		LEED Accredited Professional	

### III. METHODOLOGY

This section introduces the methodology which is applied in this research to achieve the research aim. Basically, this research work includes five different phases. First phase of research covers the project title and identification of the objectives. Second phase of research covers review of literatures. Third phase of research includes overview of different project management phases. Fourth phase includes factors to be implemented easily to construct green building. In this phase data analysis was done by RII techniques to rank the factors.

#### Data analysis approach

The collected data were analysed through the following statistical techniques and indices:

#### RII (RELATIVE IMPORTANCE INDEX)

The Relative importance index (RII) will be used to rank (R) the different factors that are easy to implement on any construction. The ranking makes it possible to cross compare the relative importance of the factors are perceived by the three groups of the respondents.

$$RII = \frac{\sum w}{A * N}$$

Where,

W=weight given to each factor by the respondents (ranging from 1 to 4),

A= highest weight (i.e. 4 in this case),

N= total number of respondent.

No.	Respondent	Questionnaire Distribution	Questionnaire Received	% of Response	% Total
1.	Contractor	78	40	51.28	43.02
2.	Consultants	51	28	54.90	30.10
3.	Site Engineer	56	25	44.64	26.88
Total		185	93	50.27	100.00

The top 10 factors which are easily implemented on any construction to make it a green building according to different stakeholders are as follows:

**TABLE 1: TOP 10 FACTORS**

TOP 10 FACTORS	CONTRACTORS	CONSULTANTS	SITE ENGINEERS
1	Site selection	Alternate transportation	Alternate transportation

2	Innovation in design	Site selection	Local / regional materials
3	Alternate transportation	Local / regional materials	Light Pollution reduction
4	Storm water management	Storage & collection of recyclables	Site selection
5	Certified wood	Light Pollution reduction	Storage & collection of recyclables
6	Light Pollution reduction	Resource reuse	Measurement & verification
7	Day light & views	Recycled content	Certified wood
8	Storage & collection of recyclables	Construction water management	Water efficient landscaping
9	Local / regional materials	Innovation in design	Innovation in design
10	Water efficient landscaping	Brownfield redevelopment	Recycled content

#### IV. CONCLUSION

- This findings are the factors which directly leads the construction to be a Green building. The purpose of the study is to find most easily implemented factors on any construction to make it a green building.
- Findings in this study are the factors segregated by questionnaire survey and these factors are easy to achieve during construction and make it an eco-friendly construction.
- Most easily achievable top 10 factors according to contractors are site selection, Innovation in design, Alternate transportation, storm water management, certified wood, light pollution reduction, day light and views, storage and collection of recyclables, local / regional materials, water efficient land scaping.
- Most easily achievable top 10 factors according to consultants are Alternative transportation, Site selection, Local/Regional materials, Storage & collection of recyclables, Light pollution reduction, Resource reuse, recycled content, Construction water management, Innovation in Design, Brownfield redevelopment.
- Most easily achievable top 10 factors according to Site engineers are Alternative transportation, Local/Regional material, Light pollution reduction, Site selection, Storage & Collection of recyclables, Measurement & verification, Certified wood, water efficient landscaping, Innovation in Design, Recycled Content.

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