

# Study of different EMS with SWOT, energy and cost benefit analysis and star rating system for integrated EMS with gap analysis for sustainable development in construction sector

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*Abstract-In an environmentally stressed world, green buildings are moving from curiosity to a necessity. Construction activities itself disturb the environment. There is a need of EMS for sustainable development from every aspect of construction during design, construction to operation and maintenance stage. There are national, international Environmental management systems like LEED, TERI, eco friendly assessment by IIEC and EMS ISO 14001. The 5R concept refuse, reduce, reuse, reform, recycle is adopted. There are similarities and differences, benefits and obstacles associated with the different EMS. There is a need of finding strengths, weaknesses; opportunities and threats (SWOT) of any EMS in India. There is a need of modified EMS as per local requirements. Integrated environmental management can be done through checklist and gap analysis for eco friendly elements. Though the initial cost of green building is more, it is always cost effective from safety, health, environmental and economical point of views.*

**Keywords :**Green building, Gap Analysis, Integrated EMS, SWOT

## I. INTRODUCTION

Man himself has exploited environment which has hampered the ecological balance between biotic and abiotic things which further leads to environmental degradation. So there is need of education and awareness regarding eco friendly activities, green construction, green labeling and green purchasing, water and energy audit and carbon foot print. All those who are involved in construction projects including users have to accept the responsibility along with legal obligations for environmental protection. We must change the mindset of people for environment protection from top to bottom in an organization. A strong awareness of advantages of green buildings, a conscious effort to change will speed this process along. In the future years and decades the green building techniques will become common place for political, environmental and economical reason.

## II. PROBLEM STATEMENT

There are certain benefits and limitations of every EMS or

The cost, durability, availability, maintenance of the EMS and green construction including green materials and techniques. All eco friendly techniques and all EMS rating systems need to be studied under one roof. This leads to a topic of integrated EMS.

## III. METHODOLOGY OF THE WORK

1. Study of different EMS systems and visits to green buildings with at least any one EMS.
2. Survey through questionnaire for non implementation of eco friendly construction among the professionals
3. Energy saving and cost benefit analysis for green buildings
4. Checklist in the form of collective questionnaire, gap analysis and format for point based rating system for the integrated EMS.

## IV. SWOT ANALYSIS OF EMS

Comparing different EMS such as LEED India (IGBC), Eco housing assessment criteria (IIEC and SciTech park and PMC) TERRI/GRIHA, EMS ISO 14001, SWOT analysis of any EMS in general can be done as follows..

### Strengths

1. Durability
2. Increased aesthetic view
3. Pollution Control
4. Waste control
5. Energy savings
6. Economy
7. Good for health

### Weaknesses

1. More documentation
2. More difficult to understand and implement, record ,control
3. More Cost of certification
4. Legal requirements are more
5. Complex nature due to special characteristics

### Opportunities

1. Pollution Control, waste Management
2. Environmental economical Designing, supervision
3. Energy auditing

rating system. The EMS should be modified as per local conditions. Developers find difficulty to apt for green buildings. There is a little awareness among the people about

- 7.Environmental monitoring and auditing
- 8.Landscaping
- 9.Eco advertising tourism, Eco labeling, eco product supply
10. Developing environmentally friendly technologies materials and other products.

#### Threats

1. Lack of government support,
2. Corruption
3. Lack of worker support
4. Lack of eco friendly materials and techniques
- 5.Increase in cost
6. Legal problems
- 7.Maintenance problems
8. More time
9. No synchroization, more complex
- 10.Messy constructions if EMS not maintained and implemented properly

Thus the SWOT analysis shows that there is a need of integrated EMS.

### V. APPLICATION OF SUSTAINABILITY

#### Pre-Design

1. Material selection
2. Building program,
3. Project budget
4. Team Selection, partnering
5. Project Schedule
6. Laws, codes and standards Research
7. Site selection

#### On-Site

- 1.Site analysis and assessment
- 2.Site development and layout
- 3.Watershed management and conservation of Site material and equipment

#### Design

1. Passive solar design
2. Materials and specification
3. Indoor air quality

#### Construction

- 1.Environmentally conscious construction
- 2.Preservation of features & vegetation
- 3.Waste management and IAQ Issues
- 4.Source control practices

#### Operation and Maintenance

- 1.Maintenance plans
- 2.Indoor quality
- 3.Energy efficiency
- 4.Resource efficiency
- 5.Renovation
- 6.Housekeeping

4.Weather forecasting, reporting

5.Conducting environmental awareness programs

6.EIA testing environmental lab checking

Respondents are asked the opinions or the reasons they have about the non implementation of EMS or green practices. Accordingly the options “Yes” and “No” for each reason are marked for each respondent and the result is analyzed.

**Table1 The reasons for non implementation of EMS for construction**

Sr. No	Reasons	Options	
		Yes (√)	NO (×)
1	Lack of worker support		
2	Lack of eco materials ,technology		
3	Extensive documentation		
4	Extra time and cost involved		
5	Increased liability		
6	More focus on appearance than sustainability		
7	More and special labor and machinery required		
8	Due to increased competition		
9	No time to learn or teach		
10	Complex nature updating monitoring		
11	Insufficient space		
12	Environmental consultancy at cheaper rate not available easily		
13	It's hard to break conventional method communication gap		
14	It's hard to convince all the team		
15	Management do not support		
16	Maintenance ,operation process is complex and time consuming		
17	No uniform concept of EMS		
18	All workers do not understand the concept of EMS		
19	Separate design construction		
20	Non integration of EMS or EMP in the original contract		

The main reasons behind the non implementation of EMS are its higher cost, no time to learn and no uniform rating system. During the survey it was found that basically respondents are little aware of cost benefit analysis, energy analysis and payback period for green buildings due to which they are not ready to extra efforts to overcome the above said reasons.

### VII. ENERGY SAVING ANALYSIS FOR SITE ORANGE COUNTY (PASHAN)

A study has been conducted for the residential complex ‘Orange County ‘situated at Baner. The complex has been received Limca Book Record and the 5star rating by Eco friendly assessment criteria by IIEC, PMC and SCITECK.

## VI. SURVEY FOR FINDING MAIN REASONS BEHIND THE NON IMPLEMENTATION OF EMS

- Depending on the responses in the first round of survey the reasons for non implementation of green practices are collectively presented and the same and some different. The considering local wind data and solar path analysis which has been confirmed later on by computer simulation. All flats are three sided open.  
No common wall in between any of the flat. Total area of openings is more than 30% of floor area.
- All points (Light, Fan, TV, Computer etc.) except power points in all flats have “Green Energy” as primary source and grid energy as “Stand by”.
- All flats have solar water heating system. Common amenities such as Lift, Water Pumps etc. are running on “Green Energy”.
- All light points in passage have time and motion sensors. . Every flat has blink free change over (BFC) switch, which limits use of current from “Green Energy” up to 1.5Amp.
- HPC has a display panel which shows all the details of hourly electricity produced by both windmills and solar PV separately, for 365 days.
- All trees planted are “Native Fauna” of Pune. The complex has a vegetable patch from where all the flat owners will get daily vegetables which are produced by organic method.
- Sewage Treatment Plant by Natural Process of Root Zone Cleaning System
- Each flat is provided with one insulated hot water tank of the capacity, for 2BHK: 125 liters per day and for 3BHK: 150 liters per day, fitted with electrical heating coil of 3KW rating with ISI mark thermostat.
- There is a Programmable Logic Controller (PLC) for automation to ensure that each flat gets fixed quantity of hot water, and also the electrical heater maintains the minimum reserve level of hot water at any given time.
- Green energy is free of cost to flat holders

To know the savings in electrical consumption the two buildings of similar architect and plan are chosen constructed in similar time period and by same developer. Thus the implementation of eco friendly techniques and EMS is the best, very suitable and easy to implement for integrated townships.

**Table2 Total savings in Orange County Phase 2(Green building) as compared to Phase1 (conventional building)**

Name and type of the building	Total units consumed
Orange County Phase1(conventional building )	260.90
Orange County Phase 2(Green building )	139.50
Total savings in Orange County Phase 2	47%

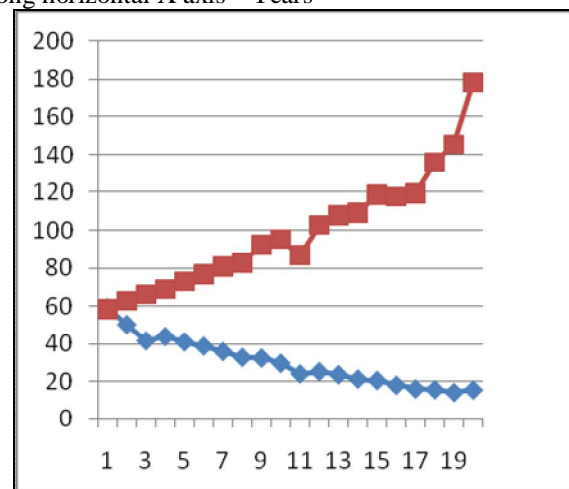
Following are the noteworthy points implemented in the complex

- Building is planned to have natural sunlight, ventilation present i.e. conformity or non compliance with standard. But there is a gap between Yes and No. So the suggestion of partial option is experimented. The partial option can be divided into “N” no of options to show the level of conformity. Here three levels are suggested for partial fulfillment of requirements  
 P1 – between 50 to 75% conformity  
 P2 –between 25 to 50 % conformity  
 P3 –between 0 to 25% conformity



## IX. LIFE COST ANALYSIS (NET PRESENT VALUE AND PAYBACKPERIOD) FOR IGBC LEED GREEN HOMES CERTIFIED RESIDENTIAL BUILDING

### A. NPV And Life Cost Analysis

Multistoried residential building is chosen as a base. Considering project aims for gold rating, 20 yrs life cycle Period is taken for cost benefit analysis.  
 Along vertical Y axis- Rs in Lacks  
 Along horizontal X axis-- Years



**Fig 1 The graph showing variation in yearly Net benefit and NPV for a life period of 20 yrs.**

Along Y axis Net benefit (Yearly)   
 Along Y axis NPV net present value (Yearly) 

Annual benefits are much more than the annual operational and maintenance costs. Payback period is 3.25 years

### A. ANALYSIS OF THE COST BENEFIT

The green cost is added in the selling price of the property. So the developer is always on a safer and beneficial side. And justifying this higher price for the green building due to environmental and health benefits and energy savings the customer is also satisfied. The net benefits also can be shared equally by customer and the developer provided the customer is aware of this cost benefit analysis if the operation maintenance is provided by the developer during the LCA

### VIII. GUIDELINES FOR USE OF THE GAP ANALYSIS CHECKLIST

In a gap list for ISO 14001 only Yes and No answers are No of green parameters and also as per the various consultants. The green parameters' cost can be calculated by different methods. But the results from the research show that the payback period of all types of green buildings for all types of EMS is mostly between 3 to 5 years. The cost benefit analysis depends on the construction, operation, maintenance cost, the type of EMS or rating system, type, number of green parameters involved, the region or location, the thumb rules used for calculation, the material, labor cost, the wastage allowed and the population.

### X. PROJECT ENVIRONMENTAL CHECKLIST IN THE FORM OF QUESTIONNAIRE FOR CHECKING ENVIRONMENTAL CONTROL MEASURES FOR INTEGRATED EMS

From 1 to 38 questions each of 10 marks

- 1) Are the objectives, goal set for your EMS?
  - 2) Is the policy made of your EMS? Is it communicated to all from top to bottom level in the construction work? Is it displayed for the people?
  - 3) Is there any detailed environmental plan regularly? Is it documented?
  - 4) Is there any separate EMS department?
  - 5) Is the checking of EMS done quarterly in a year?
  - 6) Are the roles and responsibilities properly defined?
  - 7) Is there is consideration of biodiversity protection?
  - 8) Are any eco friendly materials and techniques used?
  - 9) Is the energy saving and auditing regularly done?
  - 10) Are any considerations made in architectural designing and site planning for maximum utilization of natural gifts like sunlight, rain, wind, nature view, plantation, nature conservation etc?
  - 11) Is the water audit regularly done? Is the check for pollution and noise level regularly taken?
  - 12) Are the renewable energies used?
  - 13) Is the maintenance and operation of environmental activities done regularly?
  - 14) Is there are any programs to spread environmental awareness and education?
  - 15) Is the aspect, impact analysis is done?
  - 16) Are there any steps taken for reuse recycle and reproduce the products?
  - 17) Is the EMS documented in a proper, detailed format and preserved or maintained properly?
  - 18) Are there any other steps taken for environmental protection like eco-labeling, ecotourism, eco supply chain, eco products?
- 24) Is the wastage control is done regularly?
  - 25) Are the environmental records properly maintained? Is the Management review, record maintained?
  - 26) Are the changes and modifications/improvements are Considered in the respective EMP and documents?
  - 27) Are the legal requirements and certification requirements documented, tested and checked in a sequence?
  - 28) Are the guidelines for implementation of your EMS documented and maintained?
  - 29) Is reporting of each work, record, and change done properly in time?
  - 30) Are all procedures and plans properly documented and maintained?
  - 31) Are the reports of visits of experts, consultants to the site are maintained and properly documented?
  - 32) Are any innovative techniques adapted at site after proper testing for environmental protection?
  - 33) Is the research work, all information related to EMS and designs, suggestions, supply chain estimates and all suppliers reports properly maintained?
  - 34) Is the care taken for environmental protection during Construction?
  - 35) Are all the EMS steps checked by experts as per the guidelines of ISO or any standardized EMS rating system for which you require or maintain the certification?
  - 37) Is the training area located and is the training given
  - 38) Are all the above answers recorded in written format and explained in detail for how, when and what questions for all above?  
If answer is No or partially done, what are the steps taken or decided? Are the steps are documented?
  - 39) Air emissions (total points 20)  
Will this project/process change require an air permit or permit modification?
  - 40) Water Discharges (total points 25)  
Does the project/process change result in a water discharges?
  - 41) Storage Tanks (total points 5)  
Will underground storage tanks o be installed?  
Will tanks be installed to store hazardous waste or materials, petroleum products or propane?
  - 42) Waste Generation (total points 20)  
Will the waste be classified as wet, dry, special or hazardous?
  - 43) Energy Usage (total points 5)  
Will the project /process change effect facility energy usage?
  - 44) Other Considerations (total points 45)
    - Do recycling options and costs need to be considered? Does the project/ process change require use of toxic, hazardous or carcinogenic materials?
    - Do the project/ process materials require special handling or storage?
    - Does the project cause land disturbances?
    - Do pollution prevention issues need to be addressed?



- 19) Is the cost benefit analysis and life cycle costing, payback period calculation done for your green cost and EMS?
- 20) Are there any alternatives/ options to avoid severe impacts for certain aspects?
- 21) Is the gap analysis done?
- 22) Are the preventive and corrective measures communicated properly to all?
- 23) Are there any safety norms? Is the risk and disaster analysis is done? Are there any emergency norms?
- Does the project/process change alter or add to current facility aspects?
  - Does the project/process change require change to Emergency Response Methods?

- Does the project/process change impact the surrounding community (i.e. odor, Noise)?
  - Are there any wild life or land use issues?
- Obtained for category B and A projects. A public hearing now an integral part of EIA (Environmental Impact Assessment). People participation in project implementation is a very effective tool for EMP (Environmental Management Plan implementation).

For projects involving rehabilitation, upgrading, expansion or privatization of existing facilities, remediation of existing environmental problems may be important than mitigation and monitoring of expected impacts. For such projects the management plan focuses on cost effective measures to remediate and manage these problems.

**Table 2 Points allotment for each question in the checklist for Integrated EMS**

Options	Points for questions 1 to 38 (total points for each question as 10)	Points for questions 39 to 44 (total points for each question as 5)
Y	10	5
P1	8	4
P2	5	3
P3	3	2
N	0	0

**Table 3 Star rating system suggested for integrated EMS**

Points	Stars allotted	Rating reward allotted
Between 401 to 500	* * * * *	Five star
Between 301 to 400	* * * *	Four star
Between 201 to 300	* * *	Three star
Between 101 to 200	* *	Two star
Between 50 to 100	*	One star

### A. Goals of EMP

1. Energy efficiency
2. Water and material efficiency
3. Indoor and outdoor environmental quality enhancement
4. Use of natural resources
5. Waste control
6. Maintaining healthy and safe surroundings

### B. Green Tips

1. Stack effect can be used for high rise natural ventilation
2. For already being constructed buildings the building design and material cannot be changed. But there are possibilities to increase green cover, reduce water consumption, recycle the sewage, segregation of solid waste and covering it into value added products and switch over to water and energy efficient gadgets.
3. Sustainable transport and greener supply chain management practices should be considered
4. Vastushashtra guidelines can be followed
5. Use of sensor network, efficient use of energy and HVAC, Hybrid system during day and night and also during exceptional climate events can be practiced
6. Smart green roof can be considered.

## XII. CONCLUSION

The demand for construction is continuously rising in urban and rural area. Commercial exploitation of traditional building by various industries has aggravated the situation. In short A green building is one where the qualities of both indoor and outdoor environment have been considered and protected during its design construction, maintenance and use. Patients recover fast when they are able to see natural views, the stress is reduced. Humans require contact with nature to stimulate the development of emotional, cognitive and social potential. It is possible to have self independent buildings relying on renewable energies. The research shows that it is possible. Only we have to remember "Energy conserved is energy generated" It is better way to adopt preventive measures rather than

Below 50	--	No star
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1<sup>st</sup> International Conference on Recent Trends in Engineering & Technology, Mar-2012  
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 corrective measures. There should be stringent rules and legal regulations for adaptation of EMS. Everybody has to contribute towards sustainable development by keeping always in mind

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## XI. IMPLEMENTATION OF EMP

EMC (Environmental Management Cell) is to be established with sufficient staffing and budget. Under EP rules (1986) Government of India has notified EIA notification of 2006 that under which Environmental clearance is to be "Think globally and act locally".

The outcomes of the study clearly show that green buildings are a boon for the investors, yielding high returns as compared to investments in the conventional buildings or other investments, in a shorter duration. Thus even though the initial cost of Green building is high currently it is justified to pay this price for healthy and energy efficient living.

For sustainable design three major aspects to be corporate Functional performance--- safety, durability and serviceability

Economic performance –minimum life cycle and user cost  
 Environmental performance--- Minimum green house gas emissions reduced material consumption, and better energy efficiency.

In India probably there are too many old building and hence it is near impossible to implement these guidelines on them. Government environment website has a lot of guidelines but it has not been put in as a law. We need to think how to convert old buildings into eco friendly constructions.

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