Identification and Prioritization of Critical Factors In Project Management Practices of Sustainable Projects

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Abstract- *The study is intended to identify and prioritize the critical managerial factors for project success of green certified sustainable commercial buildings, as it is high time to extensively adopt sustainable practices in building construction industry that consumes a lion share of total energy usage. The factors considered are from the inception stage to completion of execution and hand over of the project as a valuable occupiable asset. Lean prioritization approach adopted in product development and management is used in this study to address the most important factors. A two-phased questionnaire survey was conducted for the study. The first phase of questionnaire was to get a list of must have factors for project success from the list of factors identified with the help of literature review. It was followed by phase 2 survey for ranking the factors. Henry Garrett Ranking method was used for data analysis. Based on the response from 29 respondents 16 critical factors were identified from 38 factors. Further to making this list of critical factors, a checklist of activities was made to address these factors for validation on projects with inputs from the same 29 respondents and also literature review. Validation of critical factors based on checklist was done on a completed IGBC gold certified stadium project in Ahmedabad. The relationship with the identified critical factors to project success was hence mapped and validated.*

Keywords- Commercial buildings, critical factors, green certification, Henry Garrett ranking, prioritization, sustainable buildings.

I. INTRODUCTION

Construction sector in India has achieved a growth rate of 8.7 percent in the year 2018-2019 (Union Budget,2019) whereas the global average growth rate of this industry is 3.2 percent. According to the Global Status Report by IEA (2018), it was identified that 36% of global energy use is by buildings excluding the energy associated with transportation of construction related materials. We live in an era that faces global climatic change and international discussions are conducted all around the world to control these climatic changes. In the Indian context, it is the commercial buildings that have the higher energy consumption growth rate. As per NMEE, Bureau of Energy, commercial and residential buildings have got energy saving possibilities of nearly 20 percent. It is 'Sustainable buildings' concept that could address positively the energy savings and environmental responsibility throughout the life cycle of the building. But aiming for a sustainable built environment needs a shift in goals incorporating eco-efficient parameters like environment quality, resources, emissions, biodiversity, social equity in design, construction, operation, disassembly, disposal etc. Superior planning and more complex integrated project delivery process are required for sustainable, high-performance buildings compared to traditional buildings(Lapinski et al. (2006)). Though it is extremely important to go sustainable especially in the commercial sector, the number of such green certified buildings are few. Recent literature reviews point out that sustainability goals in the project includes quite more aspects apart from the conventional management-oriented ambitions of time, cost, quality. Existing managerial efficiencies and inefficiencies of sustainable buildings should be reanalysed and a prioritized approach to all the critical factors to project success should be studied in detail to overcome the bottlenecks in implementation of green rated commercial building projects in India. According to FIDIC project sustainability management guidelines, the significant impacts and issues in one part of the world regarding sustainable development becomes unimportant in another. Literature study shows analyses of management challenges in sustainable buildings in various parts of the world, but a detailed identification of all the critical factors in existing Indian construction scenario and proper prioritization of these managerial factors in a project demands a meticulous research, mainly to facilitate sustainable practises in the construction industry and to avoid the wasteful, non-value added works that are being done.Lean prioritization approach adopted in product development and management is used in the study to address important factors first. The idea of prioritization is to focusses on more value generation activities for the success of a certified sustainable commercial project.

The study focusses on enhancing green certified commercial projects in India. It includes

a. Identification of all significant managerial factors for completion of green certified commercial building projects in India.
b. Lean Prioritizing (ranking) of the shortlisted factors using the analysis tool of Henry Garrett Ranking method and finding critical factors in its prioritized order.
c. Validation of these prioritized factors based on a checklist for these factors and by analyzing it on a completed green certified commercial project.

II. LITERATURE REVIEW

According to Swarup et al. (2011) the traditional delivery traits have got much of wasteful reworks, many changes, delays and overproduction. There is high process waste in green building construction because of lack of prioritizing of important attributes (Lapinski et al. (2006)). There are many factors that are involved in the success of a construction projects. The factors identified has been categorized into 4 different sections as client specific, team procurement related, team characteristics, technology and external factors.

There were some studies done on impact of owner's commitment on sustainable building projects. Swarup et al. (2011) finds owners' strong commitment towards sustainability that is identified in the mission/vision of project rather than owner's interests in grands and LEED certifications plays a vital part in success of the sustainable project. This factor is not found as a strong credit in traditional building projects. Type of owner i.e., public or private, and timing of the commissioning agent's involvement in the project process affects the construction speed as identified by Korkmaz et al. (2010). Hwang et.al (2017) identified client's ability to define scope as one of the critical risk in sustainable building projects. In 2019 studies of Raouf et al. recommended that the owners should be the stakeholder who set up the construction contracts and also define the scope of risk and responsibility for the parties to be agreed upon. The early adoption of sustainability objectives in the project is accounted as a lean element that helps in project success and also proper budget allocation for the project (Lapinski et al. (2006)). Venkataraman et al. (2018) identified client's selection of consultant and contractor companies based on the size of the project as one of the critical factors in sustainable projects. Korkmaz et al. (2010) found that CMR and DB outperform DBB in delivery speed in green building project in US. Due to the increasing challenges and complexity within the sustainable projects, the use of traditional DBB delivery methods cannot be matched. Based on the PDS studies on projects that use Integrated project delivery, Construction management at risk, and design build, it was found that sustainable buildings have an elevated need for integration and efficiency in the delivery process. These buildings also require extreme attention to be given to the quality aspect as well (Raouf et al.,2019).According to Gultekin et al. (2013) design build method of project delivery, initial involvement of all relevant project parties including the contractor in design meetings, energy performance simulations preferably from the concept design, owner's strong involvement on scope definition and risk allocation are the strong project delivery indicators

Hwang et.al (2017) identified that the shared information regarding sustainable building construction, complex green building certification approval procedures, scientific data backing for decision making etc. as some of the potential risks in green buildings. Bynum et al. (2013) in his survey found that primary application of BIM was project coordination and visualization compared to performance evaluation of buildings.

The researcher is intending to identify the most significant factors based on the responses from the respondent, which is exactly the use of Henry Garrett method of ranking. The frequency of occurrence of different ranks should be considered in the analysis to eliminate the effect of outliers. This method makes use of Garrett table to convert the percent position to score (S, Dhanavandan (2016)). This method of data analysis has been used in past studies of human resource, management research etc. The sample size of the study also fits in this method.

III. METHODOLOGY

The research methodology adopted for the study is based on pragmatic paradigm approach. This philosophy of social science research appreciates the plurality of methods. Here the importance is given to the research question. As a part of the study, it is required to have a mixed method with both quantitative and qualitative methods. The study is entirely based on the responses from the phase 1 and phase 2 level of questionnaire survey.

Method for validation study on a completed green ratedproject

After the prioritization of factors based on Henry Garrett method is completed, ranks corresponding to all the factors is obtained. Considering the factors whose score is greater than mean value of scores the critical factors are found. To analyze the implementation of these critical factors, a checklist to be made, showing the activities to be done to

positively address the factor. For that, data analysis output has to be sent to all the 29 respondents along with some insights from literature review for receiving inputs from respondents for the preparation of checklist. Based on the checklist prepared, the attention given to the critical factors to be learnt and the project performance parameters of the project also to be analyzed. Validation of the identified critical factors will be done by mapping the relation between project performance and critical factors.

IV. DATA COLLECTION

The data collection involved 2 phases. The first stage for shortlisting and second stage of prioritization of shortlisted factors. The success of the project was defined based on the value generated to client in terms of a green rated sustainable commercial project. This value involves the business aspect and the sustainable aspect as mentioned in the figure below.

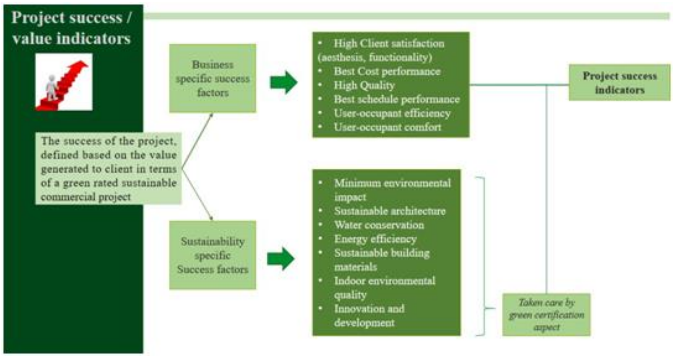

Figure 2. Project success indicators

Only managerial factors were being studied as a part of research. A list of 88 factors was identified by literature review, referring various websites, FIDIC guidelines etc… since it is difficult to rank 88 factors and also to get the list of must have factors by eliminating the desired factors. An initial stage shortlisting of factors by selecting the most significant factors and removal of insignificant factors was done by experts who have sound experience in sustainable construction industry and academics (as academician).

In order to do the data shortlisting and data prioritization, it was important to define what is the value indicators or project success indicators for the study.

Phase1

In phase 1 respondents were asked to fill the survey form in word file. The identified factors were categorized under separate headings for ease and clarity in shortlisting. The factors were classified under headings namely client specific, procurement specific, team management specific, regulatory and green certification specific etc… The details of sample size, expertise and experience requirements of respondents are shown in the table below

Table 2: Phase 1 survey sample size and requirements

Qualificationof respondents	• 10ormoreyearsofexperienceinconstructionofsustainablebuilding projects •10ormoreyearsofexperienceasacademician •Bothcriteria inclusive
Actual sample size	3

Based on the responses the list of factors was shortlisted from 88 to 38 factors. The methodology adopted is illustrated as shown below.

Table 3: sample of Phase 1 survey analysis format

Sl. No	Factor	Factor ID	R 1	R2	R 3
1	Client Involvement	**F1**	S	S	S
2	Client type (public/private)	**F2**	S	I	I
3	Client to propose sustainable features for the project	**F3**	S	I	S
4	Primary reasons to go for "green"	**F4**	I	S	I
5	Timing of introducing green feature in the project	**F5**	S	I	S
6	Client's ability to define scope	**F6**	I	S	I
7	Client's ability to make decisions	**F7**	I	S	S

This analysis is done for the entire 88 factors.

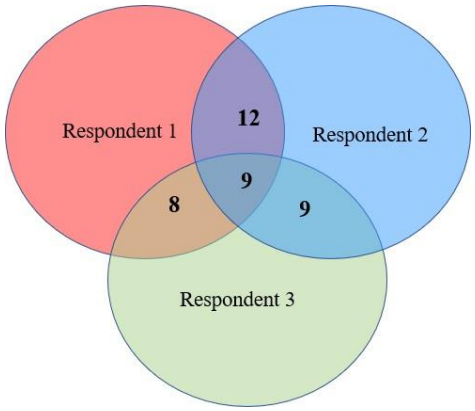

Figure 3. Sample outcomes

The method used for shortlisting the factors was to

- Selected all factors that were found significant by all the respondents
- Also, selected factors marked significant by any 2 of the respondents

- Mathematically, with the help of sets, the selection criteria can be expressed as factors marked significant falling under the category R1 ∩ R2 + R2 ∩ R3+R3 ∩ R1-2(R1 ∩ R2 ∩ R3). Where R1, R2, R3 are number of factors marked significant by respondents 1,2,3 respectively.

After analysis based on the above criteria, the factors were reduced to 38 factors, for the next stage of data collection.

Phase2

A list of 38 factors were prepared based on the data analysis output of phase 1. In this phase the respondents are required to rank the 38 factors. The phase 2 questionnaire was prepared as spreadsheet in excel. For the study, it was planned to have 30 respondents. Responses were collected from 31 respondents, but 2 respondents did not satisfy the experience requirement of the respondents. Hence data was analyzed based on the input from 29 respondents.

In order to make the processes simpler and effective, a questionnaire was prepared in excel sheet that consisted of 2 steps. The first step was to categorize the entire list into 3 groups as high, medium and low priority levels by choosing from the dropdown list. This categorization had to be done considering the defined value indicators of the project. In order to make further clarity regarding factors, a screen tip/description was written to all factors, further a pdf was sent along with the questionnaire

A program was coded in spreadsheet based on array function to dynamically update another set of tables for step 2, based on the input in the first table. And respondents were requested to rank the newly updated list. Each of the 3 columns of ranking for high, medium, low to be ranked separately from 1 to n factors.

DATA ANALYSIS

Steps followed in analyzing the data based on Henry Garrett method is as shown below (Garrett, H.E. & Woodworth, R.S. (1969).

Step 1:

As a first step of analysis, the ranks given to 38 factors by all the respondents are tabulated in a separate spreadsheet as shown in table below. Serial numbers correspond to respondent numbers. The entire consolidated ranking of factors is included in the annexure 1.

Table 4: Sample consolidated ranking for factors

	F1	F2	F3	F4	F5	F6
Sl. No	Client Involvement	Client to propose sustainable conceptto the project	Timing of introducing green feature in the project	Client's ability to make decisions for the project	client's ability for team procurement	Importance of "sustainable goals" for the project
1	9	31	8	29	1	22
2	8	28	7	33	32	6
3	12	30	11	6	31	7
4	3	31	1	17	8	16

Step2:

As per Henry Garrett ranking method, it is required to count the number of times, a factor was marked rank 1, 2, etc. for that another sheet was prepared, counting the number of times different ranks were given to all factors as shown in figure 5.2. First row represents the rank ID, i.e., rank 1, rank 2 etc…Factors from 1 to 38 listed along column 1.The entire counting of ranking of factors is included in the annexure 2.

Table 5: counting repetition of ranks for factors

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
F1	2	3	3	9		2	1	3	2	1		1		
F2						1	1		1					1
F3	6	4	3	1	2		3	2			4			
F4				1		1	1				1	1	2	
F5	1			1			1	2		1	1			
F6	2	3	4			1	2		2	1	1	4		1
F7	2	1	5	1	3	3	1	2	1	1				3
F8		6	2	2	7	2	1	1	2	1	1	2		
F9	5		2		3		1	1				1		1
F10		2	1	3			3		1			1		1
F11	1	2	1	2	3	3		1		1		1	2	
F12				1	1		1	1	1	1	2	1	1	4
F13						1		1		1		2		1
F14			2	2	2	2	1	3	5	3	1	1	1	1
F15									1	2	1		2	2
F16						1							2	
F17			1			3			2	2	2	1	2	1
F18							3					1	3	
F19	3	2	1		1	1	1	1		1	3	1		

Step3:

Next the percent positions of various ranks calculated.
Using the equation, 100(R-0.5)/N
Where R stands for Rank (1 to 38)
N stands for total number of ranks, which is 38.
After calculating the percent positions, the Garrett value associated with percent positions, identified using Garrett

Ranking Conversion Table. The entire table of Garrett Value added in annexure 3

Table 6: Calculation of Percent Position and Garrett Value

Rank	100(R-0.5)/N	Percent position	Garrett Value
1	100(1-0.5)/38	1.32	91
2	100(2-0.5)/38	3.95	84
3	100(3-0.5)/38	6.58	79
4	100(4-0.5)/38	9.21	76
5	100(5-0.5)/38	11.84	73
6	100(6-0.5)/38	14.47	71
7	100(7-0.5)/38	17.11	69
8	100(8-0.5)/38	19.74	67
9	100(9-0.5)/38	22.37	65
10	100(10-0.5)/38	25.00	63
11	100(11-0.5)/38	27.63	62
12	100(12-0.5)/38	30.26	60
13	100(13-0.5)/38	32.89	59
14	100(14-0.5)/38	35.53	57
15	100(15-0.5)/38	38.16	56
16	100(16-0.5)/38	40.79	55
17	100(17-0.5)/38	43.42	53
18	100(18-0.5)/38	46.05	52
19	100(19-0.5)/38	48.68	51
20	100(20-0.5)/38	51.32	49

Step4:

Once the Garrett values identified for various Ranks, all the ranks multiplied by the Garrett value as shown in the table below, the values in the second column were multiplied by 91, which is the Garrett value of Rank 1, similarly 3rd column multiplied by 84, which is the Garrett value for Rank 2. This is done for all the columns, based on the corresponding Garrett values of all the 38 ranks. The entire step 4 of analysis is added in annexure 4.

Table 7: Multiplying ranks with Garrett values

	1 * 91	2* 84	3*79	4*76	5*73	6*71	7*69	8*67	9*65	10*63	11*62	12*60	13*59	14*57
F1	182	252	237	684	0	142	69	201	130	63	0	60	0	0
F2	0	0	0	0	0	71	69	0	65	0	0	0	0	57
F3	546	336	237	76	146	0	207	134	0	0	248	0	0	0
F4	0	0	0	76	0	71	69	0	0	0	62	60	118	0
F5	91	0	0	76	0	0	69	134	0	63	62	0	0	0
F6	182	252	316	0	0	71	138	0	130	63	62	240	0	57
F7	182	84	395	76	219	213	69	134	65	63	0	0	0	171
F8	0	504	158	152	511	142	69	67	130	63	62	120	0	0

Step5:

To obtain the Garrett scores of all the factors, the values in rows (based on above figure), corresponding to a single factor was summed up.

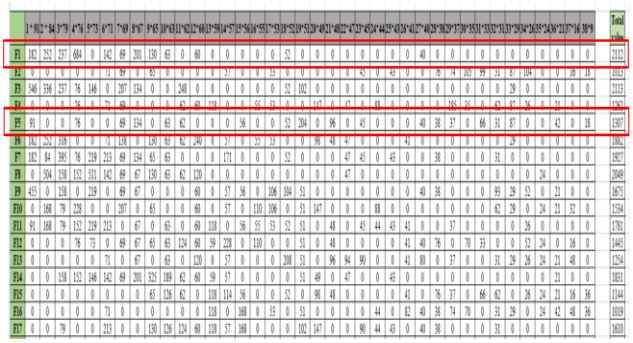

Figure 4: Total score of all factors

The total score of factors 1 F1, summed up to a value of 2112 and similarly for all other factors. After finding the total value of all factors, the average score of each factor was calculated by dividing the scores by total number of respondents (29). The factors were then arranged in the descending order of average scores and factors which had a score greater than the mean score was considered to be the critical factors.

Table 8: List of critical factors

Rank No	Average value	Factor
1	72.86	Timing of introducing green feature in the project
2	72.83	Client Involvement
3	70.66	Contractually agreed green requirement clauses: consultants
4	66.45	Contractually agreed green requirement clauses: contractors
5	64.90	Importance of "sustainable goals" for the project
6	63.14	Early involvement participants: consultants
7	61.41	project sustainability management plan
8	60.52	Proper communication plan
9	60.00	Effective preproject planning
10	57.76	Project delivery system
11	55.76	High level of integration
12	55.52	Align sustainable features to project budgets
13	53.31	Commitment of all project participants
14	52.90	Importance of selection criteria in request for proposal
15	52.10	Use of energy and lighting simulation (numerical analysis)
16	49.90	Green implementation process during design phase

A prioritized list of 16 factors was obtained after analysis. These factors are studied further and checklist made for all the factors. Also, the stage at which factor to be considered, impacted success parameters also identified for all the 16 factors.

Based on a checklist that was made by taking inputs from the same 29 respondents to address these factors, the performance of a completed IGBC Gold certified project was studied as a part of validation.

V. CONCLUSION

Based on the data analysis it was found that early introduction of sustainable features to the project is highly important for project success. Though involvement of client is not that important in traditional building projects, it is not the case with green rated sustainable projects. Contractual agreements between consultants and contractors plays a vital part in getting things done properly as planned. Contracts therefore helps both the client and consultant/contractor side to stick to the planned aspects of projects and getting things done on time. The identification of all consultants required for the project and their early involvement in the project has got a lot of advantages in terms of project success. It helps in efficiently utilizing all skills and knowledge favourable for the best construction of the project.

Preparation of a project sustainability management plan emphasizes on greater monitoring and enhancement of sustainability features for the project. It also makes all project participants aware of sustainable requirements, hence aligning their actions positively towards green requirements. The study also found that a proper systematic communication management plan should be made during the initial stage of the project and it should be followed throughout the execution till the handover is complete. The importance of preproject planning especially for a sustainable project is to tap all the possibilities in favor to sustainability well in advance. Some of the preproject planning activities if missed, could affect the project adversely like the considerations for higher level of certification, proper plan for utilization of demolished materials in case of redevelopment project etc..

The project delivery system is the method adopted by the client in executing the project. It defines the structure of the relationships of the parties, their roles and responsibilities. It is recommended to use the best project delivery method, considering the effectiveness, advantages and shortcomings of various delivery methods possible for the project. High level of integration falls as the 11th important critical factor. The respondents found it very important to have a synchronous relationship among different consultancies and contractors for project success. Followed by the next critical factor which is alignment of sustainable features to project budgets which has to be considered during the initial phase of the project.

Commitment of all project participants was identified as the 13th important critical factor. The respondents agreed that a clear definition of roles and responsibilities of project participants and their total commitment towards the project plays an important role in better project performance. It is important that the RFP specify the required experience of consultants and contractors on green rated project of similar scope and cost. The use of energy, lighting simulation and green implementation process during design phases were also identified as critical for project success.

Validation study was done on Motera stadium project Ahmedabad, which is a redevelopment project. It looked forward for the best possible green certification from IGBC, and expected a silver certification. Looking on the project performance parameters, it can be understood that client satisfaction for the project was pretty good. Though the project achieved the level of sustainability above target, it could have stood as a best project under commercial projects achieving a platinum certification, in fact the only platinum certified stadium project so far, if proper consideration was given regarding avoiding landfilling and reuse of materials from the demolished project. Also, there was a delay in the project by nearly 13 months mainly due to the clearance issue, which falls under the scope of client. The client involvement factor, which has got second priority, mentioned 11 actions in favour of the factor. Some of these actions were not properly considered in the project. There was a significant delay in rerouting the high-power cable passing below the stadium ground. Also, a HT line (torrent power), passing across the site delayed the roof construction. It can be seen evidently that out of the 16 critical factors listed, though satisfactory performance was being done for the lesser significant factors, slight misconduct in top priority factors affect the project performance significantly. Preproject planning for the project had some inefficiencies, especially in separating the reusable materials before demolishing the old building. As a result of unplanned demolition, a lot of waste piled up in landfill.

Lean prioritization of factors, that was used in the study is a method adopted in product development and management in improving the speed of production and reducing the cost by addressing the value adding factors first. This concept applied in the thesis to make a prioritized list of factors that favour the success of a green rated commercial sustainable project suited it very well to give proper attention to important factors. Based on the validation study it was found that in order to face the complexities involved in a certified sustainable project, it is important to seriously consider the identified critical factors and the checklist aids in considering those factors.

There were some limitations in the study, mainly in the validation part. A fully operational green rated commercial building (with all the required data) was not analyzed as a part of validation. Also, the sample size of respondents in phase 1 and phase 2 of the study could have improved. Checklist might have included more guidelines if a greater number of interviews was conducted for it. Some of the personal interviews and travel plans for fully operational sustainable commercial project study was cancelled due to COVID-19 pandemic.

Future studies are recommended by validating the findings by applying it on functional, green certified commercial projects in various parts of the country. Suitability of the research findings on housing projects could also be checked. Again, the checklist used for performance evaluation has got further scope of improvement based on inputs from more respondents who are experienced in this field. This study could also be extended to the operational phase of sustainable projects, to identify the critical factors in that phase as well. Also, construction industry is dynamic and a lot of sophistication occurs as time passes, the validity of the findings should be checked then with the existing technologies and managerial efficiencies.

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ANNEXURE 1

Consolidated Ranking of Factors by all the Respondents

Respondents	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	F25	F26	F27	F28	F29	F30	F31	F32	F33	F34	F35	F36	F37	F38
	Client Involvement	Client to propose sustainable concept in the project	Timing of introducing green feature in the project	Client's ability to make decisions for the project	client's ability for team procurement	Importance of "Sustainable goals" for the project	Contractually agreed green requirement clauses : contractors	Contractually agreed green requirement clauses : consultants	Project delivery system	Importance of selection criteria in request for proposal	Sustainable project delivery in the Project Management Team(project sustainability management plan)	Multidisciplinary/Integrated Project Team	Early involvement participants : contractors	Early involvement participants : consultants	Higher design experience on green projects	O&M early in the delivery process	Align sustainable features to project budgets	Realistic Cost and Time Estimates	Effective preproject planning	High level of integration	Informal design communication	Proper communication plan	Design charette	Client's representative's capabilities	High level of compatibility among project team members	Green implementation process during design phase	Strong control over subcontractors	Commitment of all project participants	Clear design details and specifications	Use of energy and lighting simulation (numerical analysis)	Communication of sustainable opportunities and objectives	Apply lifecycle assessment	support actions at all levels of decision-making	Government Incentives in KRG-rated Green Building Projects	Effective environmental compliance/monitoring program	Complexity of commissioning process	Waste management plan (practices in site)	Sustainable constructability
	9	31	8	29	1	22	5	4	7	17	16	11	18	10	32	33	19	20	2	3	12	6	21	38	34	30	35	23	24	25	26	36	27	15	37	28	14	13
	8	28	7	33	32	6	4	5	1	2	3	26	27	9	14	38	13	12	11	34	35	10	25	15	16	23	24	17	22	21	36	37	20	29	19	18	29	30
	12	30	11	6	31	7	25	5	32	37	24	8	33	4	9	13	20	29	34	27	15	35	14	36	10	18	17	16	19	2	3	23	22	1	21	38	26	27
	3	31	1	17	8	16	9	5	32	33	18	4	19	14	38	6	20	30	10	11	21	12	22	34	35	29	36	23	7	24	25	37	2	13	15	26	27	28
	4	37	2	24	33	3	23	9	32	35	34	14	37	9	10	15	11	25	19	12	26	20	16	27	13	7	28	6	29	5	1	30	17	31	18	38	21	22
	3	34	4	33	38	7	5	6	1	2	8	10	27	9	36	26	11	25	12	14	38	13	35	15	16	17	24	19	20	31	21	32	22	18	23	30	28	29
	7	33	1	4	36	2	6	5	19	20	17	16	23	8	34	32	15	14	3	12	35	18	37	22	31	21	30	11	29	10	27	13	26	25	28	38	24	9
	4	30	5	29	18	1	3	2	17	19	6	31	23	7	38	37	10	24	8	25	9	11	32	26	20	22	36	12	33	21	13	35	16	34	27	28	14	15
	1	31	7	24	27	26	3	2	8	9	4	28	29	10	38	37	12	30	11	13	14	5	32	6	15	16	37	17	35	18	21	34	22	33	23	25	19	20
	9	30	11	29	8	33	32	5	36	7	12	14	34	6	28	35	15	16	1	2	24	3	23	18	19	17	25	4	27	20	21	38	22	37	26	31	13	10
	27	7	2	29	38	17	6	5	14	4	15	12	32	5	13	26	23	24	28	3	31	27	37	16	36	8	35	30	34	21	33	10	9	11	25	20	18	19
	6	38	11	36	23	12	7	8	5	24	25	13	10	9	21	30	14	19	1	3	26	2	37	27	29	31	28	4	20	15	16	17	18	30	22	27	35	26
	2	34	1	16	15	11	14	13	12	17	10	9	18	5	20	27	6	7	19	4	21	22	3	35	23	24	38	25	26	8	27	31	29	36	37	32	28	30
	3	6	7	13	4	12	10	11	5	14	29	37	8	9	38	36	15	16	2	18	17	1	19	30	31	28	27	20	21	26	25	24	32	35	33	34	23	22
	4	29	8	32	33	9	3	2	1	16	5	19	18	12	10	38	20	31	17	34	35	15	28	25	7	11	6	13	14	24	26	27	36	22	30	23	21	37
	18	33	1	20	19	3	21	22	34	36	4	5	14	13	28	38	6	7	23	12	35	2	8	9	24	27	37	26	29	11	10	30	15	31	32	16	25	17

Respondents	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	F25	F26	F27	F28	F29	F30	F31	F32	F33	F34	F35	F36	F37	F38
	Client Involvement	Client to propose sustainable concept to the project	Timing of introducing green feature in the project	Client's ability to make decisions for the project	client's ability for team procurement	Importance of "sustainable goals" for the project	Contractually agreed green requirement clauses : contractors	Contractually agreed green requirement clauses : consultants	Project delivery system	Importance of selection criteria in request for proposal	Sustainable project delivery in the Project Management Team(project sustainability management plan)	Multidisciplinary/Competent Project Team	Early involvement of participants : contractors	Early involvement of participants : consultants	Higher design experience in green projects	O&M early in the delivery process	Align sustainable features to project budgets	Realistic Cost and Time Estimates	Effective preproject planning	High level of integration	Informal design communication	Proper commissioning plan	Design charrette	Client's representative's capabilities	High level of compatibility among project team members	Green implementation process during design phase	Strong control over subcontractors	Commitment of all project participants	Clear design details and specifications	Use of energy and lighting simulation (numerical analysis)	Communication of sustainable opportunities and objectives	Apply lifecycle assessment	[illegible] support actions at all levels of decision-making	Government incentives to ERC-rated Green Building Projects	Effective environmental compliance monitoring program	Complexity of commissioning process	Waste management plan (practices in site)	Sustainable compatibility
	2	38	3	1	7	3	5	6	33	37	19	14	18	8	20	29	9	16	15	10	34	17	11	21	22	12	27	23	13	35	24	36	25	26	28	30	31	32
	4	29	1	20	28	21	2	3	5	7	6	30	22	3	31	19	32	18	11	33	23	10	17	15	14	34	35	26	36	16	25	13	27	37	38	12	9	24
	6	14	19	13	10	12	18	3	17	20	2	30	21	3	15	28	29	38	22	4	31	23	16	32	35	9	36	5	27	11	8	34	33	26	37	25	7	24
	8	33	18	11	19	12	1	2	3	4	5	34	21	20	32	38	9	17	22	10	23	6	35	24	27	7	13	14	16	15	28	29	30	36	31	37	25	26
	8	9	1	33	31	14	3	4	34	32	13	16	5	6	26	17	23	24	7	28	37	10	12	18	35	11	38	21	2	25	22	20	30	36	27	29	15	19
	4	17	11	22	21	10	1	2	18	24	23	28	26	25	14	29	3	30	31	32	20	19	38	37	36	13	15	27	16	9	33	5	34	6	8	35	7	12
	4	34	19	7	33	20	3	2	1	32	21	11	12	22	37	13	24	14	5	6	15	23	36	33	31	27	16	28	10	34	30	36	9	17	18	8	26	25
	2	32	33	34	21	20	14	13	15	16	1	35	37	36	31	30	19	22	17	4	3	18	5	23	24	28	29	6	11	10	7	12	9	8	27	38	26	25
	10	28	2	12	11	9	8	7	3	4	5	27	36	19	29	37	25	24	1	26	38	6	30	20	23	22	33	21	32	18	17	35	15	16	31	34	13	14
	4	23	3	20	19	1	6	5	27	7	2	34	35	8	18	24	10	33	28	21	29	9	17	36	32	16	37	15	22	30	11	13	31	12	25	38	14	26
	4	37	5	30	29	2	8	9	28	3	6	7	12	10	11	15	13	14	27	16	38	17	18	36	35	19	23	24	20	21	22	34	33	1	25	26	31	32
	1	34	2	32	19	3	14	12	18	20	13	21	22	4	35	36	6	7	17	33	16	15	5	30	31	8	37	9	10	11	28	29	26	25	38	27	23	24
	4	25	3	29	36	2	28	35	1	12	26	14	37	11	13	15	27	30	6	16	10	5	24	31	22	20	32	21	23	9	19	38	18	17	34	33	7	8

ANNEXURE 2

Counting repetition of ranks for factors

	1	2	3		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
F1	2	5	5		9		2	1	5	2	1		1						1									1											
F2							1	1		1					1			1						1		1			2	2	5	5	1	5	4			1	2
F3	6	4	5		1	2		5	2			4							1	2														1					
F4					1		1	1				1	1	2			1	1			5		1		2					5	1		2	5	1		1		
F5	1				1			1	2		1	1				1			1	4		2		1				1	1	1		2	1	5			2		2
F6	2	5	4				1	2		2	1	1	4		1		1	1			2	1	1				1							1					
F7	2	1	5		1	5	5	1	2	1	1				5				1				1	1		1			1				1						
F8		6	2		2	7	2	1	1	2	1	1	2										1													1			
F9	5		2			5		1	1				1		1	1		2	2	1								1	1				5	1	2		1		
F10		2	1		5			5		1			1		1		2	2		1	5				2								2	1		1	1	2	
F11	1	2	1		2	5	5		1		1		1	2		1	1	1	1	1		1		1	1	1	1			1					1				
F12					1	1		1	1	1	1	2	1	1	4		2			1		1					1	1	2		2	1			2	1		1	
F13							1		1		1		2		1				4	1		2	2	2			1	2		1			1	1	1	1	1	5	
F14			2		2	2	2	1	5	5	5	1	1	1	1					1	1		1			1											1		
F15										1	2	1		2	2	1			1		2	1					1		2	1		2	2		1	1	1	1	4
F16							1							2		5		1		1					1		2	1	1	2	2		1	1		1	2	5	4
F17			1				5			2	2	2	1	2	1	5				2	5			2	1	1		1	1				1						
F18								5					1	5		5	1	1	1	1		1		4	2					1		1		1			4		1
F19	5	2	1			1	1	1	1		1	5	1			1		5		2			2	1				1	2			1			1				
F20		1	5		5		1				2	1	5	1	1		2		1			1				1	1	1	1				1	2	2				
F21			1							1	1		1		1	2	1	1			1	2		2	1		2			1		2			1	4		1	5
F22	1	2	1			2	5			1	5	1	1	1		2		2	2	1	1		1	2				1								1			
F23			1			2			1			1	1		1		2	2	1	1		1	1	1	1	1			1		1		2			2	1	5	1
F24							1			1						5	1		2		1	1	1	1	1	1	1	2			2	1	1	1	1	1	5	1	1
F25								1			1			1	1	1	2			1	1		2	2	2			1		1		4	1		1	4	2		
F26								2	2	1		2	1	1			2	2	1	1	1	1	2	1	1			1	2	1	1	1			1		1		
F27							1							1		1	1	1					1	2	1			2	2	1	1		1	1		5	5	4	2
F28					2	1	2				1	1	1	1	1	1	1	2		1	1	5		5	1	1	2	1	1		1								
F29		1						1			2	1		1	1		2			1	5	1	2	1	1		1	2		5			1	1	1	1	1		
F30		1				1			1	2	2	5				2	1		2		1	4			2	2	1				1	1			1	1			
F31	1		1					1	1		1	1		1			1	1		1		5	2		1	5	2	2	2		1			2			1		
F32						1					1		1	5				1			1			1	1			1		2	2	1	1		5	2	5	2	2
F33		1								5						2	1	1	2		1		4			1	2	2		1	2	1	1	2	1		1		
F34	2						1		1			1	1	1		1	1	2	1				1			2	2			1	1	2		1	1	1	5	2	
F35									1							1			2	1		1	1	2		5	1	5	2		1	2	1	1	1			5	2
F36									1				1				1		1		1			1		2	2	2	2	1	2	1	1	1	2	1		1	5
F37								5		1				2	5	1			1	1		2		2	1	2	5	1	2	1		2				1			
F38									1	1	1		1	1	1	1		1		2	1		2		5	2	5	1	1	1	2		2					1	

Annexure 3

Garrett Ranking Conversion Table

GARRETT RANKING CONVERSION TABLE

The conversion of orders of merits into units of amount of "socres"

Percent	Score	Percent	Score	Percent	Score
0.09	99	22.32	65	83.31	31
0.20	98	23.88	64	84.56	30
0.32	97	25.48	63	85.75	29
0.45	96	27.15	62	86.89	28
0.61	95	28.86	61	87.96	27
0.78	94	30.61	60	88.97	26
0.97	93	32.42	59	89.94	25
1.18	92	34.25	58	90.83	24
1.42	91	36.15	57	91.67	23
1.68	90	38.06	56	92.45	22
1.96	89	40.01	55	93.19	21
2.28	88	41.97	54	93.86	20
2.69	87	43.97	53	94.49	19
3.01	86	45.97	52	95.08	18
3.43	85	47.98	51	95.62	17
3.89	84	50.00	50	96.11	16
4.38	83	52.02	49	96.57	15
4.92	82	54.03	48	96.99	14
5.51	81	56.03	47	97.37	13
6.14	80	58.03	46	97.72	12
6.81	79	59.99	45	98.04	11
7.55	78	61.94	44	98.32	10
8.33	77	63.85	43	98.58	9
9.17	76	65.75	42	98.82	8
10.06	75	67.48	41	99.03	7
11.03	74	69.39	40	99.22	6
12.04	73	71.14	39	99.39	5
13.11	72	72.85	38	99.55	4
14.25	71	74.52	37	99.68	3
15.44	70	76.12	36	99.80	2
16.69	69	77.68	35	99.91	1
18.01	68	79.17	34	100.00	0
19.39	67	80.61	33		
20.93	66	81.99	32		

ANNEXURE 4

Calculating total Garrett scores for factors

Rank	100(R-0.5)/N	Percent position	Garrett Value
1	100(1-0.5)/38	1.32	91
2	100(2-0.5)/38	3.95	84
3	100(3-0.5)/38	6.58	79
4	100(4-0.5)/38	9.21	76
5	100(5-0.5)/38	11.84	73
6	100(6-0.5)/38	14.47	71
7	100(7-0.5)/38	17.11	69
8	100(8-0.5)/38	19.74	67
9	100(9-0.5)/38	22.37	65
10	100(10-0.5)/38	25.00	63
11	100(11-0.5)/38	27.63	62
12	100(12-0.5)/38	30.26	60
13	100(13-0.5)/38	32.89	59
14	100(14-0.5)/38	35.53	57
15	100(15-0.5)/38	38.16	56
16	100(16-0.5)/38	40.79	55
17	100(17-0.5)/38	43.42	53
18	100(18-0.5)/38	46.05	52
19	100(19-0.5)/38	48.68	51
20	100(20-0.5)/38	51.32	49
21	100(21-0.5)/38	53.95	48
22	100(22-0.5)/38	56.58	47
23	100(23-0.5)/38	59.21	45
24	100(24-0.5)/38	61.84	44
25	100(25-0.5)/38	64.47	43
26	100(26-0.5)/38	67.11	41
27	100(27-0.5)/38	69.74	40
28	100(28-0.5)/38	72.37	38
29	100(29-0.5)/38	75.00	37
30	100(30-0.5)/38	77.63	35
31	100(31-0.5)/38	80.26	33
32	100(32-0.5)/38	82.89	31

33	100(33-0.5)/38	85.53	29
34	100(34-0.5)/38	88.16	26
35	100(35-0.5)/38	90.79	24
36	100(36-0.5)/38	93.42	21
37	100(37-0.5)/38	96.05	16
38	100(38-0.5)/38	98.68	9