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Implementation Barriers of Green Building Design in Indian Construction Sectors

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***Abstract*: Constructions of sustainable buildings are the mostly occurring in India but for these green buildings they are so many problems will be occurred. This research explains how green building is slowly becoming more accepted but it is not occurring fast enough and it needed to be finding out the barriers that slowing down the adoption. The various factors, which becoming the barricades to the successful implementation of the green building in Indian construction industry are identified through the comprehensive study of the literatures. The identified problems are framed as a questionnaire and survey conducted over various construction organizations. The collected data were statistically analyzed through SPSS software and the results were examined.**

***Keywords*: Rating, Response and percentage of Response for each factor, Relative Importance Index (RII), Mean, Standard Deviation, Normality check, Kruskal walli's Htest, Null hypothesis test.**

1. Introduction

Construction of sustainable buildings is the mostly occurring in India but for these green buildings they are so many problems will be occurred. From those problems they want to do the questionnaire survey and then to find the drivers for growth of green development and to reduce consumption of materials, energy, water by green building design elements.

Green building design can be more complicated than what is typically required for conventional buildings, considering that evaluation of alternative materials and systems is commonly necessary by the design team. In these way there is a so many affecting problems are occurring in the proper implementation of green buildings. So for that want to study the elements of the green building design and construction for sustainable buildings.

The major scope of these project is to study the carbon foot print (amount of carbon dioxide released in to the atmosphere) of building alongside the economic incidents to build green projects in India. Green building is on the rise around the world, through a mix of voluntary certification and mandatory requirements. The overall LEED rating system of the USA has expanded its international presence. Today green building is the only way for the construction industry to move towards achieving a sustainable development, taking into account environmental, socioeconomic and cultural issues

Green building is an important topic nowadays and only once it is fully understood, may it be implemented and put into practice. To do so, one must measure the benefits of the costs and amount of money saved throughout the lifecycle of the building as well as the amount of resources saved as well to fully realize the fruits this delivery method invokes. The whole intent of the green building delivery method is to provide an environmentally clean and healthy society which would utilize less of our limited building resources as well as natural resources so as to create a sustainable world. Sustainable development here means meeting the needs of the present without compromising the ability of future generations to meet their needs.

2. Methodology

The literatures of green building progress in India, as well as other countries scenarios were studied to identify the barriers encountered along with the measures taken in green building movement across the countries, which could be implemented in Indian context. Survey questions are prepared after the literature study. The survey was conducted through a questionnaire distributed randomly to the various construction organizations. The questionnaire form was designed into the following sections: 1. Respondents profile, 2. Education, 3. Designation, 4. Work experience, and 5. Factors influencing the implementation. The respondents were asked to rate the problem statements with Likert scales (on 1 to 5-point basis). Furthermore, the data was statistically analyzed using SPSS software tool, and the results were examined and concluded.

In the preparation of questionnaires some problems are occurred for list out the major factors and sub factors affecting on the sustainable buildings and the identifying the factors from the number of the literatures and articles, newspapers etc., are also problems facing in the identifying the factors.

3. Result analysis

From the collection of responses for factor the complete project results are done by using SPSS software. Relative Importance Index (RII) is a method used to determine the weight age of a particular variable when there are multiple responses under that variable. RII helps in determining the contribution of a particular variable that makes to the prediction of a criterion variable both by itself and combination with other.

$$RII = \frac{\sum W}{(A * N)}$$

RII = relative importance index; W = weighting given to each factor by respondents (ranging from 1 to 5); A = highest weight (i.e., 5 in this case); and N = total number of respondents.

The table 1 shows the rankings by RII of various factors and amongst the 37 factors the rank one is the ID F19. (Economical risk due to green building investment) Most of the respondents strongly agreed that the construction organizations show difficulties for the investment and that becoming the implementation barrier of green building and sustainable design followed by rank two F23 (Are the national green building standard are using in your green construction), rank three F27. (Technology of Renewable Energy Company's (TRECO) tool was used in case of biomass and carbon trusts) and so on.

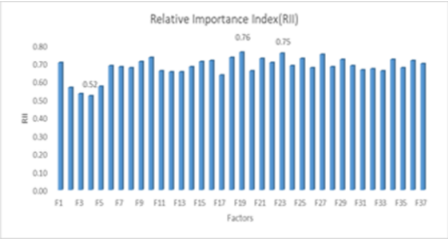

Fig 1. Graph indicating Relative importance index (RII) for Factors (F1- F37)

A. *Annova (kruskal wallis H test)*

Analysis of variance (ANNOVA) is a statistical method used to test differences between two or more means. It may seem odd that the technique is called "Analysis of variance" rather than "Analysis of means". If several independent samples are involved, ANOVA is the usual procedure, when the assumptions of ANOVA are not met, an alternative technique was developed called the Kruskal-Wallis one-way Analysis of variance or the H-test. This test helps in testing the null hypothesis that k independent random samples come from identical populations against the alternative hypothesis that the means of these samples are not all equal. Standard deviation is the most useful and the most popular measure of depression. The deviation of the observations from the AM are considered and then each squared. The sum of the squares is divided by the number of observations. The square of the SD is known as variance and is denoted as σ^2 or SD is the positive square root of variance.

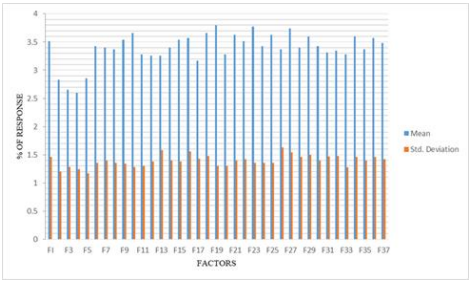

Fig. 2. Graph indicating Mean and Standard deviation for (F1-F37)

Table 1
Indicating number of responses, Ranking, RII of each factor

ID	SDA	DA	NU	AG	SA	RII	Ranking
F1	5	4	7	6	13	0.702857	14
F2	3	15	6	7	4	0.565714	35
F3	9	5	14	3	4	0.531429	36
F4	9	7	10	7	2	0.52	37
F5	4	10	12	5	4	0.571429	34
F6	3	8	5	9	10	0.685714	17
F7	5	4	8	8	10	0.68	20
F8	5	3	10	8	9	0.674286	23
F9	3	6	6	9	11	0.708571	12
F10	3	3	9	8	12	0.731429	4
F11	5	4	8	12	6	0.657143	28
F12	5	6	7	9	8	0.651429	31
F13	8	4	5	7	11	0.651429	31
F14	5	4	8	8	10	0.68	20
F15	4	4	8	7	12	0.708571	12
F16	6	4	4	6	15	0.714286	10
F17	6	6	7	8	8	0.634286	33
F18	4	5	6	4	16	0.731429	4
F19	2	5	6	7	15	0.76	1
F20	4	6	8	10	7	0.657143	28
F21	4	4	6	8	13	0.725714	6
F22	4	6	5	8	12	0.702857	14
F23	2	6	6	5	16	0.754286	2
F24	3	8	5	9	10	0.685714	17
F25	4	3	7	9	12	0.725714	6
F26	7	6	3	5	14	0.674286	23
F27	7	0	4	8	16	0.748571	3
F28	4	8	5	6	12	0.68	20
F29	5	4	6	5	15	0.72	8
F30	5	4	7	9	10	0.685714	17
F31	6	5	6	8	10	0.662857	27
F32	5	7	5	7	11	0.668571	26
F33	4	6	7	12	6	0.657143	28
F34	4	6	4	7	14	0.72	8
F35	4	7	6	8	10	0.674286	23
F36	4	6	5	6	14	0.714286	10
F37	3	9	3	8	12	0.697143	16

The likert scale representation of factors like (1 for SDA,2 for DA, 3 for NU,4 for AG and 5 for SA), if the response for a factor should be very high as compared to other factor, the mean value also increase linearly. Standard deviation shows that how much the factor responses are deviated from the mean average values. hence high mean value factor should have less standard deviation. Coefficient of variance defined as the ratio of arithmetic mean and standard deviation. The coefficient of variance should be least for good factor. The standard deviation and variance, according to experience for each factor, in that F19(Economical risk due to green building investment) get highest mean value (3.8) compared to the other factor. that's means the respondence ranking corresponding to this factor be very high and coefficient of variation value for this factor (34.25211) be least followed by the rank two for F23 (Are the national green building standard are using in your green construction), and so on.

B. *Combined mean factor*

Combined mean factor is to be determined for finding the dominate factor for the risk to the green building construction sectors. A combined mean is simply a weighted mean, where

Table 2
Combined Arithmetic mean of factors

S. No	Factors	Combined Arithmetic Mean
1	Capital cost will be high in green building projects	2.89
2	Company policy for green buildings	3.48
3	Decision of control carbon emissions of materials	3.299
4	Risks factors in green building investment	3.54856
5	Green building performance codes used to measure ratings	3.55
6	Green building performance measure using tools	3.54288
7	Performance of green buildings in greenhouse effect	3.41716
8	Cost benefit by using buildings	3.46284

the weights are the size of each group. For more than two groups: Add the means of each group each weighted by the number of individuals or data points

The combined mean among the following factors risk factor in green building investment (3.54856), green building performance code (3.55), green building performance measures (3.5428) are the major risk put forward by the respondance profile as the barriers for the implementation of green building design in Indian construction sectors followed by the other factor

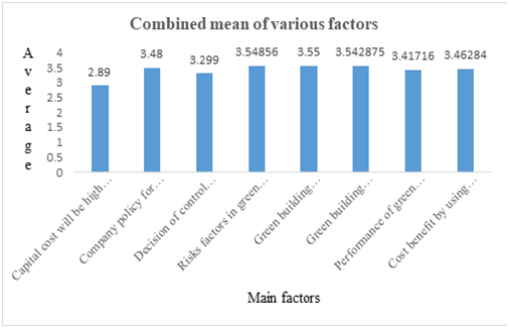

Fig. 3. Indicating combined mean for eight main factors

C. *Normality check*

An assessment of the normality of data is a prerequisite for many statistical tests because normal data is an underlying assumption in parametric testing. There are two main methods of assessing normality: graphically and numerically. the testing for normality procedure in SPSS Statistics for the specific statistical test you are using to analyze your data, we provide comprehensive guides in our enhanced content. For each statistical test where you need to test for normality, we show you, step-by-step, the procedure in SPSS Statistics, as well as how to deal with situations where your data fails the assumption of normality

The table 2 presents the results from a well-known test of normality, namely the Shapiro-Wilk Test. The Shapiro-Wilk Test is more appropriate for small sample sizes (< 50 samples), but can also handle sample sizes as large as 2000. For this reason, we will use the Shapiro-Wilk test as our numerical means of assessing normality.

We can see from the above table that for the dependent variables F1-F37, the data was not normally distributed. If the Sig. value of the Shapiro-Wilk Test is greater than 0.05, the data is normal. If it is below 0.05, the data significantly deviate from a normal distribution, hence Kruskal-Wallis H test for three or more unrelated samples was carried out.

Table 3
Normality check for (F1-F37) factors

Tests of Normality			
Shapiro-Wilk			
Factor	Statistic	df	Sig.
FI	0.837	35	0
F2	0.874	35	0.001
F3	0.878	35	0.001
F4	0.897	35	0.003
F5	0.911	35	0.008
F6	0.874	35	0.001
F7	0.875	35	0.001
F8	0.881	35	0.001
F9	0.87	35	0.001
F10	0.862	35	0
F11	0.887	35	0.002
F12	0.891	35	0.002
F13	0.839	35	0
F14	0.875	35	0.001
F15	0.862	35	0
F16	0.801	35	0
F17	0.888	35	0.002
F18	0.809	35	0
F19	0.828	35	0
F20	0.902	35	0.005
F21	0.842	35	0
F22	0.854	35	0
F23	0.814	35	0
F24	0.874	35	0.001
F25	0.85	35	0
F26	0.808	35	0
F27	0.748	35	0
F28	0.854	35	0
F29	0.816	35	0
F30	0.87	35	0.001
F31	0.867	35	0.001
F32	0.861	35	0
F33	0.896	35	0.003
F34	0.827	35	0
F35	0.878	35	0.001
F36	0.832	35	0
F37	0.842	35	0

D. *Kruskal-wallis H test for three or more unrelated samples*

If several independent samples are involved, ANOVA is the usual procedure, when the assumptions of ANOVA are not met; an alternative technique was developed called the Kruskal-Wallis one-way Analysis of variance or the H-test. This test helps in testing the null hypothesis that k independent random samples come from identical populations against the alternative hypothesis that the means of these samples are not all equal. The alternative hypothesis is often the hypothesis that you

believe yourself! It includes the outcomes not covered by the null hypothesis. Here we are accepting all the null hypotheses that the distribution of all the factors (F1-F37) are same across various categories of respondents Designation also we can conclude that all the independent samples come from identical populations. Remember that there will be some sample means that are extremes – that is going to happen about 5% of the time, since 95% of all sample means fall within about two standard deviations of the mean. What happens if we run a hypothesis test and we get an extreme sample mean? It won't look like our hypothesized mean, even if it comes from that distribution. We would be likely to reject the null hypothesis. But we would be wrong.

4. Conclusion

- The highest ranked factor ID-F19(economical risk due to green building investment), can be concluded as the number one barrier that affects the successful implementation of the green building at present scenario from the survey.
- The economic risk in the green building investment factor were found to be the highest mean rating (above 3.8), design includes permits and legal cost mean rating (below 2.6).
- Coefficient of variation value should be least for the first rank factor with high mean value and shows less deviation followed by other factors.
- In the green buildings are preventing the value of active renewable energy technologies F25are limited, tools designed to support stake holder's decisions also have high marginal mean value.
- Here we are accepting all the null hypotheses that the distribution of all the factors (F1-F37) are same across various categories of respondent Designation also we can conclude that all the independent samples come from identical populations.

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