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Affordable Green Housing, "Is it a possible solution for sustainability and huge housing demand"

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Abstract: With urbanization, population is at it hike and current status in the construction industry is to develop large scale affordable housing for the necessity of urban India. The construction industry is the primary energy-consuming industry and even emits many greenhouse gasses. It drains around 38% of the total energy globally, not including water and other essential resources. All of this is contributing to global warming and environmental misbalance. While catering such high housing stock we have to consider its impact on environment first. It is extremely important to think about environment before us. The trends in construction industry has highlighted the green building features and need for affordable building and thus unifying both to form green affordable building module which will be the best option for E.W.S and L.I.G category. But these benefits are not visible be consumer and even people from industry and thus this research tries to investigate to investigate the awareness about green building and the new concept of affordable green building and challenges faced in its implementation and major barrier in its way.

Index Terms **– sustainability, affordable housing, barriers in affordable green building.**

I. INTRODUCTION

Current population is 1.35 billion 2 nd most populated after china. Construction industry contributes to 8.7 % GDP of India and expected CAGR is 10 % making 3 rd largest markets for housing. Due rapid development there is rise in global population but, earth's total resources are suitable only for a few billion people at the current rate of demand, which is harmful. Today development due to urbanization in India, there is a massive requirement of housing especially affordable housing. Cities in India lack low-cost housing, this results in formulation of slums thus they lack the basic amenities for life and fail to be equal citizens. However, it is essential to consider it an urgent issue and establish an extensive framework for affordable housing development (JONES LANG LA SEILER).

Ministry of Housing and Urban Poverty Alleviation (MHUPA), estimated shortage of 18.78 million, over which 95% of the shortage is for EWS and LIG and the rest for MIG and LIG in its 12th, five-year plan(IGBC). If the backlog of housing is maintained, 30 million additional houses will be required by 20201 (JONES LANG LA SEILIE). Thus to cater this huge demand PMAY-U is targeting to build approx. Twelve million dwelling units for the urban poor by 2022. Depending on the categories, 30 sq m. for EWS and 60 sq.m. For LIG (PMAY). This huge housing will directly and indirectly hamper our environment.

Green building is not a new concept has deep roots in nineteen century traced to a structure in London's Crystal Palace were passive techniques for roof ventilation and underground air-cooling chambers were used improving the efficiency of the building. The green building concept got its publicity in the 1960s-1962s from book "Silent Spring" by Rachel Carson (CHRISTINA M.WEBB). According to the act 2007 of energy independence and security, green buildings are high-performance buildings which optimize and integrate all major performance credits like water and energy conservation, safety, security durability, accessibility, cost-benefit, productivity sustainability, functionality and functionality operational consideration. (World Green building Trends 2018).

Benefits of green building are known worldwide. Green building concept consider orientation of structure, efficient placement of windows to maximum utilization of natural light making it energy efficient building thus reduce greenhouse gas emissions and becomes cost-effective. (MOHD YASIR LAEEQ). According to the Australian green building council, Productivity was boomed to 25% from 1%, thus high relative investment return, high market value for assets (Haynes 2007; Nushrat Shabrm).

Thus considering the benefit green building provides, unifying it with affordable housing will be natural fit. Affordable and sustainable housing is also defined as housing that satisfies the requirements and needs of the current age without compromising the capacity of other age yet to meet their housing need and demand". Affordability and sustainability are firmly associated with economic, social and environmental components. (Arman Et. Al, 2009).There are different views of people at a different times and different phases. "On the other hand, there is indisputable evidence supporting the view that cost barrier is perceptual rather than real and that the benefits of sustainability outweigh the cost"(Van Hal 2007; Power 2008). There are realistic challenges associated with accepting the tension between affordability and sustainability (Arman Et. Al, 2009).

II. NEED OF THE RESEARCH

The current status in the construction industry is to develop large scale affordable housing for the necessity of urban India. While catering such high housing stock we have to consider its impact on environment first, global warming, climatic change and greenhouse gas have already hated hard. It is extremely important to think about environment before us. Resources are limited land is deteriorated by deforestation, water is adulterated and air is polluted. Wendell berry stated, "Earth is what we have in common" thus it's our responsibility to take care of it. Affordable housing with sustainable features would be the best possible solution to this housing problem. There are different views of people at a different times and different phases. "On the other hand, there is indisputable evidence supporting the view that cost barrier is perceptual rather than real and that the benefits of sustainability outweigh the cost"(Van Hal 2007; Power 2008). But still consumer, real estate developer chooses convention building option over green building to avoid the risk factor. Our governments have already known these facts and thus encourage the industry by providing incentives, subsidy, extra FSI. Thus affordable green building is a key to this entire mess. Thus project aims to investigate level of awareness in construction industry about the knowledge about the green building, affordable green building concept. It also covers study of rating system, its awareness. This research revolves around principle members from construction industry.it also aims to understand requirements of consumer from construction industry.

III. METHODOLOGY

To get in depth of the topic various literature reviews were studied. To achieve our research aim it was necessary to understand what people think about the affordable green building concept, hurdles in the implementation of affordable green building and green building is done. Do they use it, do consumer ask them for sustainable structure do they encourage their consumer and thus to archive it a survey in construction sector was necessary. Primary data for our research was collected from survey or say case study with help of interview and questionnaire. Its important have unbiased opinion on the concept. Thus survey in which people from construction sectors like architect, civil engg. Real estate developers were included. A sample size play an important role in survey .surveying educated people was easy and thus an online survey was carried out. After collection of primary data its analysis is to be done. Analyze of Quantitative data requires careful interpretation as it deals with numerical data and question such as how many and how much and open ended questions also. And thus understanding meaning behind each questions is important .To ensure that the findings and outcomes were not biased efficacy checks were done and results are presented in conclusion.

IV. CASE STUDY- (SURVEY)

To Study of different factors involved in affordable green building concept an intense questionnaire was prepared and people from different profession were considered to have different perspective. Each group was studied with a different purpose and to discover diverse culture. "SURVEY A" was also an online survey carried out to investigate the awareness about green building and the new concept of affordable green building and challenges faced in its implementation and major barrier in its way. The survey also includes some question regarding Rating system and its acceptance and benefits to builder and contractors. Sample size of 25 participants posted their responses in the survey, which included 15 male and 10 female in between the 25 to 54 years age group, having experience in construction industry for about 2 years to 15 years. The major intention of survey was to understand, people view on all the technical concepts and its applicability from the technical people itself and thus the survey was conducted. Awareness about this new concept in the construction industry, was also the main aim and thus they were questioned and their respond was collected and analyzed in a statically form.

V. RESULTS

As discussed above, survey was conducted and primary data was collected, collected data then was analyzed with the help of professional statistical analyst for clear and unbiased result. Depending on the question various hypothesis were built by clubbing some question and then their results are shown.

Hypothesis 1: Awareness of customers about green features in homes is statistically significant
Hypothesis 2: Establishment of distinctive advantage in the market place of companies with green image is statistically significant

Table [1]

Q no.	Response	Agree	Neutral	disagree	Total	Mean	Variance	|t| cal	P value	Conclusion
1	Do your customers ask for green features in homes?	14	7	4	25	2.4	0.583	2.618615	0.0150	Significant *
3	Do you think companies which can establish themselves with green image will have distinctive advantage in the market place?	19	1	5	25	2.6	0.667	3.41	0.0012	Significant*

(Source: Primary data collection)

*: significant at 5%

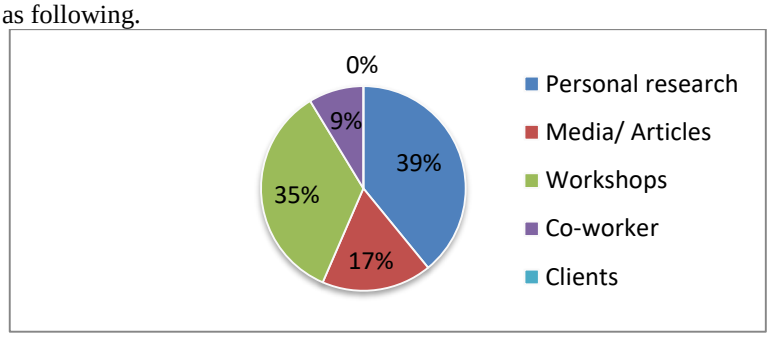
From the table number [1], it is concluded that, Z value lies in the rejection region i.e. 'P' value is < 0.05. So that, null hypothesis is rejected.

Therefore accept the hypothesis 1 that awareness of customers about green features in homes is statistically significant.

Also, accept the hypothesis 2 that establishment of distinctive advantage in the market place of companies with green image is statistically significant.

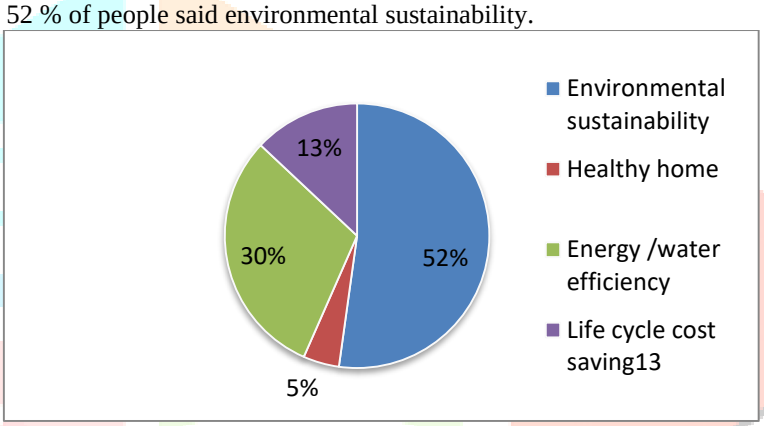
Green building concept has a great future ahead looking at its benefit and maximum consumer's awareness, but about 40% are not aware. Thus awareness program for these people are necessity so that 100% of people know it and progress on it for betterment of themselves and environment.

Further participants were asked, what was their source of information, on green building concept and practice, and then their respond was recorded as following.



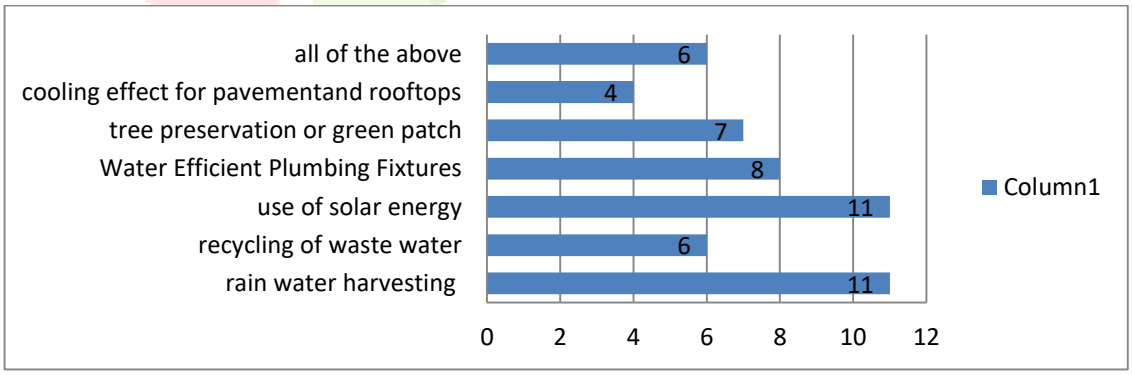
(Source: Primary data collection) (Q.2)

Later they were demanded to define green building to someone with no prior knowledge of the concept, in which areas, you will focus on to which about 52 % of people said environmental sustainability.



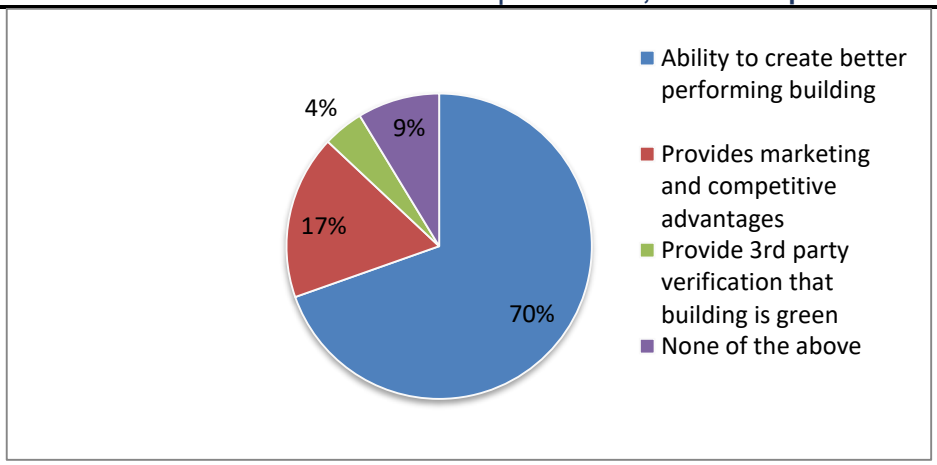
(Source: Primary data collection) (Q.4)

Adding more to these survey participants were asked, do their building incorporate any of the green building features for conservation of resources , to check their own their awareness. Only 6 participants clicked on all the above out of 25 people. Whereas 11 participants out of 25 used solar energy and rain water harvesting in their building, thus taking a step towards green building.



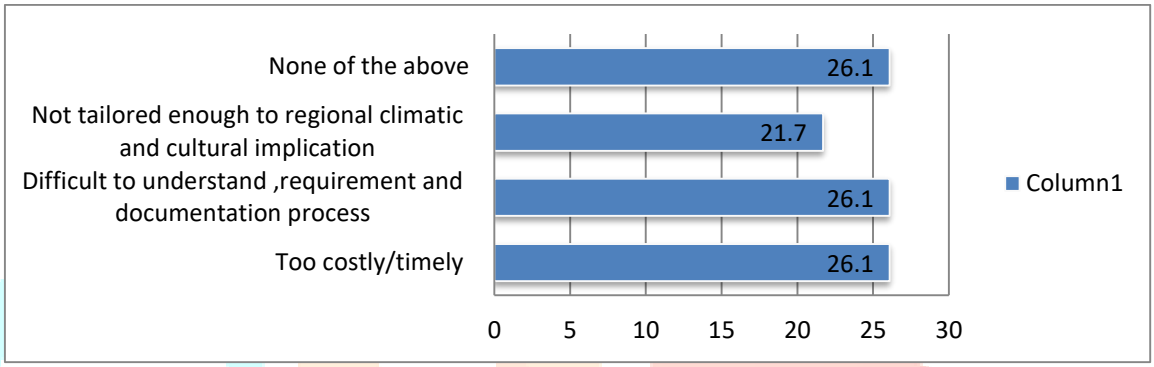
Green building feature (Q.5) (Source: Primary data collection)

Rating system has been a guideline for green building concept in today's world. They have their own merits and demerits and it is was necessary to know them and understand them. Participant's responds on this was recorded and graphically represented.



Benefits of Rating Systems (Q.6.) (Source: Primary data collection)

Further parameter according to consumer for rejecting rating systems were discussed graphically represented below.



Reasons for rejecting rating system (Q.7)

Hypothesis 3: According to industry personnel the barriers in green building activity are significantly important

Table [7]

Response	Yes	No	total
higher first cost	9	16	25
lack of political support	4	21	25
affordability(this concept is for high-end project)	5	20	25
lack of public awareness	17	8	25
lack of trained and educated green building professionals	15	10	25
unable to prove business due to split of capital cost and operating cost	2	23	25
	52	98	150

(Source: Primary data collection)

Sample proportion = 0.346,

Calculated value of |t| = 3.067, 'P' value = 0.0053

As 'P' value < 0.05, reject the null hypothesis. Hence, accept the hypothesis that according to industry personnel the important barriers in green building activity are statistically significant.

Statistical analysis proved that there are various barriers between green building and its acceptance, two of the major barriers are lake of awareness and lake of educated and trained professionals. Thus it necessary to understand the root cause and plan to cure it.

Hypothesis 4: According to industry personnel permits, legal cost and the registration cost of certification of green buildings are significantly more.

Table [8]

Q. No.	Response	Agree	Neutral	Disagree	Total	Mean	Variance	|t| cal
9	Do you agree that the permits and legal cost are high, and higher is the registration cost of green buildings certification	15	1	9	25	2.56	0.34	4.81

(Source: Primary data collection)

From the table number [9], it is concluded that
Sample mean = 2.24, sample variance = 0.34,
Calculated value of |t| = 4.81, 'P' value = 0.0001(one sided test)
Calculated value of |t| lies in the acceptance region i.e. 'P' value is > 0.05. So that, null hypothesis is accepted. Therefore accept the null hypothesis. That is according to industry personnel permits, legal cost and the registration cost of certification of green buildings are significantly more. Thus it proves green building certification adds up the cost and extends the time of the process.
Coming to the important topic and the topic of concern i.e. affordable green build, participants were asked some question related to this topic.

Hypothesis 5: Opinion of industry personnel about affordable green buildings is statistically significant
Table [9]

Q. No.	Response	Agree	Disagree	Total
10	Do you think that the specifications sheet for affordable buildings will be same for affordable green certified buildings	4	21	25
12	Affordable green buildings require less frequent maintenance in comparison to conventional affordable buildings.	17	8	25
13	Do you think quality of recycled material for construction is good when compared to fresh material?	10	15	25
14	Do you agree that height of the building play an important role while designing affordable green building	21	4	25
15	Do you think that consuming full FSI is more important, when you go for high-rise structure?	17	8	25
17	Do you think operating cost plays important role in affordable green building	24	1	25
18	Do you think about the operating cost of feature like lift, solar system, STP, will it be affordable to the people EWS category	11	14	25
19	Do you think that green buildings/ houses increases its resale value	11	14	25
20	Do you think companies which sell green homes will be able to sustain for a longer period of time in the market in comparison to others?	24	1	25
	Total	130	95	225

(Source: Primary data collection)

From the table number [9], it is concluded that
Sample proportion = 0.62,
Calculated value of |t| =3.53, 'P' value = 0.005
Calculated value of |t| lies in the rejection region i.e. 'P' value is < 0.05. So that, null hypothesis is rejected. Therefore accept the hypothesis that opinion of industry personnel about affordable green buildings is statistically significant.
Above hypothesis and its analysis clears that affordable green building is a good option for environment as well as individual living in them. Looking at the response of the individual it is clear that not all are clear about the concept and their advantages. it is 100% sure that opinions of all may not match and thus it is necessary to create awareness about it and make people understand about it and its benefits and this can be done only and only by creating awareness about it.

Further participants were asked to respond on expected payback period on the initial investment according to their view to which the participants recorded their response is shown graphically
Table [10]

Playback period	Response
0-5 years	4
6-10 years	8
11-15 years	3
15 + years	0
I do not know	10
Total	25
Mean	7.83 years
S.D.	3.71 years
C.V.	49.25%

(Source: Primary data collection)

Out of 25 industry respondents, 10 are saying that they don't know about playback period expected on initial capital investment for green technologies for affordable green buildings. While 15 know about it. So, the average playback period expected on initial capital investment for green technologies for affordable green buildings is 7.53 years (approx. 8 years) with Standard Deviation (S.D.) 3.71 years and Coefficient of Variation (C.V.) 49.25%.

Hypothesis 6: According to industry personnel affordability of green buildings is statistically significant

Table [11]

Q. No.	Response	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	Total
11	What do you think about the statement "green buildings are actually affordable?"	1	2	10	11	1	25

(Source: Primary data collection)

From the table number [10], it is concluded that
Sample mean = 3.32, sample variance = 0.733,
Calculated value of |t| = 1.879, 'P' value = 0.0724
Calculated value of |t| lies in the acceptance region i.e. 'P' value is > 0.05. So that, null hypothesis is accepted. Therefore the statement "green building is actually affordable" was statistically rejected. This proves that maximum people are unaware of the benefits of green building and thus more than 50% of people disagreed with the statement.

VI. CONCLUSION

This research incorporated survey with common educated people and people from LIG and MIG to understand their needs their view about the on-going affordable green building concept. Response collected in the survey is generous but has its own limitation while analysing it as it was for a small sample size. Realization of the environmental problem and necessity to overcome them is best known by this group of people due to working in same industry. But their willingness to acquire new technologies and techniques is less, due to less information of their benefits and price. The survey also brought up some points and regions which act as barriers which create challenges in unifying affordability and green building. Affordable green building is the best concept looking at the current scenario of the environment and the need for housing. Due to less knowledge this concept is rejected and considered as costly and time consuming concept.

It's important to make people know they are Less expensive houses easy maintain, simpler to operate healthier to live in and perfectly environmental friendly. Green building brings lots of benefits for the people like tax saving, thus saves residents money and contributes to resource consumption. Green building certification of these affordable green building is also a topic for debate, but the concept provides a good planning designing framework for affordable housing. Thus it is a matter of choice; it's a green building even if the certification is not done. Green building programme enhances the value of affordable housing by promoting quality construction and high performing houses to this over sensitive low income communities. The research at the end brings many such points which need to be studied further to put forth a significant triple line benefits

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