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Adoption of Green Building Concept by Selected Builders of Vadodara City in Selected Housing Colonies Constructed by Them

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Abstract

Buildings have major environmental impacts over their life cycle. Hence, there is a need to design and construct a green building which minimizes the issues related to environment deteriotion due to construction of buildings. A green building uses less energy, water and natural resources. It generates less waste and provides a healthy living environment for the occupants. The construction industry is a larger user of natural resources, therefore there is a need to design building with low environmental impacts. Green buildings are upcoming concept and the need for present day construction industry, so as to have sustainable development. It has been observed that Vadodara city has witnesses a remarkable growth in the construction of commercial as well as residential sectors. The concept of green building has been more widely adopted in commercial sectors rather than residential sectors. Hence, a study was conducted to find out the opinion of the builders regarding adoption of green building concept in their construction of residential sectors, reasons for adopting the green building concept and the barriers faced in adopting the same. The data were gathered through a questionnaire from a sample of 75 builders through convenience sampling. Descriptive and relational statistics was used for presenting results. The findings of the study revealed that majority of the builders were middle aged and their professional association was the main source of information about green buildings. More than one half of the builders had low extent of exposure to various sources of information. Environmental aspects were the reason as stated by builders behind the adoption of green building design and construction. Majority of the builders faced lack of technical knowledge of the project team, contractors and clerk and lack of interest in implementing green building concept as high extent of barrier in adopting green building design and construction. Majority of the builders had somewhat favourable opinion regarding green building. A significant relationship was found between reasons for adopting green building design and construction by the builders and opinion of builders regarding the same. The builders can be made aware through an educational programmegiven by the educational institution about the impact of the buildings on the health of the occupants and to construct a building which incorporates features of green building.

Keywords: Green building, opinion of builders.

Introduction

India's economic development propelled by rapid industrial growth and urbanization is causing environmental problems that have local, regional and global significance[1]. Changes brought by the Industrial Revolution (1750-1850) in agriculture, manufacturing, mining, transportation, and technology had a profound effect on human society. Solutions of eradicating poverty, food security, living standards, etc. in the modern concept of economic development but on the other hand it is observed that the environment is paying the price for it[2].

The cumulative effects of the degradation of the Earth's natural environment have increased the scale of the sustainable development challenge enormously. It is evident that that human activity is causing an irreversible damage to the global environment[3], which has adverse impact on the quality of life of future generations[4]. Hence, the concern for sustainability is even more in recent times. Ancient Indians were much aware about the ecology and sustainability. It helps in solving specific environmental problems and the modern principles of sustainability were adopted at that time. But fortunately those golden principles laid have been forgotten[5].

Construction industry is growing rapidly all over the world. Buildings have major environmental impacts over their entire life cycle which ranges from their designing, construction, operation, maintenance, renovation and deconstruction[6]. Resources such as ground cover, forests, water, and energy are depleted to give way to buildings. The construction business accounts for approximately 45-50 percent of comprehensive power consumption, just about 50 percent of all-inclusive water usage, and more or less 60 percent of thetotal usage of unprocessed or raw materials. Alternatively, the construction sector chips in 23 percent of atmospheric contamination, 50 percent of climate change gases, 40 percent of drinking water contamination, in addition to an added 50 percent of landfill

wastes. It is imperative that construction companies ought to put a spotlight further on diminishing waste fabrication, capitalizing on the reuse of salvage, and crafting sustainable buildings[7].Over last few years 'go green' philosophy has been developed. Building construction sector is no exception to this. This concern has led to the development of "Green Buildings". Green buildings are designed and constructed to maximize the whole lifecycle performance and conserve resources[6]. The green building emphasizes reduction of environmental impacts through a holistic approach to land and building uses and construction strategies[8].

Green building incorporates several environment sustainable features than the conventional buildings. As per IGBC, "Green building is the one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional buildings". The Indian Green Building Council (IGBC) promotes "Leadership in Energy and Environmental Design" (LEED) which started in 2001. The Energy and Resource Institute (TERI) has a programme namely "Green Rating for Integrated Habitat Assessment" (GRIHA). They promote whole building approach to sustainability by addressing performance in the five areas viz. sustainable site development, water saving, energy efficiency, material selection and indoor environment quality[9].

Benefits of Green Buildings: The main objective of green building is to incorporate sustainable features right at the design stage, where, the entire supply chain-from material sourcing, energy modelling, resource reuse, civic amenities to waste disposal- is considered[9]. Sustainable design helps to reduce the amount of energy required to cool, heat, and light the buildings by utilizing passive strategies such as day lighting, thermal mass, and shading, using sunlight through passive solar and photovoltaic techniques and using plants and trees through green roofs. With installation of water conserving fixtures and through rainwater harvesting system, green buildings can reduce the amount of water required for non consumption uses. Efficient landscape and roof designs can also mitigate storm water runoff. Green building installs equipments which help to reduce the environmental impact on global warming, ozone depletion, and air pollution. It promotes utilization of recycled building materials to lessen the burden on the landfills[8].

Barriers to the Development of Green Buildings: There are some barriers in way of adopting green buildings. One of the barriers is the additional cost incurred in its construction and difficulty in getting positive returns on this extra investment of the builders and developers if their green building projects are not sold. Another barrier is the lack of technical knowledge and skill on part of the builders, developers, contractors and project team. Lack of availability of funds, space and materials needed in the construction of green buildings are also the major barriers. Procuring green certification is difficult, lengthy and expensive process which is a great barrier. Lack of interest on the part of all the stakeholders are important barrier to progress of green building. Multi-dwelling homes (where collective decision making is necessary) pose a particular challenge to green building refurbishment[11-16].

Rationale for the study: India, too, faces the environmental challenges of the construction sector. The housing sector in India is growing at a rapid pace and contributing immensely to the growth of the economy. The conventional houses of India were "environment friendly", having provision for good amount of natural light and fresh air. With the technological advancement in the construction industry, invention of new building materials and scarcity of space these concept of environment friendly houses had been overlooked. This had a negative impact on the indoor and outdoor environmental conditions. Therefore, it is the Green Homes which would play a critical role towards averting major ecological crises. Now there is an imminent need to introduce green concepts and techniques in this sector, which can aid growth in a sustainable manner.

Due to the fact that the construction industry is traditionally a large user of natural resources, the necessity to design buildings with a low environmental impact is increasing. The extent of environment friendliness of the existing residential buildings means that the building has to address a set of criteria such as site location, energy efficiency, water efficiency, sustainable material selection and indoor environmental quality. The people can be made aware about the impact of the buildings on their health and to retrofit the existing building by incorporating environment friendly features. In the past few years Vadodara city has witnessed a remarkable growth in the construction of residential units. However, at that time all the builders might not have paid much attention to its influence on the residents and environment.Green building is accepted worldwide in the recent past. It is heartening to know that the concept of Green Buildings is now being adopted in the Indian real estate industry. However, efforts are not enough and a greater push is required to make real estate environment sustainable.

There is still a vast community that either is unaware of sustainable design concept, indifferent to its cause, or unconvinced of its advantages. To convince owners, builders, and designers and other stakeholders about the benefits of sustainable design, it is necessary to make them understand the numerous advantages of green building concept. Improved environmental performance of the buildings constructed by the builders can also add to their reputation and they can get returns of their investments in green buildings. However, it is necessary to find out the opinion of builders regarding green buildings and the barriers faced by them in adopting green building design and construction. The opinion of the builders regarding the green building is sure to influence the projects they undertake for construction.

Consumer's perception regarding Green Buildings can influence the property market by pitching demand for green credentials of the buildings. The educational institutions can play crucial and significant role in creating awareness among various target groups through formal and non-formal programmes. LEED and GRIHA are working towards designing environment friendly buildings. They are also creating awareness among the consumers, builders, developers, architects or designers by organizing seminars, conventions and training programmes.

A multi-pronged approach by the private and public organizations, educational institutions, research organizations and the government in popularizing and promoting "Green Buildings" will have a positive, large and long term impact on the macro environment. Considering this an important issue, a study was conducted on "Adoption of Green Building Concept by Selected Builders of Vadodara City in Selected Housing Colonies Constructed by them". Vadodara city is fast growing city with lots of constructions for commercial as well as residential purpose. Many new construction projects are coming up every day which would have impact. Hence, it was thought essential to find out opinion of builders regarding "Green Buildings" and the barriers they face so that some strategies can be evolved for promoting "Green Building" concept.

Some of the studies for the interest of the present research have been found on "Green Buildings and Sustainable Environment", "Green Building and Productivity", and"Barriers in adopting Green Building concept", "Benefits of Green Buildings". Several studies have been conducted in the department of Family and Community Resource Management on "Green building materials", "Environment knowledge and Concern", "Indoor Air Quality", "Water Management and Quality of Water", "Energy Auditing", "Solid Waste Disposal Practices", "Net Zero Buildings"and "Vertical Gardens" at Post graduate and Doctoral level. No researches were found which focused on finding out the opinion, reasons and barriers faced by the builders regarding the adoption of Green Buildings.

Statement of the problem: A study was conducted with the main aim to find out opinion of builders of Vadodara city regarding Green Buildings

Objectives of the study: i. To find out the opinion of the builders regarding adoption of green building concept in their construction of residential sectors. ii. To find out the reasons for adopting the Green Building concept and iii. To find out the barriers faced by the builders of Vadodara city in adopting the same.

Methodology

Research design: The present investigation was a descriptive research.

Variables under study: There were two sets of variables selected for the present study viz. independent and dependent. The independent variables were Personal (such as age and education of the builders and duration of time for working as builder). Sources of information on Green Building and kinds of construction projects undertaken by the builders were the situational variables for the study. The dependent variables were reasons for adopting green building design and construction, barriers in adopting green building design and construction and opinion of builders regarding green buildings.

Explanation of the Conceptual Framework: It was theorized that personal variables of the builders (age, education and duration of time for working as builder) and situational variables (sources of information on green building and kinds of construction projects undertaken by them) have influence on the reasons and barriers in adopting green building design and construction and opinion of builders regarding various aspects of Green Buildings. It was also hypothesized that the extent of opinion of builders regarding the concept of Green Building has an interrelation with the extent of influence of reasons and extent of barriers faced in adopting Green Building design and construction. The extent of influence of reasons and extent of barriers faced in adopting Green Building design and construction are also interrelated with each other.

Sampling Procedure: The data were collected from Vadodara City through convenience sampling. A list was obtained from 'CREDAI' (an association of builders of Vadodara city). Out of 300 builders of Vadodara City, seventy five were selected who had adopted some aspects of green building in their construction of residential colonies.

Tool for data collection: Development and Description: The tool to collect data was a questionnaire as it helped to collect data from large data. The questionnaire contained three Likert type scales i. The Reasons for adopting Green Building scale. The reasons were categorised as 'Economic' 'Environmental' and 'Others' with a response structure of 'To great extent', 'To some extent' and 'To least extent'. Score of 3 through 1 were ascribed respectively to these responses. ii. A scale to find out the Extent of Barriers Faced in Constructing a Green Building scale. The barriers were classified as 'Lack of technical knowledge', 'Availability of funds, space and materials', 'Green certification process', 'Lack of expected returns' and 'Lack of interest'. The responses were 'Major barriers', 'Minor barriers' and 'Not a barrier' where the scores ascribed were from 3 to 1 was respectively to these responses. iii. Opinion of Builders Regarding Green Building Scale. It had 5 point continuum for the responses 'Strongly agree', 'Agree', 'Neutral', 'Disagree' and 'Strongly disagree'.

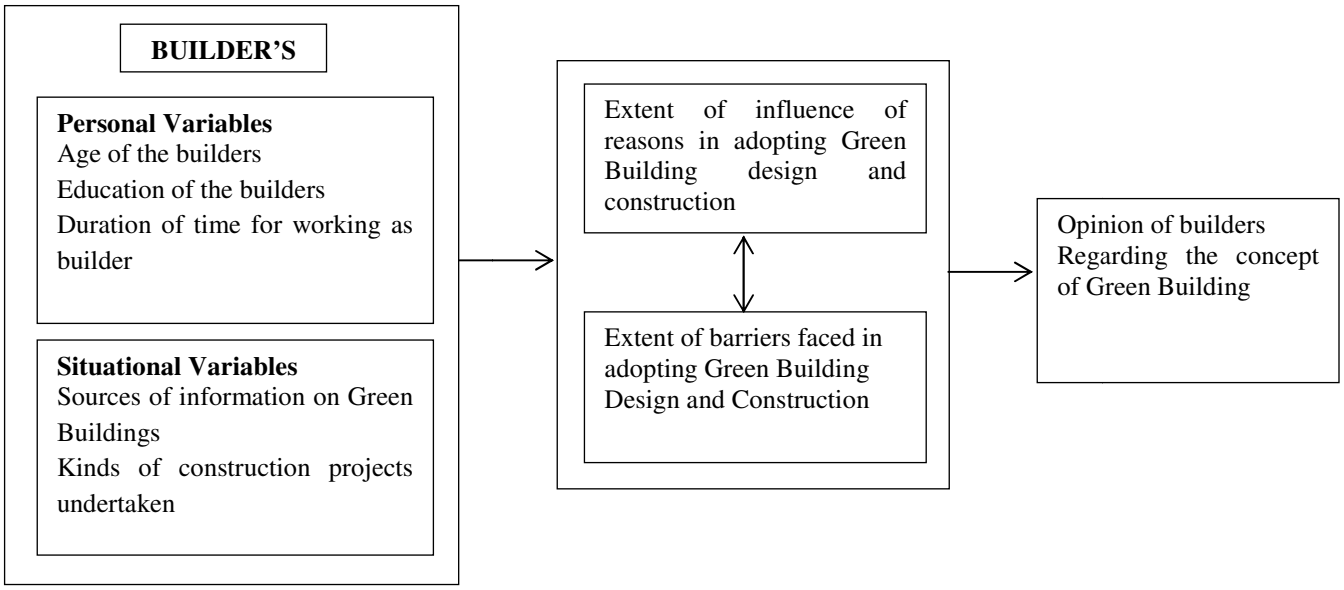

Figure-1
Schematic Framework to Show Hypothetical Relationship among Variables under Study

Establishment of Content Validity of the Scales: The scales developed for the research were subjected to establishment of content validity. The scales were given to a panel of 11 judges from Department of Family and Community Resource Management, Faculty of Architecture, Experts and Professors from other Universities (S.N.D.T. University, Mumbai), Practicing and working builders, architects and civil Engineers. They were requested to check the clarity and relevance of the content for each scale. They were also requested to state whether each statement fell in the category under which it was listed. A consensus of 80% among the judges was taken as a yardstick for inclusion of the statement in the final tool. No changes were required to be made in the tool.

Establishment of Reliability: The reliability of the scales was established through split half method. For this method the scales were divided in two using odd and even method. The correlation was found between the two halves. Spearman-brown correction formula was applied to estimate the reliability coefficient for the entire scale. The reliability coefficient derived for the four scales Extent of influence of reasons in adopting Green Building design and construction, Extent of barriers faced in adopting Green Building design and construction and the opinion of builders regarding the concept of Green Buildings was 0.846, 0.647 and 0.746 respectively.

Results and Discussion

Major Findings: The major findings of the study are reported broadly under the heads of background information, extent of influence of reasons and barriers faced in adopting green building design and construction and opinion of builders regarding green building.

Background Information consisted ofbuilders' age, education, duration of work as builder, kinds of projects undertaken, sources of information regarding green building and extent of exposure to the sources of information on green buildings.

Age of the respondents: The age of the respondents ranged between 21 to 65 years with a mean of 43.01years. The data in figure-2 revealed that two third of the respondents were in the age group of 36 to 50 years. Less than one fourth of the builders were in the age group 21 to 35 years. Thus most of the builders were middle aged.

Age of The Respondents (n=75)

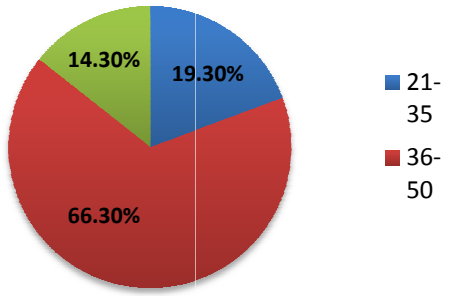

Figure-2
Distribution of respondents according to their age

Education of the respondents: Education of the respondents was studied in terms of formal education obtained by them.The

opinion of the builders is intimately linked to their education. The present study showed thatone half of the respondents were holding Bachelors degree in Arts. More than one fourth of the respondents were diploma degree holder in civil engineering (figure-3).It can be concluded that majority of the builders were from Arts background which can be a reason for forming opinion regarding Green Building concept and barriers behind its adoption.

Duration of time working as builder: It was assumed that the experience of the respondents working as builder might be related to their opinion regarding Green Buildings.The number of years for which the builders were working in this profession ranged between 10 to 35 years with the mean of 16.05 years. It was found that less than one half of the respondents were working as builders since 11 to 20 years. One third of the builders were in the field of building construction since 21 to 35 years. It can be concluded that most of the builders were experienced in their field of work (Figure-4).

Extent of exposure to the sources of information on green building: The builders were asked to state that from various sources of information (12) as per the list provided, which ones they referred to gather information regarding Green Building. The responses of 'referred' and 'not referred' were given scores of 1 and zero respectively. The possible scores obtained on the different sources of information regarding green buildings were divided into three categories having equal interval which determined the extent of exposure to the sources of information on green buildings. It was found that the more than one half of the respondents had low extent of exposure and less than one half of the respondents had moderate extent of exposure (figure-5).

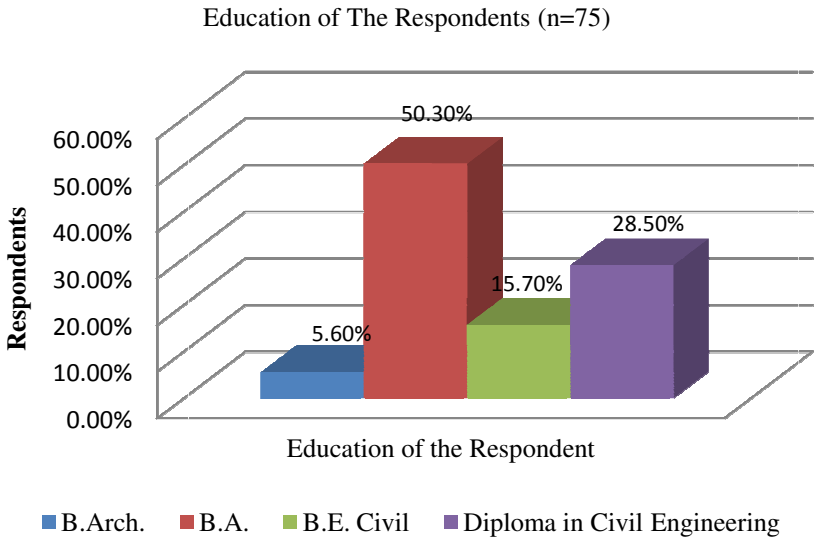

Figure-3
Distribution of the respondents according to their education

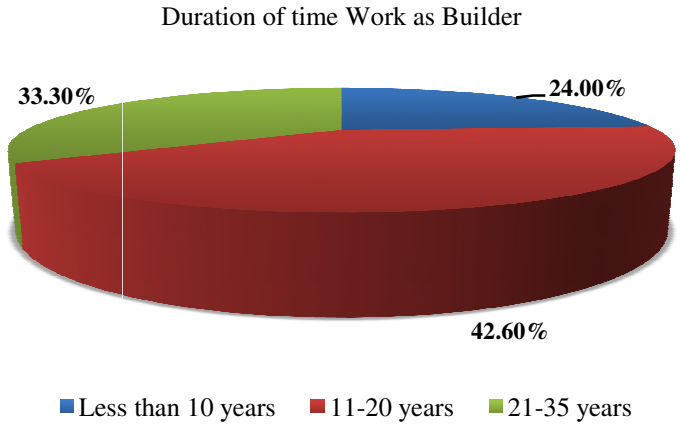

Figure-4
Distribution of the respondents according to duration of time working as builder

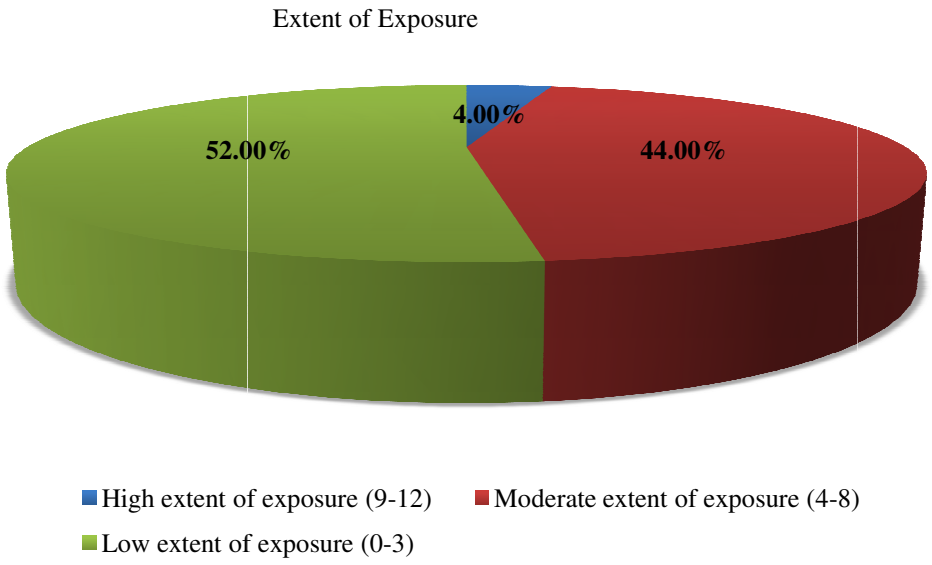

Figure-5
Distribution of respondents according to their extent of exposure to various sources of information regarding Green Buildings

The various sources of information were categorised as Print, Courses and Seminars on Green Buildings, Audio-Visual, Personal research and Word of mouth. On comparing the mean weighted scores, it was found that print media such as newspaper and magazine articles were found to be the main sources mostly referred by the builders in obtaining information regarding Green Buildings by the builders.

Kinds of Projects in which Green Building elements were incorporated: In this section the builders were asked to reflect the kinds of building projects in which they had incorporated Green Building elements. The projects identified were public or private projects in which the builders had worked so far.

The results indicated that majority of the builders had incorporated Green Building elements in Private projects as shown in figure-6. Only 6.66 per cent of the builders had incorporated Green Building elements in public projects. It can be concluded from the findings that the builders might had felt freedom in implementing Green Building elements in their private projects.

Importance of various aspects of green building to builders: The respondents were asked to state various aspects of green building (viz. energy efficiency, material and resources, indoor environmental quality, water conservation and sustainable site planning) in order of importance to them. Nearly two third of the respondents considered energy efficiency, indoor environment quality and water conservation aspects of green building as most important as other aspects as indicated in figure-7. Less than one half of the respondents considered material andresourcesand water conservation as most important.

Extent of influence of reasons for adopting green building: This section deals with various reasons which influenced the builders to adopt green building concept. The researcher considered it important to find out the reasons which influenced builders to adopt the green building concepts in their projects. The reasons were categorized into three sub scales viz. “Economic reasons”, “Environmental reasons” and “Other reasons”. The responses were sought in terms of influence “To a great extent”, “To some extent” and “To least extent”, which were ascribed scores of 3 through 1. They were summated and the extent of influence was found out. It was found that the “environmental reasons” were influencing to a great extent to less than two third of the builders for adopting green building while “other reasons” such as to adopt new idea and concept were influential to somewhat extent. Mean weighted scores for each item and category were computed which ranged between 1 and 3.

Figure-8 states that less than one half of the respondents had moderate extent of influence of economic reasons in adopting Green Building design and construction. The environmental reasons were influencing to a great extent to less than two third of the builders for adopting green building while other reasons such as to adopt new idea and concept were influential to somewhat extent. The other reasons for adopting green building design and construction were influential to somewhat extent to less than three fourth of the builders. The mean weighted score for the sub aspects supported this finding.

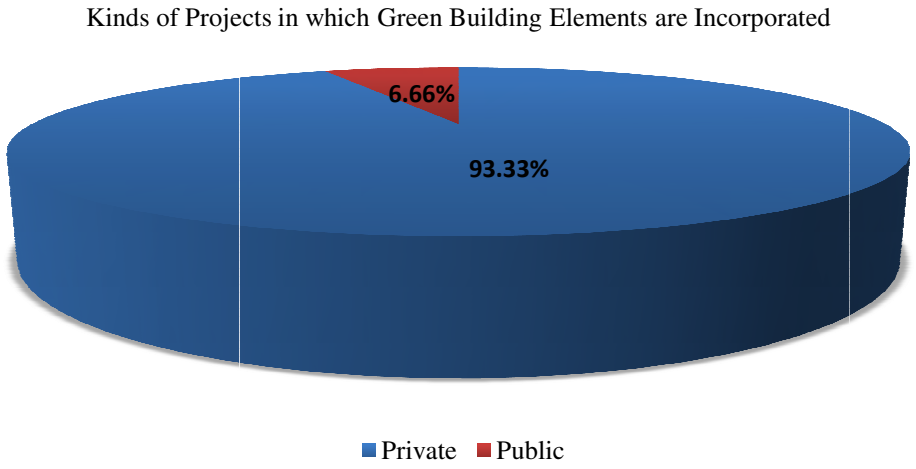

Figure-6
Distribution of respondents according to the kinds of projects undertaken by them

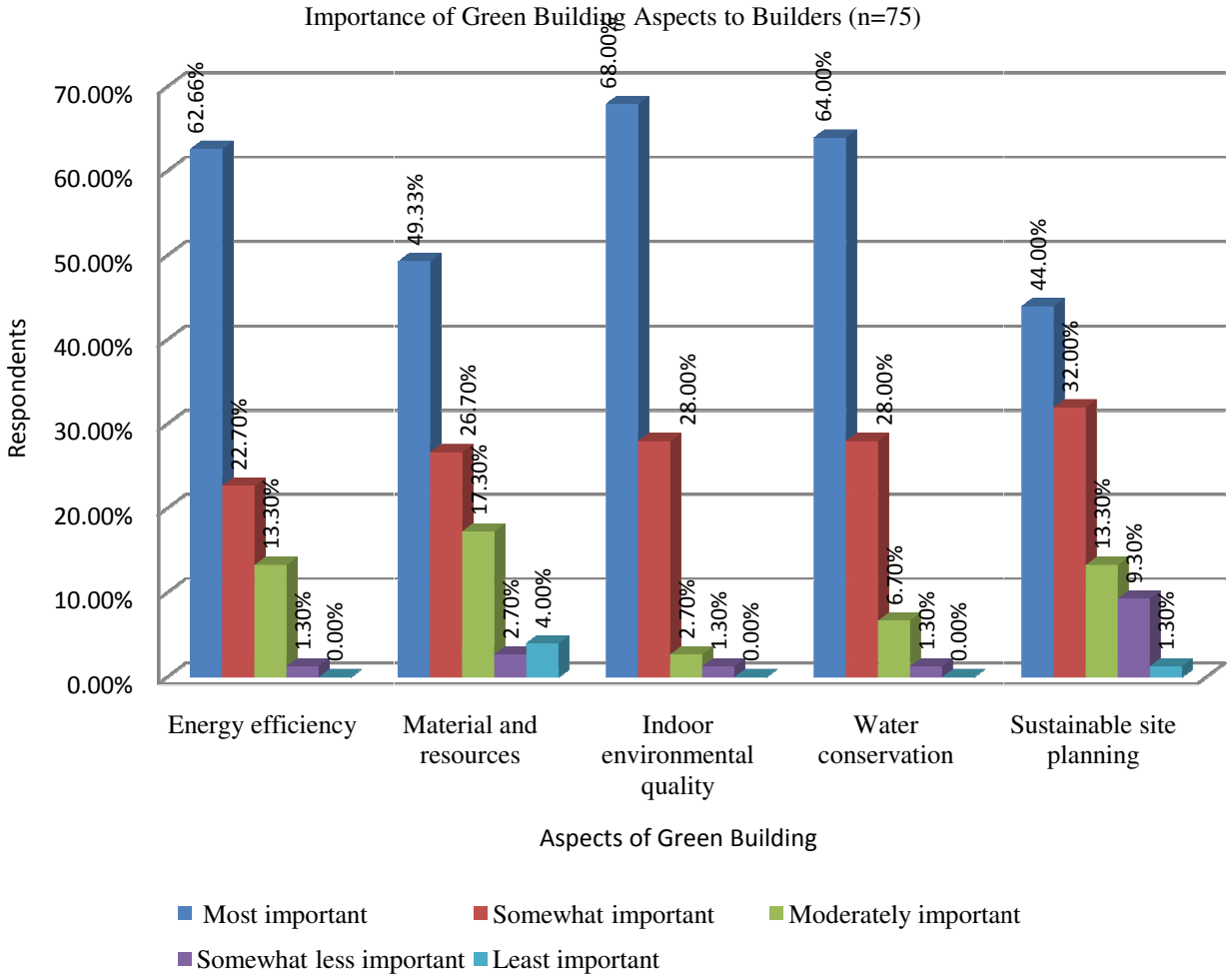

Figure-7
Distribution of respondents according to their importance of green building aspects

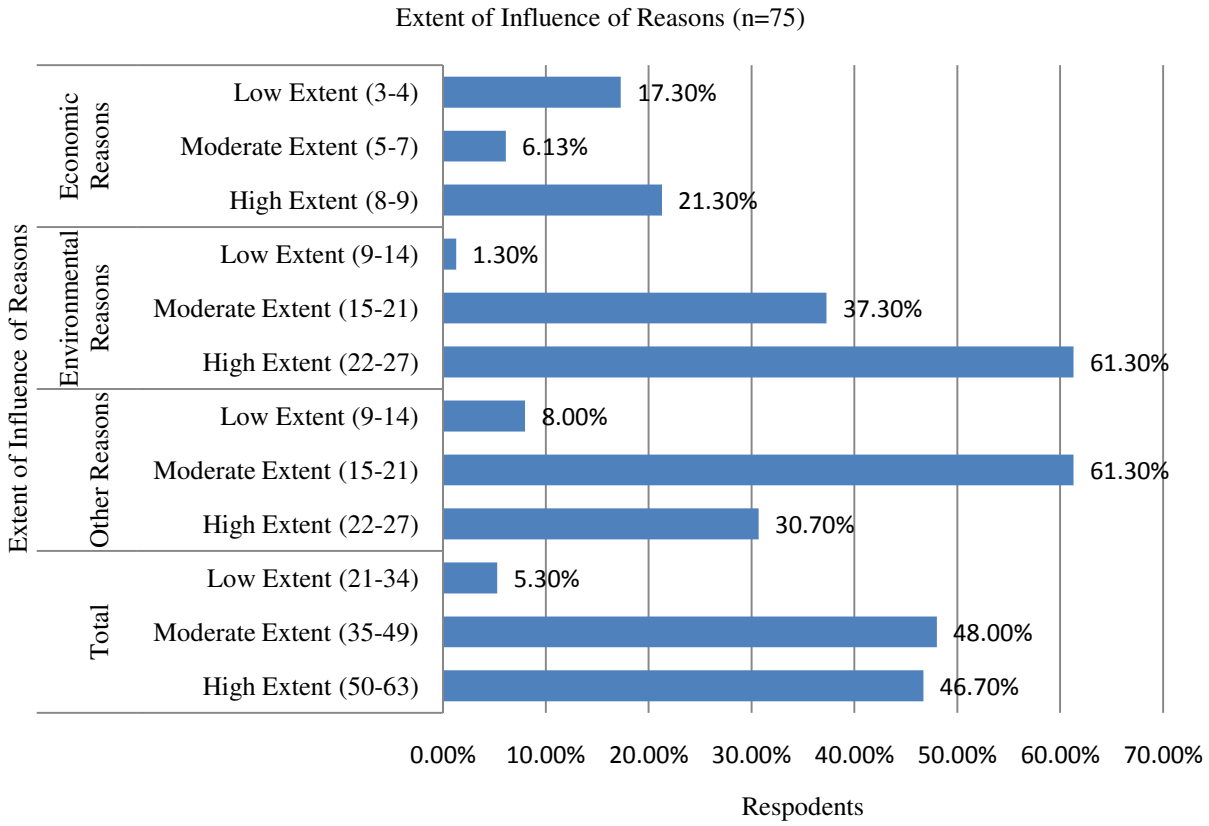

Figure-8
Distribution of respondents according to their extent of influence of reasons for adopting green building features in the construction

Extent of Barriers faced in adopting Green building: The responses of builders about extent of influence of reasons ("To great extent", "To some extent" and "To least extent") were given scores of 3 through 1 respectively. The possible maximum and minimum scores was divided in three categories having equal intervals. Higher the scores indicated high extent of influence. It was found that lack of technical knowledge of the builders, contractors, clerk and the other project team was found to be high extent as barrier faced by majority of the respondents amongst all other categories. More than three fourth of the respondents faced moderate extent of barriers in availing funds, space and materials for constructing green buildings (Fig 9). Mean weighted scores for each item and category were computed which ranged between 1 and 3.

It was found that lack of technical knowledge of the builders, contractors, clerk and the other project team was found to be high extent as barrier faced by majority of the respondents amongst all other categories. More than three fourth of the respondents faced moderate extent of barriers in availing funds, space and materials for constructing green buildings (Figure-9). The mean weighted score computed for the each category of reason supported this finding.

Opinion of builders regarding green building design and construction: It was thought to find out the opinion of the builders regarding green building aspects because it was assumed that the consumers will purchase or choose the house which are built on green building principles only if the builder's will provide it. Builder's opinion regarding green building design and construction will affect their consumers. Several statements were framed to find out the opinion of the builders regarding green building aspects. The scale had 5 point continuum for the responses 'Strongly Agree', 'Agree', 'Neutral', 'Disagree' and 'Strongly Disagree'. The score of 1 to 5 was ascribed respectively for positive statements and the scores were reversed for negative statements. The possible maximum and minimum scores was divided in three categories having equal intervals which determined the extent of favourableness about opinion of builders regarding green buildings.

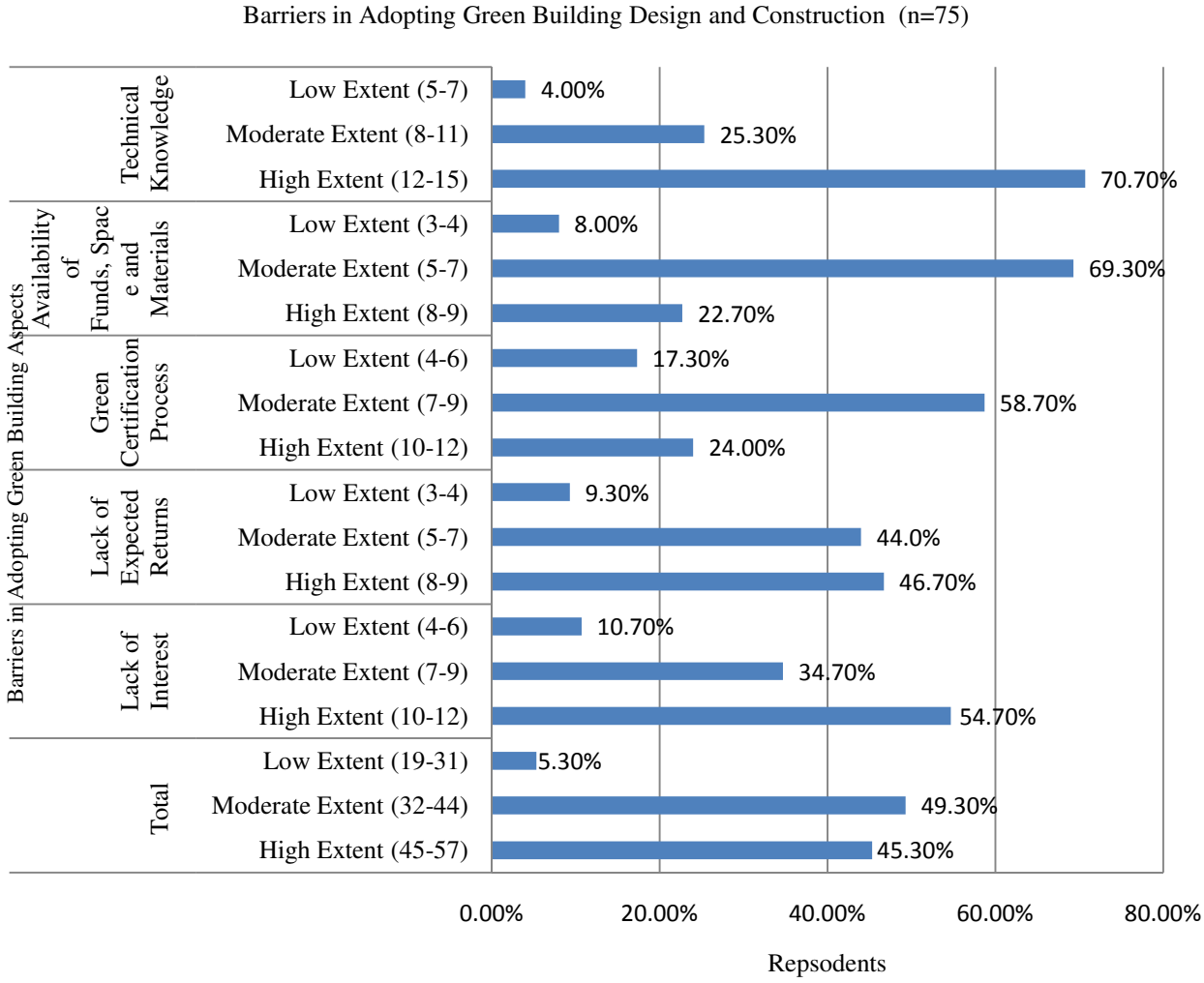

Figure-9
Distribution of respondents according to the barriers faced in adopting green building

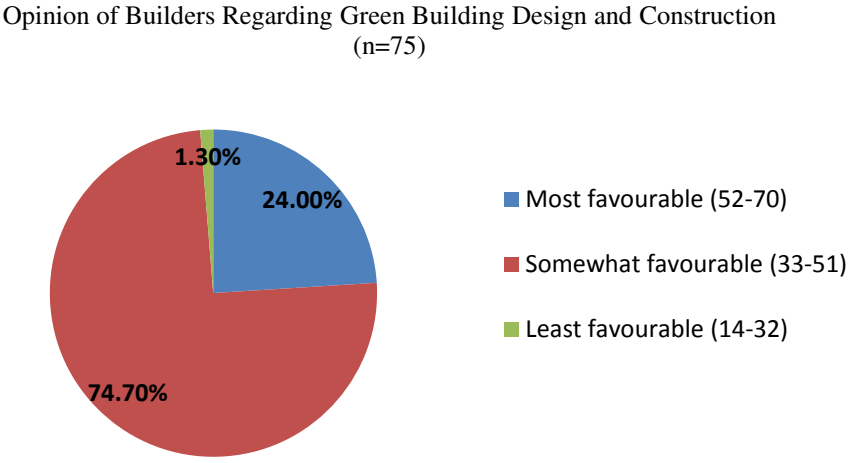

Figure-10
Distribution of respondents according to their opinion regarding green buildings

The data in figure-10 revealed that more than one half of the builders strongly agree that "Due to the deterioting environmental quality of Vadodara city, the Green Building design and construction should be promoted" (56.0%) followed by "Green Building design and construction helps in balancing the negative effect of various kind of pollution, hence should be implemented in Vadodara city" (50.7%) and "Green Building design and construction is a tool which enables the designer to apply green concepts and criteria, so as to reduce the environmental impacts " (49.3%). Less than one half of the builders agreed that People of Vadodara city are environment conscious so Green Building design and construction is encouraged by them (49.3 %) and "As the city of Vadodara is witnessing tremendous growth in infrastructure and construction development, Green Building design and construction can aid growth in a sustainable manner" (46.7 %). Less than one half of the builders were neutral about the concept that "Constructing a Green Building proves to be costlier than ordinary building" (45.3%). Less than three fourth of the builders disagreed that it is difficult to design the building as per the standards and recommendation of LEED than designing the simple houses (61.3%). Less than one half of the builders strongly disagreed that people at present are not aware of Green Building design and construction, therefore, they do not opt for such housing (40.0%).

It can also be concluded from the data that majority of the respondents had "somewhat favourable" opinion regarding green building. Less than one fourth of the respondents had "most favourable" opinion regarding green buildings.

Testing of Hypotheses: For the purpose of statistical analysis the hypothesis was formulated in null form.

HO_1: There is no interrelationship between extent of influence of reasons for adopting green building design and construction, extent of barriers faced in adopting green building design and construction and opinion regarding green building concept.

Coefficient of correlation was computed to test this hypothesis. The data in table-1 shows a significant relationship was found between extent of influence of reasons for adopting features of green building design and construction and opinion of builders regarding green building. Hence, the null hypothesis was rejected in this case. Since the relationship was positive, it could be concluded that as the respondents had favourable opinion, there were high extent of influence of reasons for adopting green building concept in their design and construction. No significant relationship was found between the extent of influence of reasons for adopting features of green building design and construction and extent of barriers faced in adopting green building design and construction and opinion of builders regarding green building concept. Hence, the null hypothesis was accepted in this case.

Conclusion

It could be concluded that majority of the builders were middle aged, and with B.A. and working as builder since 21 to 35 years. Builders ranked energy efficiency, indoor environment quality and water conservation as most important aspect of green buildings. Environmental aspects were the most influential reason for adopting green building. Builders reported lack of technical knowledge of the project team as the barrier in implementing green building design and construction. Majority of the builders had somewhat favourable opinion for green buildings. The respondents applied green building design and construction in the private projects undertaken by them rather than other projects. The high extent of influence of reasons for adopting green building design and construction were related positively with the favourable opinion towards green buildings.

Table-1
Coefficient of Correlation to ascertain relationship between selected variables

	Selected variables	n	r-value	Level of significance
I.	Reasons for adopting green building	75	0.138	N.S.*
	Barriers faced in adopting green building			
II.	Reasons for adopting green building	75	0.400	0.01
	Opinion of builders regarding green building			
III.	Barriers faced in adopting green building	75	-0.091	N.S.*
	Opinion of builders regarding green building			

*Not Significant

The growing global crisis has created the need to adopt the concept of green buildings. Real estate activities, being one of the significant contributors to energy consumption and usage of resources, are working towards the development of green buildings to reduce environmental impacts. In India, this concept is still in infancy stage due to various barriers faced by the builders. The overall assessment brings out that there is very poor level of information on green buildings, cost and paybacks in the public domain. There is a need to encourage those working in construction industry receive sufficient training to develop the green building skills that are required. It was found in the present study that lack of technical knowledge of builders, contractors, and the project team was the major barrier faced by the builders in adopting green building design and construction. A training programme by IGBC and GRIHA can be organized by CREDAI for its member builders. It was also highlighted that there was lack of expressed interest from potential home owners. The department of Family and Community Resource Management can play an important role in creating awareness among the potential home owners through formal and non formal education.

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