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Extent of environment-friendliness of selected existing residential buildings of Vadodara

SHILPI SARASWAT[1]* AND MANEESHA SHUKUL[2]
Assistant Professor[1] and Professor & Ex.-Head[2]
Department of Family and Community Resource Management,
Faculty of Family and Community Sciences,
The Maharaja Sayajirao University of Baroda, Vadodara (Gujarat) India

ABSTRACT

Population growth and housing development have many impacts on the environment and on quality of life issues. The sheer number of existing housing units as well as the potential impact of future growth directly speaks to the need of an integrated green building approach to housing. The environment of existing residential building can create a sizeable impact on the global environment and health of the users. An environment friendly building is one that does not adversely affect the larger environment and the health of its users. 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 assite location, energy efficiency, water efficiency, sustainable material selection and indoor environmental quality. The attention of the government can be drawn towards the deterioting condition of the environment due to the construction of the non environment friendly buildings. 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. Hence a study was conducted to find out the environment friendliness of the existing residential buildings of Vadodara city. The data were gathered through observation from a sample of 220 existing residential buildings which were constructed between January, 2005 to December, 2013 through purposive sampling. Descriptive and relational statistics was used for presenting results. The findings of the study revealed that majority of the houses had moderate extent of greenness for all the sub aspects. Nearly three fourth of the respondents' houses had moderate extent of greenness on the overall scale. The results of mean scores were found highest for the sub aspect "Indoor Environment Quality" and lowest for "Innovative Ideas sub aspect. The findings of the study would provide feedback for the younger generation, common man and the government. The people can be made aware to select or construct those housing only which are Environment Friendly through an educational programme given by the educational institution.

Key Words : Existing residential building, Environment friendliness

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INTRODUCTION

Growing Human activity has increased the concern for sustainability even more in recent times. Sustainability in real estate context is not only limited to energy conservation, but also includes resource usage, impact on the neighbouring environment and working conditions for tenants (Roy and Gupta, 2008). Among the other production and manufacturing sectors, building and construction sectors occupies the first place as the largest contributor to pollution and natural resource consumption (Levine *et al.*, 2007 and Plank, 2008). In order to control the effects of construction on the environment to improve the performance of the built environment in terms of health and environmental aspects, "green" or "sustainable" buildings were introduced (Kibert, 2012). The green building concept broadly integrates many interests and aspects of sustainability emphasising reduction of environmental impacts through a holistic approach to land and building usage and construction strategies (Roy and Gupta, 2008 and Dwaikat and Ali, 2014).

Green building and sustainability are often used interchangeably, but the terms are far from synonymous. Sustainability, a very broad and far reaching concept, is the underlying principle of green building (Timothy, 2010). Green Buildings are designed to meet certain objectives such as protecting occupant's health, improving employee productivity, using energy, water and other resources more efficiently, and reducing overall impact to the environment (Zigenfus, 2008 and Mathew, 2015). It maximizes the use of efficient building materials and construction practices, optimizes the use of onsite sources, uses minimum energy to power itself, uses efficient equipment to meet its daily consumer consumption, maximizes the use of renewable sources of energy, uses efficient waste and water management practices, and provides comfortable and hygienic indoor working conditions (Mohanty *et al.*, 2010). The building may be simple compared to a lot of creative designs that is seen at the moment, but its beauty lies in its objectives, these buildings combine the creation of designer and splendour of nature and greenery which gives the design the beauty of the scene. This practice expands and complements the classical design of the building with respect to the economy, benefits, and the durability and comfort (Zaid, 2011).

The overall benefits of green buildings mostly depend upon the extent to which the sustainable features are addressed during the initial planning and design. A green building is most likely to succeed in its objectives if sustainable features are envisioned and incorporated right at the design stage. The design has to take into consideration the entire supply chain – from material sourcing, energy modelling, resource reuse, basic amenities and waste disposal to tenant education (Roy and Gupta, 2008).

Green building construction has taken off significantly over last decade in India. Several institutional and government bodies have come forward to build sustainable buildings (Mehta and Porwal, 2013). The green building movement in India started with the establishment of the IGBC in 2001, which was an initiative of the Confederation of Indian Industries (CII) along with the World Green Building Council and the USGBC (Times of India, 2015).

According to Wilson, 2006, "Green buildings practices are commonly defined by the areas of the environment they affect: energy, water, site, air quality and materials". Indian Green Building Council (IGBC), 2012 defines it as "one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier

spaces for occupants, as compared to conventional buildings".

The Greenness of the building is assessed on the following five broad areas:

i. Sustainable site Selection
ii. Safeguarding water and water efficiency
iii. Energy efficiency and renewable energy
iv. Conservation of materials and resources
v. Indoor environmental quality

A green building rating system is an evaluation tool that measures environmental performance of a building through its life cycle from inception through operation. It usually comprises of a set of criteria covering various parameters related to design, construction and operation of a green building. Each criterion has pre-assigned points and sets performance benchmarks and goals that are largely quantifiable. A construction project is awarded points once it fulfils the rating criteria. The points are added up and the final rating of a project and greenness is decided. Globally, green building rating systems are largely voluntary in nature and have been instrumental in raising awareness and popularizing green building designs. The two rating systems most popular in India are Leadership in Energy and Environmental Design (LEED) by Indian Green Building Council (IGBC) and Green Rating for Integrated Habitat Assessment (GRIHA) by The Energy and Resource Institute (TERI). The Indian Green Building Council (IGBC) promotes "Leadership in Energy and Environmental Design" (LEED) which started in 2001. LEED is a third party certification programme and the nationally accepted benchmarkfor the design, construction and operation of high performance green building.

Both the rating programmes promote a whole building approach to sustainability by recognizing performance in five key areas of human and environmental health: Sustainable site development, water savings, energy efficiency, materialselection and indoor environmental quality. An additional category, Innovation and Design Process, addresses sustainable building expertise as well as design measures not covered under the five environmental categories.

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. Due to the fact that the construction industry is traditionally a largest user of natural resources, the necessity to design buildings with a low environmental impact is increasing. This augurs well for the country and now there is an imminent need to introduce green concepts and techniques in this sector, which can aid growth in a sustainable manner. 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 has 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. Green building is accepted worldwide in the recent past.

Vadodara city has witnessed a remarkable growth in the construction of residential units during the later part of the twentieth century and during the early year's twenty first century. At that time all the builders might not have paid much attention to its influence on the residents and environment. Now, that builders are also becoming conscious of environmental impact of constructions made by them, they incorporate several aspects so as to make the

buildings environment friendly. Now the upcoming buildings are made "green" but the existing building can also be improved to make them environment friendly. There is a need to find out the extent to which the residential units constructed by the builders are "Green"- meaning environment friendly. Based on findings suggestions can be given to make them "Green".

Statement of problem :

The present research aims to assess selected houses of Vadodara City with regards to the extent they are "Green".

The present study has the following specific objectives :

1. To ascertain the background information about selected home owners of Vadodara city.
2. To assess the extent of Greenness of the selected existing houses.

METHODOLOGY

The research design for the present investigation was descriptive. The housing colonies which were constructed by the selected builders between 2005 and 2013 were selected through Snow ball sampling method, the housing units (houses) were selected from these colonies. Houses from each of the colonies ranging from 1 to 3 were selected. Thus 220 houses were considered as sample for present study.The data were collected through observation checklist for the assessment of the selected houses. The observation checklist contained items indicating the greenness of the house in various aspects of the green building such as sustainable site selection, water efficiency, energy efficiency, material and resources, indoor environment quality and innovative ideas. The factors were assessed through observation and for some factors equipments were used. The presence and absence of the factor were assessed by response "Followed" or "Not Followed", "Present" or "Not Present", "Applied" or "Not Applied" but in order to maintain consistency and clarity in the responses the responses are presented here in the form of "Yes" and "No". Each factor was assigned marks. For each positive response the marks assigned were given and for negative response 'zero' was assigned. The marks obtained were counted for each sub scale for each of the house. Higher scores indicated high extent greenness of the house. The minimum and maximum possible scores of each of the scales were divided into 3 categories having equal interval for all the scales which determined the extent of greenness of the selected existing buildings. The scale was subjected to establishment of content validity. The reliability coefficient derived was 0.786 through test – retest reliability. It was hypothesized that the extent of greenness of the selected house varies with the selected Personal, Family and Situational variables of the home owners.

RESULTS AND DISCUSSION

The findings of the study obtained through the analysis of the data supported discussion and interpretations are presented here.

Section I: Background information of the respondents:

This section deals with the personal and family information of the respondent. It was

revealed that the mean age of the respondents was 42.05 years. More than one half of the respondents belonged to the age group of 36 to 50 years. Information regarding the education of the respondents highlighted that less than one half of the respondents were graduates and more than one third of the respondent were post graduate. It was found that less than three fourth of the respondents were working in service sector (Fig. 1). The total monthly family income ranged from Rs. 28,000 to Rs. 2, 00,000 with a mean income of Rs. 88,153.64 (Fig. 2). Majority of the respondents were residing in tenement or twin duplex type houses. Less than one half of the respondents purchased or constructed their house between the year 2008 and 2010 (Fig. 3).

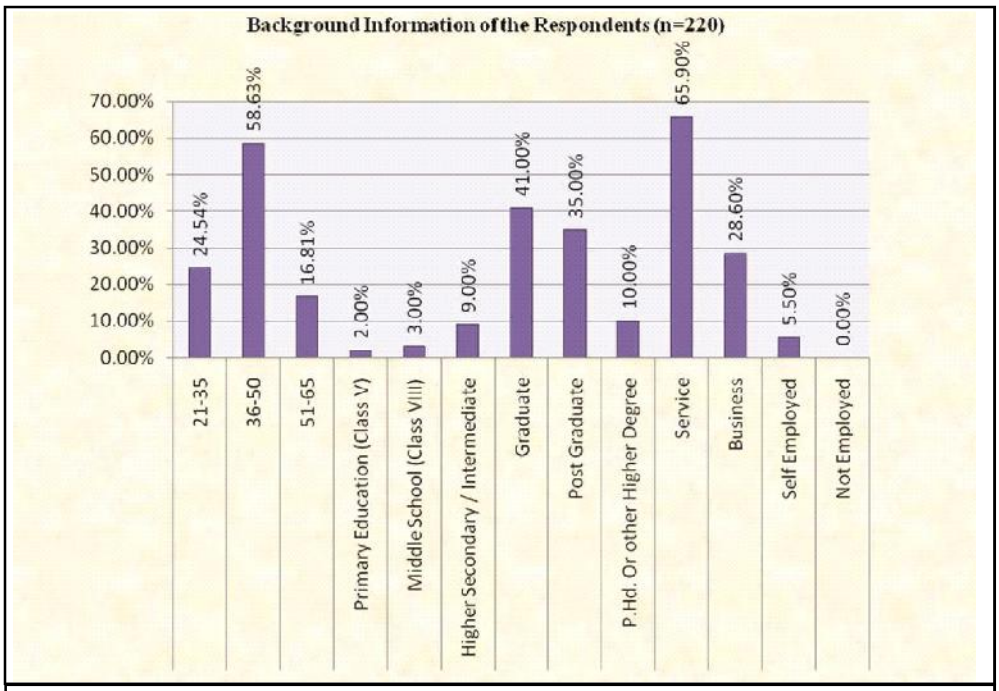

Fig. 1 : Percentage Distribution of the respondents according to their Gender and Age

Section II: Assessment of the selected houses for their extent of greenness:

For the purpose of analysis and discussion each of these factors were referred as sub scales.

"Site selection" as factor for assessing the selected houses:

The statements under this group were mainly related to the local regulations, certifications, landscape and garden, measures to reduce soil erosion, basic amenities around the house, measure to reduce heat island effect both roof and non-roof and stormwater management techniques. The entire sub scale was assessed by observation.

Regarding the "Site selection" it was found that the house plan was approved from the competent local government authority of the all respondent and they had obtained "Fit for

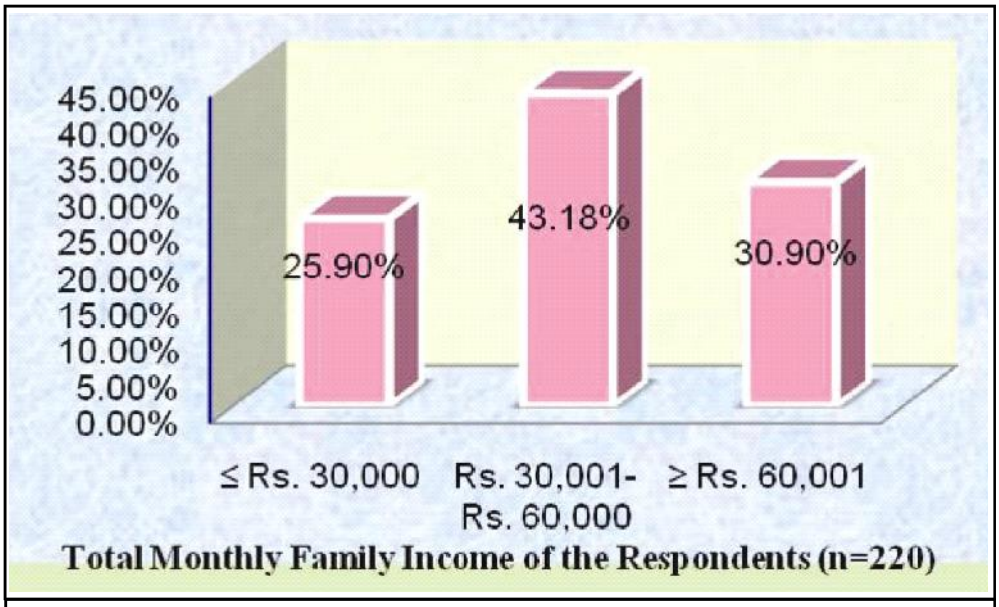

Fig. 2 : Percentage distribution of respondents according to their Total monthly family income and type of family

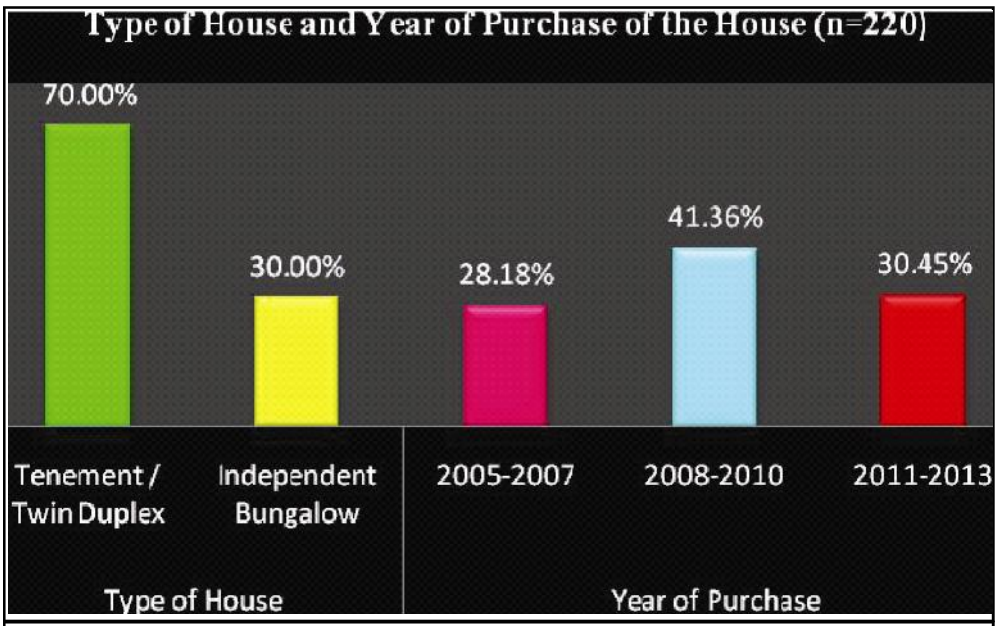

Fig. 3 : Percentage Distribution of the respondents according to their Type of House and Year of purchase of the house

occupancy" document. The mean weighted score was found to be highest for this aspect (Table 1). Majority of the houses did not have Green Certification from Leadership in Energy and Environment Design (LEED) or Green Rating for Integrated Habitat Assessment

Table 1: Distribution of selected houses according to factor "Site selection"

Sr. No.	Site selection	Total Weighted mean (0 - 1) (intensity index)
1.	Local Regulation	1.0
2.	Certification	0.014
3.	Landscape and Garden	0.366
4.	Measures to reduce soil erosion	0.173
5.	Basic Amenities	0.526
6.	Measures to reduce Heat Island Effect	0.167
7.	Stormwater Management	0.211
	Overall weighted mean	0.351

(GRIHA). The mean weighted score for this aspect was found to be the lowest amongst all of the factors. It was found that two of the houses had received 'Gold' rating from LEED and one had received Pre certification from LEED at the time of data collection. Mature trees were grown in west direction of the house so as to give shade and reduce heat in majority of houses (Table 1). The roof surface was vegetated with potted plants in majority of the houses. One half of the respondents used sometimes organic and sometimes chemical fertilizers for the plants. Nearly forty per cent of the respondents used only chemical fertilizers for plants. Very few respondents (9.5 % and 9.1 %) had adopted mulching and permanent seeding as one of the measures to reduce soil erosion in available landscape, respectively. Three fourth of the respondents had not used permeable material for paved areas in their houses. Majority of the houses had access to at least five amenities, within walking distance of 1 km. the most common amenities which were within walking distance of 1 km of the houses were Grocery store (98.6%), Place of worship (97.7%), Playground (91.8%), Electrician/plumbing services (90.4%), Dhobi/Laundry (89.1%), Restaurant (88.2%) and Pharmacy (81.8%).

The shade from tree falls on pathway of less than three fourth of the houses, on parking area of less than one fourth of the houses and on the entire building of only fifteen per cent of the houses (Table -1). RCC plain material was used in parking area of more than one half of the houses followed by Fiber Reinforced Plastic (25.9 %). Majority of the houses had white/mosaic tiles constructed on the terrace as one of the measure adopted to reduce heat island effect. Majority of the houses had tiled floor around the building. Recharge bore was constructed where terrace water was collected in bore or tank in only 0.5 per cent of the houses which is one of the stormwater management techniques. The sub factor "Certification" had the lowest weighted mean and "Basic Amenities" had the highest weighted mean in the range of 0 to 1 (Table 1).

"Water Efficiency" as factor for assessing the houses:

This sub scale consisted of statements related to installation of water efficient fixtures, water meter, water level controller in water tank, plantation of drought tolerant species of plants and economic use of water by the family members (Table 2). The aspects of water efficiency were assessed through observation while economic use of water by the family

Table 2: Distribution of selected houses according to factor "Water Efficiency"

Sr. No.	Water efficiency	Total Weighted mean (0 - 1) (intensity index)
1.	Installed water efficient fixtures	0.184
2.	Installed water meters	0.239
3.	Installed water level controller in water tanks	0.564
4.	Grown drought tolerant species of plants	0.177
5.	Economic use of water by family members	0.968
	Overall weighted mean	0.426

members was calculated through a formula.

In more than one half of the houses approximately hundred per cent of the water efficient fixtures and fittings for potable water usage and water efficient flushing systems were installed. Majority of the houses had not installed main water meters. None of the houses had installed submeters for domestic hot water and domestic hot water. Only 2 respondents (*i.e.* 0.9 %) of the houses had installed submeters for landscape water consumption. Majority of houses had installed a water level controller in overhead water tank**.** The weighted mean for this aspect was found to be highest amongst all aspects. Less than three fourth of the houses had grown 25 per cent of drought tolerant species of plants (Table 2), shrubs and trees in their garden. Majority of the respondents and their family members economically used water. The weighted mean was found to be lowest for "Grown drought tolerant species of plants" and highest in "Economic use of water by family members" sub factors.

"Energy efficiency" as factor for assessing the houses:

The aspect on "Energy Efficiency" included the statements related to installation of CFC free equipments, energy meters, BEE rated electric fittings, solar lights and solar water heaters. Other statements were related to energy performance within the building. All the factors were assessed through observation (Table 3).

It was found that majority of the respondents had installed CFC free Refrigerators while more than one half of the respondents had installed CFC free Air conditioners in their houses. All the respondents had installed energy meters for lighting at their houses. Majority of the respondents had not installed BEE rated electrical fittings in their houses. A little more

Table 3 : Distribution of selected houses according to factor "Energy Efficiency"

Sr. No	Energy efficiency	Total Weighted mean (0 - 1) (intensity index)
1.	Installed CFC-free equipments	0.743
2.	Installed energy meters	0.297
3.	Electric fittings installed with BEE (Bureau of Energy Efficiency) rating	0.101
4.	Energy performance within the building	0.550
5.	Use of Solar Energy	0.143
	Overall weighted mean	0.367

than three fourth of the respondents had installed 3 star rated refrigerators. More than one half of the respondents had installed 3 star rated air conditioner. Less than one half of respondents had installed T_5 tube lights everywhere in their home but more than three fourth had installed it at some places (Table 3). Less than three fourth of the respondents had installed LED lights at some places in the house. Majority of the respondents had electronic regulators at their house.

Majority of the respondents had constructed weather shed (97.7%), fixed blinds or curtains on doors and windows (96.8%), set the thermostat of the refrigerator at correct temperature (90.0%) and left enough space between refrigerator and wall. Less than one half of the respondents had not placed television, room heaters and other electrical appliances near Air conditioner (Table 3). Majority of the houses had illumination level of lights less than 50% of the regularly occupied rooms in the house. Very few respondents had installed solar lights at their houses while only 20.9 per cent of the respondents had installed solar water heaters at their houses. The sub factor "Electric fittings installed with BEE (Bureau of Energy Efficiency) rating" had the lowest weighted item mean and "Installed CFC-free equipments" had the highest weighted item mean in the range of 0 to 1.

"Material and resources" as factor for assessing the houses:

The section on "Material and Resources" contained statements regarding the extent of use of local materials, provision for separation of waste, adoption of waste management techniques, use of recycle materials and other building materials. The scale was assessed through inquiry from the respondents and observation (Table 4).

Table 4: Distribution of selected houses according to factor "Material and Resources"

Sr. No.	Material and Resources	Total Weighted mean (0 - 1) (intensity index)
1.	Local material used in construction	0.488
2.	Provision for separation of waste	0.045
3.	Adopted waste management techniques	0.265
4.	Recycle materials used in the construction of the building	0.143
5.	Building Materials	0.334
	Overall weighted mean	0.255

It was observed that less than three fourth of the houses had used 75 per cent of the local building materials in the construction of the house. One third of the houses had used 50 per cent of the local building materials in construction of the house. Majority of the houses did not have provision for separate bins to collect organic waste, plastic, paper, glass etc. Majority of the respondents had not adopted waste management techniques such as Vermicomposting and Bio gasifiers at their house. Recycled tiles were used in less than one half of the houses. Conventional bricks were used in the construction of walls of the houses (Table 4). Tinted glasses were used for doors, windows and ventilation in more than one half of the houses while less than one fourth houses used plain glasses for the same. More than one half of the houses' exterior walls were finished by water repellent paints. The weighted item mean was found to be lowest for "Provision for separation of waste" and highest in

"Local materials used in construction" sub factors (Table 4).

"Indoor environment quality" as factor for assessing the houses:

The indoor environment quality included the statements related to type of window constructed, provision for cross ventilation, paints used on the wall, material of carpets, provision for daylighting and installation of exhaust systems (Table 5). The scale was assessed through observation and light meter was used for finding out the day lighting quotient of different rooms and the readings were then applied in the formula.

Table 5: Distribution of selected houses according to factor "Indoor Environment Quality"

Sr. No.	Indoor Environment Quality	Total Weighted mean (0 - 1) (intensity index)
1.	Type of window constructed	0.498
2.	Provision of cross ventilation	0.680
3.	Paints used on wall	0.258
4.	Material of carpets	0.922
5.	Installed exhaust systems	0.603
6.	Provision for daylighting	0.339
	Overall weighted mean	0.550

Openable type of window was constructed in living room, kitchen and bedrooms of majority of the houses. Majority of the houses had Venetian blinds with louver in the bathroom window. Majority of the houses had openings on at least two different directions of the house for cross ventilation**.** Majority of the houses did not have ventilators for fresh air intake in the rooms where split AC's were installed. Almost all of the houses were provided with adequate windows and door for fresh ventilation in the living area, kitchen and bathrooms. Interior walls were painted with low VOC paints in one half of the houses. More than one third of the houses had whitewash/Distemper/Wall paper/Texture as a finish on interior walls. Carpets made of naturally available materials like coir, wool etc were used in majority of the houses. Majority of the houses had forced ventilation (exhaust fan) in the kitchen. More than three fourth of the houses had forced ventilation in toilets while one fourth of the houses had it in bathrooms (Table 5). Majority of the houses had exact daylighting provision in bedrooms, kitchen and living room respectively while less than three fourth of the houses had exact provision of daylighting in bathrooms. The sub factor "Paints used on the walls" had the lowest weighted item mean and "Material of carpets" had the highest weighted item mean (Table 5).

"Innovative ideas" as factor for assessing the selected houses:

Innovative idea is a factor which is considered with the thinking that some respondents might be aware about the new technology and hence might have adopted it in their houses. These factors were provision for rainwater harvesting, installation of grey water treatment plant, management of irrigation system and others. Observation technique was used to assess this sub scale (Table 6).

Majority of the houses did not have provision for collecting and reusing roof rainwater

for non-portable uses such as for irrigation, urinal flushing and toilet purposes. Provision for collection and reuse of roof rainwater for ground water recharging through filtration media and recharge bore, collecting pond, impervious surface and landscaping respectively were not provided in majority of the houses. Grey water treatment plant was not installed for irrigation purpose in all of the houses and for flushing purpose in majority of the houses. The entire houses had not installed central shut-off valve (tap) and sprinklers, very few had installed porous pipes for irrigation, drip irrigation and time based controller for the valves respectively as efficient irrigation technologies for landscaping (Table 6). None of the houses had installed sucking flushing systems and waterless urinals. The sub factor "Others" which included statements regarding installation of sucking flushing systems and waterless urinals had the lowest weighted mean and "Provision for Rainwater Harvesting System" had the highest weighted item mean in the range of 0 to 1 (Table 6).

Table 6: Distribution of selected houses according to factor "Innovative Ideas"

Sr. No.	Innovative Ideas	Total Weighted mean (0 - 1) (intensity index)
1.	Provision for rainwater harvesting	0.026
2.	Installed grey water treatment plant	0.002
3.	Management of irrigation system	0.006
4.	Others	0.00
	Overall weighted mean	0.008

Extent of "Greenness" of the selected houses: Overall View:

The extent of greenness was analysed in terms of high, medium and low scores obtained on sub-scales and on the entire observation checklist. The scores on each of the item of the scale were summated and possible range of minimum to maximum scores was divided into three categories having equal intervals. The high scores were considered as high extent of greenness. The possible score on the scale was 0 to 183 (Fig. 4).

Analysing the entire scale, it was observed that none of the houses were found having high extent of greenness. Majority of the houses were green to moderate extent. Low extent of greenness was reflected in less than one fourth of the cases.It was also found that 85 per cent to 86 per cent of the houses had moderate extent of greenness for the factors "Material and Resources" and "Indoor Environment Quality" respectively and 62 per cent to 69 per cent of the houses also had moderate extent of greenness for the factors "Water Efficiency" and "Sustainable Site" respectively. Negligible per cent of the houses had high extent of greenness for the factors " Indoor Environment Quality", "Water Efficiency", "Material and Resources" and "Energy Efficiency" respectively (Fig. 4).

The weighted mean computed for each factors for assessing the existing selected buildings reflected that the scores for "Indoor Environment Quality" was found to be the highest amongst all the aspects. The aspect of "Innovative Ideas" scored the lowest. The overall weighted mean on all the factors was0.327 (Fig. 5).

Testing of hypotheses :

A number of hypotheses were formulated on the basis of objectives of the study. For

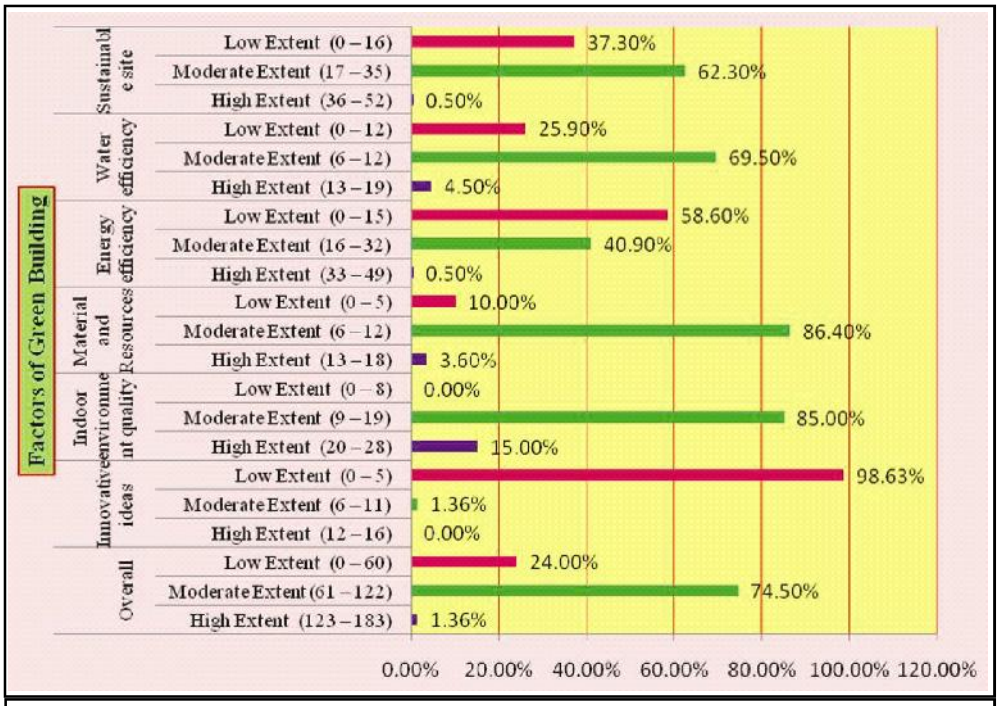

Fig. 4 : Percentage Distribution of according to "Extent of Greenness" of the selected houses

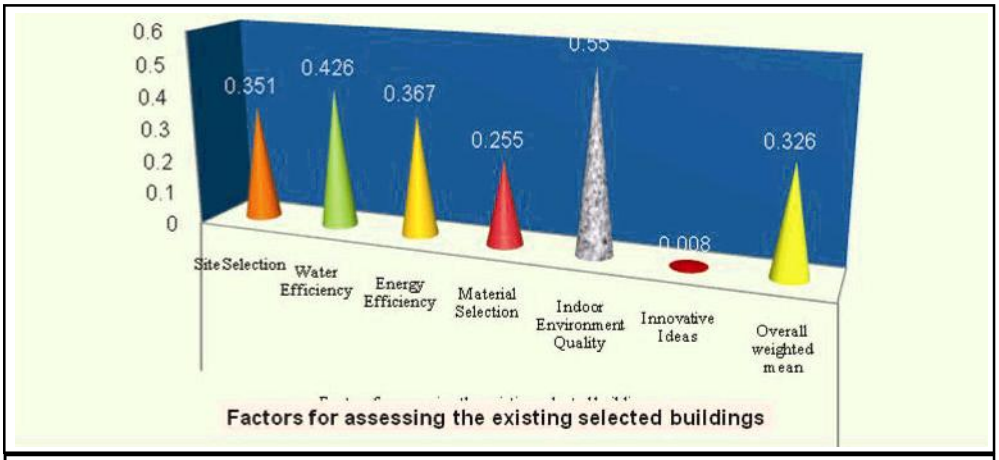

Fig. 5 : Weighted mean for the "Extent of Greenness" of the selected houses

the purpose of statistical analysis, the hypotheses were formulated in the null form. The results are presented here.

Ho_1:

The extent of greenness of the selected house does not vary with the selected Personal, Family and Situational variables of the home owners

For the purpose of statistical analysis, sub hypotheses were framed in null form.

$Ho_{1.1}$:

There exists no relationship between the extent of greenness of the selected house and age and monthly family income of the home owners.

The computation of Co-efficient of Correlation was not found significant. Hence the null hypothesis was accepted in both the cases (Table 7).

Table 7 : Co-efficient of correlation showing relationship between extent of greenness of the selected house and age and monthly family income of the home owners

Sr. No.	Selected variables	n	r-value	Level of significance
1.	Extent of greenness of the selected houses			
	Age of the home owners	220	0.010	N.S.*
2.	Extent of greenness of the selected houses			
	Monthly family income of the home owners	220	-0.081	N.S.*

Note: *N.S. =Not Significant

$HO_{1.2}$:

There exists no variation in the extent of greenness of the selected houses with the educational level and occupation of the home owners

Analysis of Variance was computed to test the hypothesis. The F values were not found to be significant for the variation in the extent of greenness of the selected houses with the educational level and occupation of home owners (Table 8). Hence, the null hypothesis was accepted and it was concluded that extent of greenness of the selected houses did not vary with the education of the home owners.

Table 8 : Analysis of Variance showing variation in the extent of greenness of the selected houses by the educational level and occupation of home owners

Sr. No.	Selected variables	df	Sum of squares	Mean squares	F value	Level of significance
1.	Education					
	Between Groups	5	675.862	135.172	0.795	N.S.*
	Within Group	214	36374.915	169.976		
2.	Occupation					
	Between Groups	2	12.916	6.458	0.038	N.S.*
	Within Groups	217	37037.862	170.681		

Note: *N.S. =Not Significant, df=Degree of Freedom

$HO_{1.3}$:

There is no difference in the extent of greenness of the selected houses and type of family and type of house of the home owners.

The computation of t value did not show any significant difference in the extent of greenness of the selected houses and type of family and type of house of the home owners (Table 9). Thus the null hypothesis was accepted. Thus, it was inferred that the type of the

Table 9 : t-test showing the difference in the extent of greenness of the selected houses and type of family and type of house of the home owners

Sr. No.	Variables	Mean Scores	t value	df	Level of Significance
1.	Type of family				
	Nuclear	67.89	1.60	218	N.S.*
	Joint	71.19			
2.	Type of house				
	Tenement/ Twin Duplex	69.06	0.29	205	N.S.*
	Independent Bungalow	69.00			

Note: *N.S. =Not Significant, df=Degree of Freedom

family and type of house did not cause any difference in the extent of greenness of the selected house.

Conclusion :

The existing house of the respondents were analysed for the extent of greenness. Majority of the houses had moderate extent of greenness for all the sub aspects except "Energy Efficiency". About three fourth of the respondents' houses had moderate extent of greenness on the overall scale. On computing the mean scores, the scores were found highest for the sub aspect "Indoor Environment Quality" and lowest for "Innovative Ideas" sub aspect. The study on "Assessment of selected houses and knowledge of the owners regarding Green buildings" was conducted. The 'Greenness' of their houses reflected that they were Green to a moderate extent. This reflects the need to make home owners and builders aware about the upcoming concept of 'Green buildings'.

Implications of the study :

The findings of the study brought out number of implications. The educational institutions such as filed of Family and Community Resource Management, Architecture, Interior Designing, Civil Engineering, and Environmental Studies can make efforts creating awareness regarding Green buildings through the curriculum up gradation, extension programmes, conducting more related researches, conducting seminars, training programmes and workshops and skill development. Government should make efforts in formulation strategies and policies which mandate builders to adopt features of green building in the construction projects.Government must give subsidy to the builders for buying Green building materials and in implementing features of Green building in their construction projects in order to reduce its construction cost. Government can give incentives as a motivator for the builders and buyers for choosing Green building options in their construction projects easily and freely.The Non-Governmental organizations working for environment protection can organize awareness camps, street plays or by using folk media for various stakeholders of Vadodara city for creating awareness regarding Green buildings and their benefits. LEED and GRIHA should step forward and in collaboration with the educational institutions for creating awareness among the potential existing home owners as well as students who are the future home owners. They can also take up projects on converting the existing residential buildings into

green buildings along with new construction as majority of the houses assessed in the present study were Green only to a moderate extent.The findings of the present research would act as a feedback to the Architects, Interior Designers and builders to realize the need of constructing a Green building and promote in Vadodara city.The home owners who were the sample of the present study were given feedback regarding the extent to which their houses were assessed as "Green" and were informed about it. They were highly motivated to implement many of the measures to make their houses more environment friendly.

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