CHAPTER – I
INTRODUCTION

Environmental crisis is a serious problem which is posed to world today as well as the world in the future. The world's population has grown exponentially since the Second World War, and there is currently a pressure on available land and natural resources. The society will eventually be faced with the depletion of the most widely used resources.

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 human activities are causing an irreversible damage to the global environment (World Economic and Social Survey, 2011), which has adverse impact on the quality of life of future generations (Wernick et. al, 1997). Hence, the concern for sustainability is even more in recent times.

Tremendous rate of real estate development across the globe is imposing immense pressure on the environment and its natural resources. 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 (Fazli and Faridi, 2011). Resources such as ground cover, forests, water, and energy are depleted to give way to buildings.Humans face a range of negative impacts linked to the way buildings are designed, built, and maintained.

As technology matured and grew more sophisticated, so did man's ability to exploit it. The structures that humans built became more technologically advanced and less reliant on the natural elements of the world. Builders and designers slowly started adopting new ideas that were neither indigenous nor sustainable. With the advent of advanced heating and air conditioning systems in the 20th century, it became relatively easy to alter the internal

environments rather than adapt to the natural one that surrounded the human beings.[1]

The construction industry poses a major challenge to the environment. Buildings have impact on the environment in a number of ways, which range from the excavation of construction sites to the materials used in construction. The construction and operation of buildings, they require significant input of energy, water and raw materials. Buildings are also responsible for considerable quantities of waste and emissions, including greenhouse gases. As per manual by GRIHA (2010), globally, buildings are responsible for at least 40% of the energy use. An estimated 42% of the global water consumption and 50 % of the global consumption of raw materials are consumed by buildings when taking into account the manufacture, construction and the operational period of the buildings. In addition, building activities contribute an estimated 50% of the world's air pollution, 42% of its greenhouse gases, 50% of all water pollution, 48% of all solid wastes and 50% of all CFCs (Chlorofluorocarbons) to the environment. Buildings are major consumer of water during construction and operation. Extensive urbanization is leading cause of environmental degradation. Vegetation and tree cover give way to urban areas with large expanses of pavements, buildings, and other structures, thus eliminating cooling provided by the vegetation. Urban heat island impact gives rise to increased temperatures. As the developmental path charted, it is important to keep eyes on the environmental damage. It is extremely important to pause and carry out some necessary course of action for benefit of mother earth and for future generations.

The world is now slowly realizing the importance of environmental conservation. In the later part of the twentieth century 'Go Green' philosophy has been developed. Building construction sector is no exception to this. The construction industry also has shown considerable awareness towards preserving the ecological balance through various green practices. Awareness is being translated into practices and eco-friendly real estate projects, products and services are emerging faster than ever (Chopra, 2008).

Mounting concern for the environmental impact of real estate has necessitated the formulation of sustainable solutions.

> "Sustainable development is defined as meeting the needs of the present generation without compromising the ability of future generations to meet their needs"
>
> Brundtland, 1987

This has led to the advent of the sustainable real estate and related 'green homes' concepts.

> "At its basis, sustainable real estate is all about using resources in a sustainable manner and addressing the demands of the present without compromising the ability of future generations to meet their own needs"
>
> Times of India, 2014

> "A sustainable building maximizes operational efficiency while minimizing environmental impacts"
>
> USGBC, 2008

Green housing or eco-friendly homes are the integrated approach towards minimising the adverse effects of construction and its operation on the environment and promoting healthier living for people (Times of India, 2014).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 (Devi and Lakshmi, 2010). The green building emphasizes reduction of environmental impacts through a holistic approach to land and building uses and construction strategies (Roy and Gupta, 2008).

The concept of green building is not as nascent as one think it is. The ancestors worshipped the five elements of nature-Earth as 'Prithvi', Water as

'Jal', Agani as 'Energy', Air as 'Vayu', and Sky as 'Akaash'. Williams (2008), in view of traditional Indian homes, said that

> "Indian ancestors paid special attention to details like adequate sunlight and solar energy while designing their homes. India's priorities are water and waste management, energy conservation, alternative fuels and valuable resources, amongst others. It is important that we learn from our traditions and build homes which will conserve the natural resources"

Green Buildings Defined

Green building is the practice of creating structures and using processes that are environmentally responsible and resource efficient throughout a building's life cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by efficiently using energy, water and other resources, protecting occupant's health and improving employee productivity and reducing waste, pollution and environmental degradation. Green buildings offer immense potential to reduce consumption and regenerate resources from waste and renewable resources.

Chatterjee (2009) states,

> "Green building practice is a process to create buildings and infrastructure in such a way that minimizes the use of resources, reduce harmful effects on the ecology and create better environments for occupants"

As defined by Indian Green Building Council(IGBC), 2012

> "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 conventional buildings"

Green buildings may incorporate sustainable materials in their construction (e.g., reused, recycled-content, or made from renewable resources); create healthy indoor environments with minimal pollutants (e.g., reduced product emission); and feature landscaping that reduces water usage (e.g., by using native plants that survive without extra watering).[2]

According to United State Green Building Council (USGBC), 2008

> "Green buildings incorporate design and construction practices that significantly reduce or eliminate the negative impact of buildings on the environment and occupants"

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

As per IGBC Reference Guide, (2011), "LEED 2011 For India" for Green Building Rating System for New Construction and Core & Shell Projects, the terms are explained as follows:

i. **Sustainable Site Selection:** It refers to a selection of a site which comply to the local regulations of height, built-up, open space etc. and also obtain necessary certification. The site should have access to basic amenities within 1 km from the building entrance which reduces air pollution caused due to transportation. The measures are taken during a new site development as well as on a developed site to reduce the heat gains in the building from various areas in an around the building.

ii. **Water Efficiency:** It incorporates the use of strategies and technologies such as "Rainwater harvesting", "Waste water treatment plants", "Water

efficient plumbing fixtures" and "Efficient irrigation methods" that reduce the water consumption in buildings. It focuses on reuse of water for its efficient management.

iii. **Energy Efficiency:** It includes methods which help in reducing the amount of energy required for building operations through the use of BEE star rated equipments and energy efficient electrical fixtures and treatment for exterior walls, and windows. The provision for renewable sources of energy such as solar, wind and biomass are made to meet the energy requirements.

iv. **Material and Resources:** It includes the adoption of waste reduction techniques, reducing waste at its source, reusing and recycling waste. The reuse and recycling of the waste generated while construction of a building or the household waste generated after the building is occupied. The use of local building material, rapidly renewable materials and material with recycled content is focused.

v. **Indoor Environment Quality:** It integrates day lighting and lighting quality, thermal comfort, acoustics and access to views. These issues have potential to enhance the indoor environment and optimize interior spaces for building occupants.

vi. **Innovation in design:** New technologies are continually introduced to the market place and up-to-date scientific research influences building design strategies. This point considers opportunities that are not addressed by any rating programmes which may include environmental solutions specific to a particular location, condition or region.

The benefits of Green Buildings depend on the extent of sustainability features taken into consideration during its design stage (Roy and Gupta, 2008).

Benefits of Green Buildings

In terms of appearance or use, there is no difference between Green Building and the conventional ones. The major differences are that Green buildings have improved indoor environment and they offer operational savings. Green buildings can have tremendous benefits, both tangible and intangible.

Tangible benefits: The immediate and most tangible benefit is the reduction in water and operating energy costs right from day one, during the entire lifecycle of the building.

Reduced energy consumption: Green buildings are designed to save energy costs by reducing the energy consumption. One of the significant components in the concept of green buildings is using renewable energy. Solar energy and wind energy are intermittent sources of energy, so these sources have to be combined with other sources of energy or storage devices. A green building energy system consists of renewable energy, energy storage and energy management, where the variety of energy source and storage devices can be managed very well (Jiang and Rahimi-Eichi, 2009). Energy efficiency in buildings can be achieved by adopting strategies like using low energy materials, insulation for walls, roofs roof garden, glass carpet for roof, glass technology (Ramesh and Khan, 2013). Green buildings can reduce energy consumption through energy efficient lighting, air conditioning systems motors, pumps etc. It also encourages selecting or using BEE (Bureau of Energy Efficiency) labelled equipments and appliances. The energy saving by adopting these can be to the tune of 20 to 30 per cent (U.S. Green Building Council, 2008).

Reduced water consumption: Most of the Asian countries are water stressed and in country like India the water level has reduced drastically over the last decade. Green buildings encourage use of water in a self-sustainable manner through reducing, recycling and reusing strategies. This can save upto 30 to 50 per cent (IGBC, 2014).

Reduced Air Pollution: There are number of indirect sources of pollution such as vehicle pollution from the transport of building products and the manufacturing of building products. There are also direct source of pollutants such as HVAC refrigerants and the toxic emissions from the finishes. All these leads to global warming, ozone layer depletion and air pollution (Devi and Lakshmi, 2010). The Green Buildings encourage the use of alternate fuels for transportation and captive power generation.

Reduced construction waste: Green Buildings emphasise waste reduction. Construction wastes and demolition debris are the main wastes produced during the construction process, and these wastes degrade the quality of the environment. Green Buildings ensure waste reduction by the reuse and minimisation of construction wastes and debris and diverting them to recycling units, the use of existing building structure and reclaimed building materials, the increased use of recycled content in construction materials and designing the structure to which produce less scrap. Green Buildings reduce waste by approximately 50% compared with that of similar conventional buildings, hence accruing all the above mentioned benefits (Roy and Gupta, 2008).

Handling consumer waste: In residential building it is extremely difficult to handle household waste as most of the waste generated is not segregated at the time of disposal and has a high probability of going to landfills. The green buildings encourage waste management through segregation, storage and effective disposal(IGBC, 2014).

Reduced dependence on natural resources: Green Buildings also encourage using recycled and reused materials and discourages the use of virgin wood, thereby addressing environmental impacts associated with extraction and processing of virgin materials(IGBC, 2014).

Intangible benefits: The intangible benefits of green buildings include enhanced lighting, health and wellbeing of the occupants, safety benefits and conservation of scarce natural resources (Times of India, 2009). The

health and well-being of the occupants is the most important aspect of green buildings. It ensures maximum day lighting and cross ventilation and recognises measures to minimize indoor air pollutants. Gou et al. (2012) stated that green buildings can have a more significant impact on their occupant's health and productivity through improving indoor environment quality (IEQ). This can be achieved by using less toxic interiors, low-emitting adhesives, paints, carpets and composite wood, illuminating 75-90% of the space with natural light and thermal comfort due to local control over air conditioning and better ventilation. It directly translates into improved productivity and decreased ailments for occupants.

Green building has now become a flagship of sustainable development in this century that takes the responsibility for balancing long-term economic, environmental and social health (Yoon, Lee, 2003; Ando et al., 2005). It offers an opportunity to create environmentally efficient buildings by using an integrated approach of design so that the negative impact of building on the environment and occupants is reduced (Cole, 2003; Ando et al., 2005).

Barriers to the Development of Green Buildings

According to Thung(1998); Landman (1999); Anderson et al. (2000); Davis (2001); Rao and Brownhill (2001); Owen (2003), there are some barriers in adopting green buildings. They are as follows:

The greatest barrier 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. This includes the problem of the upfront cost and the on-going costs usually coming from separate budgets, if not separate organizations. **Lack of technical knowledge, skill and training** on part of the builders, developers, contractors and project team is one of the barriers felt by the builders in adopting green building concepts in their projects. **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. **Incorrect perception** that green buildings results in significantly reduced utility bills right from the start may act as one of the constraints in adopting the 'green mantra' (Times of India, Vadodara, 2014). However, the utility bills are reduced but it is a gradual process. **Lack of widely used standards** is one of the major barriers to Green Building design and construction to define consistently criteria for a "green" product, service or building. Builders are confused as to which standard of Green Building rating system to follow.

Scarcity of environment friendly products and high performance residential equipments are available in the market but many markets are still underserved by manufacturer of green products.

Despite these barriers many builders are adopting Green Building concepts in their construction.

Green Building Rating Systems

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 bench mark for 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, material selection 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.

JUSTIFICATION

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.
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 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.

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. Aware consumer clientele can also influence the property market by pitching demand for green credentials of the buildings. 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.

LEED and GRIHA are working towards designing environment friendly buildings. LEED India has undertaken several projects regarding the construction and assessment of the green Building at various places in India such as in Pune, Bangalore, Kolkata etc. 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".

It is also essential to find out the awareness of consumers, that is, the owners of the houses regarding the concept of green building, as, educated and aware consumer regarding various aspects of green building is sure to influence many of the people around as well as their children who are going to build their own houses in future.

LEED and GRIHA are also creating awareness among the consumers, builders, developers, architects or designers by organizing seminars, conventions and training programmes. But the academician can play crucial and significant role in creating awareness among various target groups through formal and non-formal programmes in a holistic manner.

A study was, hence, planned encompassing various aspects in relation to Green Building. Some of the houses constructed by selected builders of Vadodara city were considered for assessing the extent to which they are green (eco-friendly). It was considered important to study the opinion of the builders regarding green buildings and the reasons as well barriers they have for Green building concepts / features. It was also thought important to find the knowledge of the home owners whose houses were assessed.

The researcher did not come across such a study during the review of literature in which the opinion of builders was found, the houses were assessed and the knowledge of the house owners was assessed regarding Green Buildings.

Courses such as Building Material and Housing, Residential and commercial Space Designing, and Landscaping and Gardening, and Environment and Ecology are among the thrust areas of the field of Home Management/ Family Resource Management/ Family and Community Resource Management. Hence, the information gathered through the present research would widen the data base and will help in strengthening the curriculum by making suitable modifications, if needed, to incorporate the knowledge regarding Green Buildings.

The findings of the study can be submitted to LEED and GRIHA, so that they can promote this concept in Vadodara as well. The findings can prove to be highly useful to the architects and builders or contractors who are the key person behind the construction of the house; so that they can consider the guidelines given by LEED and GRIHA to make the houses that have low

impact on the environment which is the need of present era. With this background the present study was conducted.

Several studies have been conducted in the department of Family and Community Resource Management on “Organic building materials (Singh, 2006)”, “Environment knowledge and Concern” (Pawar,1993; Shukul, 1995; Patel, 2009), “Indoor Air Quality” (Ramdas, 1988; Kulshrestha ,2001)”, “Water Management and Quality of Water” (Agarwal, 1997), “Energy Auditing” (Seth, 2004), “Solid Waste Disposal Practices” (Beniwal, 1999), “Net Zero Buildings” (Campwala, 2013) and “Vertical Gardens” (Pavasiya, 2014) at Post graduate and Doctoral level. A study which assessed the existing houses for its “greenness”, knowledge of the house owners regarding “Green Buildings”, as well as opinion, reasons and barriers faced by the builders regarding its adoption had not been conducted up till now.

Statement of Problem

The present research aims to assess selected houses of Vadodara City with regards to the extent they are “Green” and also the knowledge of the house owners regarding various aspects of “Green building”. It also aims to find out the opinion of builders of Vadodara City about Green building and the reasons and barriers in adopting Green building features in their construction.

The present study has the following specific objectives

Objectives of the study

1. To find out the opinion of the selected builders of Vadodara City regarding the concept of Green Building.
2. To find out the extent of influence of reasons for adopting the Green Building design and construction by the builders of Vadodara City.
3. To find out the extent of barriers faced by the builders of Vadodara city in adopting Green Building design and construction.

4. To ascertain the background information about selected home owners of Vadodara city.
5. To assess the extent of knowledge of selected homeowners regarding various aspects of Green Building.
6. To assess the extent of Greenness of the selected existing houses.
7. To prepare an educational programme on various aspects of Green Building for various stakeholders and to test the efficacy of it.

Delimitation

The study was limited to

1. 220 owners of the home residing in different residential areas of Vadodara city.
2. The home owners who had constructed or purchased their houses (tenement/ bungalow) between 2005-2013.
3. The key decision maker who were willing to answer the questionnaire at the time of data collection.

Hypotheses

1. There exists a relationship between the opinion of builders regarding green building concept and their selected personal and situational variables.

2. There exists a relationship between the extent of influence of reasons in adopting Green Building design and construction and selected personal and situational variables of the builders.

3. There exists a relationship between the extent of barriers faced by the builders in adopting green building design and construction and their selected personal and situational variables.

4. There exists an interrelationship between the extent of influence of reasons in adopting green building design and features of builders and extent of barriers faced in adopting green building design and construction and opinion of builders regarding green building concept.

5. The extent of knowledge of the home owners regarding various aspects of Green Building varies with their selected Personal, Family and Situational variables.

6. The extent of greenness of the selected house varies with the selected Personal, Family and Situational variables of the home owners.

7. There exists a relationship between the extent of greenness of the selected houses and extent of influence of reasons in adopting Green Building design and construction of the builders, barrier faced by the builders in adopting Green Building design and construction and opinion of builders regarding Green Building concept.

8. There exists a relationship between the knowledge of home owners and the extent of greenness of the selected houses.

9. There exists a difference in the extent of knowledge of the home owners regarding Green buildings before and after the exposure to the educational programme on Green buildings.