A STUDY ON ADOPTION OF GREEN HOME NORMS IN MODERN HOUSES

Thesis

Submitted to the Punjab Agricultural University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE
in
FAMILY RESOURCE MANAGEMENT
(Minor Subject: Sociology)

By

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(L-2016-H.Sc.-327-M)

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CERTIFICATE-I

This is to certify that the thesis entitled **"A study on adoption of green home norms in modern houses"** submitted for the degree of **Master of Science**, in the subject of **Family Resource Management** (Minor subject: **Sociology**) of the Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by **Ms. Harleen Kaur (L-2016-H.Sc.-327-M)** under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE-II

This is to certify that the thesis entitled, **"A study on adoption of green home norms in modern houses"** submitted by **Ms. Harleen Kaur** (Admin No. L-2016-H.Sc-326-M) to the Punjab Agricultural University, Ludhiana, in partial fulfillment of the requirements for the degree of **Master of Science** in the subject of **Family Resource Management** (Minor subject: **Sociology**) has been approved by the Student's Advisory Committee after an oral examination on the same.

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ABSTRACT

Adoption of green home norms in modern houses was studied in three smart cities of Punjab viz Ludhiana, Jalandhar and Amritsar to find awareness level of respondents regarding environment and their concern for preserving it, adoption level of green home norms in modern houses and constraints in their adoption. Self-structured interview schedule was designed to conduct a survey. Fifty homes, constructed after 2015 were taken randomly from posh localities of each of these cities comprising a total sample of 150. Majority (86%) of respondents perceived that their housing and life style related practices did not contribute in environment degradation, rather 53 per cent blamed agricultural practices. Seventy per cent respondents did not have sufficient knowledge about environment conservation. Only 14 per cent respondents reported little to acute impact on psychological and physical health. Twenty eight per cent respondents made efforts to avoid use of harmful household chemicals. Norms related to proximity of home to civic amenities and conserving natural topography was partially/not adopted in case of 70.50 and 93.33 per cent respondents. All respondents did not adopt rain harvesting and efficient landscape design for enhancing water use efficiency. Eighty six per cent respondents did not adopt renewable energy systems. Ninety, 86.00 and 93.33 per cent respondents did not dispose off building material waste properly, used recycled material and had on-site waste treatment for organic waste respectively. All respondents had no provision of separate smoking area, carbon dioxide sensors and adequate operable window area. Lack of interest was major constraint for not adopting green home norms followed by lack of awareness and high cost.

Keywords: Green home, Modern houses, Sustainable building design, Energy efficiency, Environment concern.

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ਸਾਰ-ਅੰਸ਼

ਆਧੁਨਿਕ ਘਰਾਂ ਵਿੱਚ ਵਾਤਾਵਰਣ ਸਹਾਈ ਮਾਣਕਾਂ ਨੂੰ ਅਪਨਾਉਣ ਬਾਰੇ ਅਧਿਐਨ ਪੰਜਾਬ ਦੇ ਤਿੰਨ ਸਮਾਰਟ ਸ਼ਹਿਰਾਂ ਅੰਮ੍ਰਿਤਸਰ, ਜਲੰਧਰ ਅਤੇ ਲੁਧਿਆਣਾ ਵਿੱਚ ਉੱਤਰਦਾਤਾਵਾਂ ਦੇ ਵਾਤਾਵਰਣ ਸੰਬੰਧੀ ਜਾਗਰੂਕਤਾ ਤੇ ਉਨ੍ਹਾਂ ਦੇ ਵਾਤਾਵਰਣ ਸੰਭਾਲ ਪ੍ਰਤੀ ਚਿੰਤਾ ਲੱਭਣ, ਆਧੁਨਿਕ ਘਰਾਂ ਵਿੱਚ ਵਾਤਾਵਰਣ ਸਹਾਈ ਮਾਣਕਾਂ ਦੇ ਅਪਨਾਉਣ ਦੇ ਪੱਧਰ ਅਤੇ ਉਨ੍ਹਾਂ ਨੂੰ ਅਪਨਾਉਣ ਵਿੱਚ ਆਉਣ ਵਾਲੀਆਂ ਔਕੜਾਂ ਬਾਰੇ ਜਾਣਨ ਲਈ ਕੀਤਾ ਗਿਆ। ਇਨ੍ਹਾਂ ਤਿੰਨਾਂ ਸ਼ਹਿਰਾਂ ਦੇ ਆਲੀਸ਼ਾਨ ਇਲਾਕਿਆਂ ਤੋਂ 2015 ਤੋਂ ਬਾਅਦ ਬਣਾਏ ਗਏ 50-50 ਘਰਾਂ ਭਾਵ ਕੁੱਲ 150 ਘਰਾਂ ਨੂੰ ਚੁਣਿਆ ਗਿਆ। ਜ਼ਿਆਦਾਤਰ (86%) ਉੱਤਰਦਾਤਾਵਾਂ ਦਾ ਮੰਨਣਾ ਸੀ ਕਿ ਵਾਤਾਵਰਣ ਵਿੱਚ ਆ ਰਹੀ ਗਿਰਾਵਟ ਵਿੱਚ ਉਨ੍ਹਾਂ ਦੇ ਘਰ ਅਤੇ ਜੀਵਨਸ਼ੈਲੀ ਦਾ ਕੋਈ ਯੋਗਦਾਨ ਨਹੀਂ ਹੈ, ਬਲਕਿ 53 ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾਵਾਂ ਨੇ ਇਸ ਵਿੱਚ ਆ ਰਹੇ ਨਿਘਾਰ ਲਈ ਖੇਤੀਬਾੜੀ ਨੂੰ ਜ਼ਿੰਮੇਵਾਰ ਠਹਿਰਾਇਆ। ਸੱਤਰ ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾਵਾਂ ਨੂੰ ਵਾਤਾਵਰਣ ਸੰਰੱਖਿਅਣ ਸੰਬੰਧੀ ਪੁਖਤਾ ਜਾਣਕਾਰੀ ਨਹੀਂ ਸੀ। ਸਿਰਫ਼ 14 ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾਵਾਂ ਅਨੁਸਾਰ ਵਾਤਾਵਰਣ ਨਿਘਾਰ ਦਾ ਉਨ੍ਹਾਂ ਦੀ ਮਨੋਵਿਗਿਅਨਕ ਅਤੇ ਸਰੀਰਕ ਸਿਹਤ ਉੱਪਰ ਥੋੜ੍ਹਾ ਬਹੁਤ ਅਸਰ ਸੀ। ਅਠਾਈ ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾ ਘਰਾਂ ਵਿੱਚ ਵਰਤੇ ਜਾਂਦੇ ਹਾਨੀਕਾਰਕ ਰਸਾਇਣਾਂ ਦੀ ਵਰਤੋਂ ਤੋਂ ਗੁਰੇਜ਼ ਕਰਨ ਦੀ ਕੋਸ਼ਿਸ਼ ਕਰਦੇ ਸਨ। ਘਰ ਬਨਾਉਣ ਸਮੇਂ 70.50 ਅਤੇ 93.33% ਉੱਤਰਦਾਤਾਵਾਂ ਨੇ ਨਾਗਰਿਕ ਸਹੂਲਤਾਂ ਅਤੇ ਕੁਦਰਤੀ ਨਕਸ਼ਾਸਾਜ਼ੀ ਦੇ ਸੰਰੱਖਿਅਣ ਸੰਬੰਧੀ ਜਾਂ ਤਾਂ ਧਿਆਨ ਹੀ ਨਹੀਂ ਰੱਖਿਆ ਤੇ ਜਾਂ ਫਿਰ ਅੰਸ਼ਿਕ ਤੌਰ ਤੇ ਇਸ ਦੀ ਪਾਲਣਾ ਕੀਤੀ। ਕਿਸੇ ਵੀ ਉੱਤਰਦਾਤਾ ਨੇ ਪਾਣੀ ਦੀ ਸੁਚੱਜੀ ਸੰਭਾਲ ਲਈ ਵਰਖਾ ਦੇ ਪਾਣੀ ਦੇ ਸੰਰੱਖਿਅਣ ਅਤੇ ਸੁਚੱਜਾ ਲੈਂਡਸਕੇਪਿੰਗ ਡਿਜ਼ਾਈਨ ਨਹੀਂ ਅਪਣਾਇਆ ਸੀ। ਛਿਆਸੀ ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾ ਊਰਜਾ ਦੇ ਮੁੜ ਵਰਤੇ ਜਾਣ ਵਾਲੇ ਸਰੋਤਾਂ ਦੀ ਵਰਤੋਂ ਨਹੀਂ ਕਰਦੇ ਸਨ। ਨੱਬੇ ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾਵਾਂ ਨੇ ਇਮਾਰਤ ਨਿਰਮਾਣ ਸਮੱਗਰੀ ਦਾ ਸਹੀ ਨਿਪਟਾਰਾ ਨਹੀਂ ਕੀਤਾ, 86.00 ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾ ਮੁੜ ਵਰਤੀ ਜਾਣ ਵਾਲੀ ਸਮੱਗਰੀ ਦੀ ਵਰਤੋਂ ਨਹੀਂ ਕਰਦੇ ਸਨ ਅਤੇ 93.33 ਪ੍ਰਤੀਸ਼ਤ ਉੱਤਰਦਾਤਾਵਾਂ ਨੇ ਜੈਵਿਕ ਰਹਿੰਦ-ਖੂੰਹਦ ਲਈ ਮੌਕੇ ਉੱਤੇ, ਕੋਈ ਉਪਚਾਰ ਨਹੀਂ ਕੀਤਾ ਸੀ। ਕਿਸੇ ਵੀ ਘਰ ਵਿੱਚ ਸਿਗਰੇਟ ਆਦਿ ਪੀਣ ਲਈ ਕੋਈ ਵੱਖਰਾ ਥਾਂ, ਕਾਰਬਨ ਡਾਈਆਕਸਾਈਡ ਦੀ ਮਾਤਰਾ ਜਾਣਨ ਲਈ ਕੋਈ ਸੈਂਸਰ ਨਹੀਂ ਲਗਾਇਆ ਸੀ। ਦਿਲਚਸਪੀ ਦੀ ਘਾਟ ਉਪਰੰਤ ਜਾਗਰੂਕਤਾ ਦੀ ਘਾਟ ਅਤੇ ਵੱਧ ਲਾਗਤ ਘਰਾਂ ਵਿੱਚ ਵਾਤਾਵਰਣ ਸਹਾਈ ਮਾਣਕ ਨਾ ਅਪਨਾਉਣ ਦੀ ਵੱਡੀ ਰੁਕਾਵਟ ਸੀ।

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ABBREVIATIONS USED

ACs	–	Air Conditioners
BEE	–	Bureau of Energy Efficiency
C.F.C	–	Chlorofluorocarbon
CFL	–	Compact fluorescent light
CII	–	Confederation of Indian Industry
CRI	–	Carpet and Rug Institute
CO_2	–	Carbon Dioxide
CWPs	–	Certified Wood Products
IEQ	–	Indoor Environmental Quality
IGBC	–	Indian Green Building Council
LED	–	Light Emitting Diode
LPD	–	Lighting Power Density
LPM	–	Liters Per Minute
MSW	–	Municipal Solid Waste
PEI	–	Pro-Environmental Self-Identity
PBC	–	Perceived Behavioral Control
VOCs	–	Volatile Organic Compounds

CHAPTER I

INTRODUCTION

In India, buildings account for twenty four per cent of total household electricity consumption (Electricity 2018). India generates approximately 133-760 tonnes of Municipal sewage waste per day approximately (Kumar *et al* 2017) and the total water withdrawals in domestic sectors five per cent in 2000, by the time it will increase i.e. eight per cent by 2025 and eleven per cent by 2050 (Amarasinghe *et al* 2005). Building sector has grown significantly in India in last ten years. Still higher growth in this sector is anticipated during the coming twenty years. It is estimated that the constructed space in the housing sector is expected to rise from the present twenty billion sq.ft to hundred billion sq.ft by 2030 (Climate Works Foundation 2010). It indicates that eighty per cent of the total constructed area in India is yet to be built. Though there has a period of slow growth during the recent years the construction in housing sector in India has grown well by twenty per cent. It is worth noting that loan disbursement for housing in India rose from two hundred sixty three thousand crores in 2008-09 to three hundred sixty four thousand crores (Gokarn 2011).

In operating green homes, energy consumption is reduced by 40-50 per cent and water is saved to an extent of 20-30 per cent as compared to the conventional homes (World Green Building Council 2016). Occupant productivity in green homes is also improved as about ninety per cent of these houses have adequate day lighting and have enhanced ventilation as compared to conventional houses. A green house also has enhanced asset value resulting in higher profits in their total value. Economic life cycle performance of a green house is optimum and it minimises health problems resulting from poor indoor air quality. Strain on local utility infrastructure is minimized, air and water quality is improved, biodiversity & ecosystems get protected and enhanced, waste streams are reduced, natural resources are conserved and restored and overall quality of life is improved by adopting green norms for buildings.

Development of green buildings does not cost extra. It is simply the application of conventional wisdom, building orientation, concern about their neighbourhood and application of mind to reduce the use of materials, finest way to describe by ‘Reduce’, ‘Reuse’ and ‘Recycle’. The green buildings that used to cost 15 per cent more about eight years ago now cost just around 9-13 per cent more than conventional buildings (Jain *et al* 2013). A green home needs to address all aspects of environmental concerns related to the site, water and energy efficient practices, choice of the materials and good indoor air quality related aspects. Some of the sustainable building designs have distinct features i.e. green homes include wall and roof insulation, devices and practices regarding shading the house, use of reclaimed and recycled materials, low volatile organic compounds paints, on-site and

off-site waste water treatment, vermin-composting, roof and non-roof water harvesting, installation of the energy & water sub-metering and energy efficient appliances etc.

Some easily implementable practices like installation of solar panels, star rated appliances which are more efficient (saves up to 40 per cent) than standard appliances, shift from conventional to high efficiency water heaters, washing machines, low-flow showerheads, faucets and toilets, installation of the low-e glass windows providing best insulation for greater efficiency of cooling and heating systems contributes much in conserving the energy used in homes (Thapar 2011). Advanced door and window framing techniques uses thirty per cent less lumbar which reduces the building costs and saves two to four per cent of total energy use owing to reduced leakage of hot/cold air and improved insulation. A good design permits appropriate positioning of appliances which improves their efficiency. Heat gain through ceilings is a major predicament in keeping the buildings cool /hot. About 95 per cent of heat can be reflected away by installing radiant barriers underside of roof. Considering the projected growth of the residential sector, it is imperative to work on the agenda of green homes to ensure a sustainable living. The residential sector can contribute significantly in climate change mitigation. Green homes should be a national priority, as it is beneficial to the individual, society, and the nation. The Indian Green Building Council (IGBC), part of the Confederation of Indian Industry (CII) was formed in the year 2001 with a vision to enable a sustainable built environment for all and facilitate India to be one of the global leaders in the sustainable built environment by 2025. The first rating program developed in India has offered, exclusively for the residential sector. It is based on accepted energy and environmental principles and strikes a balance between known established practices and emerging concepts.

Appropriate site selection is important in order to control the soil erosion and sedimentation, thereby, minimizing the bad impacts to the site and surroundings. The fertile topsoil to be stockpiled prior to construction should be prevent and reuse in future or donation in order to make an environmentally sustainable house. Site for an environment friendly house should have an near and easy approach to basic amenities, so as to minimize the bad effects caused by the usage of automobile. Similarly a site for a green home should be such that it encourages to use of public transport to minimize the usage of automobile to diminish the deleterious effects on environment. Site should be prepared for a green house to minimize disturbances or restore the site so as to reduce long-term negative environmental impacts, thereby promoting habitat and biodiversity. In order to practice green thinking, preserve existing fully grown trees and plant new tree saplings, so as to promote habitat and biodiversity. To reduce negative impact on micro-climate, heat island effect needs to be minimized by shade from existing tree cover/ newly planted saplings within 5 to 8 years of planting, open grid pavers or grass pavers etc. on non-roof areas. To Minimize heat island

effect from the roof area, so as to reduce negative impact on micro-climate, material with a high solar reflective index to cover at least 75% of the exposed roof area should be used.

Green house is to improve ground water table which helps to conserve water and minimize the demand of municipal water by providing a rainwater harvesting system to collect at least 25% of runoff volumes from non-roof and roof areas. It is to minimize the pressure on waste water systems by selecting water efficient plumbing fixtures whose flow rates / capacities meet the baseline criteria. The intent is also to confirm the less water usage for landscape by limiting use of turf on the site so as to save water and/ or ensure that drought tolerant species are planted in landscaped areas and minimize the demand of water for irrigation purpose by using water efficient management systems.

The intent of energy efficiency in green homes is to avoid the use of refrigerants and ozone depleting gases, which has negative effects to the environment by using CFC-free refrigerants in Heating, Ventilation & Air-conditioning equipment and unitary air-conditioners installed in the building(s). Green homes also intend to improve energy efficiency of the building(s) to minimize environmental effects from excessive energy use by meeting baseline criteria for solar heat gain coefficient, window glazing U-value and overall roof assembly U-value. For the lighting system, residential unit should show compliance for interior and exterior lighting separately, decorative lighting in respective areas considered for lighting power density (LPD) calculations which are illuminated by external lighting but not the entire exterior area, power consumption of complete fixture including lamps and ballasts. Air-conditioning systems must be BEE minimum 3-star rated or equivalent for building energy performance

The intention of conserving energy in green homes is through promoting self sufficiency in energy through renewable technologies for on-site power generation by installing renewable energy systems for atleast 5% of total connected burden of the building. The intention is also to encourage use of solar energy for water heating applications in the building(s) by installing solar water heating system for domestic purpose to meet hot water requirement considering minimum hot water as 20 liters used per person for a day.

As far as materials are concerned, green homes need to facilitate separation of leftover at source to encourage the reuse or recycling of materials, thereby avoiding waste being sent to landfills. Provision also needs to be made to ensure effective organic waste management, post-occupancy, so as to prevent waste being sent to landfills. The salvaged building materials and products should be used to minimize the virgin materials demand, thereby, reduce the impacts associated with extraction needs to be encouraged. In building a house with green thought, use of recycled materials to minimize the environmental effects associated with the use of virgin materials and use of building materials available locally, thereby, minimizing the associated environmental impacts resulting from transportation

should also be encouraged. The virgin wood should be used to minimize, thereby, encouraging responsible forest management and use of materials which are rapidly renewable should be maximized.

To improve the indoor environmental quality in a green home, passive smoking risk the non-smoker's health, post occupancy should be minimized. Achieving minimum glazing factors, by adequate day lighting as below in at least 75% of the regularly occupied spaces by connectivity between the interior and the exterior environment. Operable windows or doors to the exteriors affected to minimize the indoor pollutants by providing sufficient outdoor air ventilation, in all regularly occupied spaces and bathrooms of each dwelling unit, such that the operable area is designed to meet the set criteria. Adequate ventilation for kitchens and bathrooms needs to be ensured so as to better the indoor environment quality in a green home. Encourage to use low-e materials so as to minimize the negative health effects on building residents.

A green home should be superior in strategy than standard sustainable design practices and the measures which are not mandated by local bye laws must be taken voluntarily. Strategies should present a comprehensive approach and have significant, measurable environmental benefits.

Hence, the current study was planned to see the level of awareness of the respondents regarding deteriorating environment and their concern for preserving it. As it is considered that an in depth knowledge about a concept leads to desired actions in that direction, level of adoption of green home norms and explore the constraints in adoption of green homes norms in the modern houses.

The citizens who afford a lavish life style and costing the most to the environment through their lifestyle practices should own the responsibility towards the deteriorating environment and adopt green home norms for the sake of the society and nation. So it was important to study the level of adoption of green home norms by them.

1.1 Objectives of the study

1.1.1 To study the level of awareness of the respondents regarding deteriorating environment and their concern for preserving it.

1.1.2 To determine the level of adoption of green homes norms in the modern houses.

1.1.3 To explore the constraints in adoption of green homes norms in the modern houses.

1.2 Limitation of the study

Although every effort has been made to make the study as comprehensive as possible, but still there are some limitations:

1.2.1 The study was limited to 150 homes only from three major cities of Punjab viz. Ludhiana, Jalandhar and Amritsar.

1.2.2 The findings of the study were based on expressed opinions of respondents and observation of their house, although every effort has been made to get the accurate information by interview schedule, but respondents were not well aware about some of the details of the construction features of their homes.

1.2.3 Though many intriguing questions were asked from the respondents to judge their awareness and concern regarding the deteriorating environment, but the majority of respondents had meager knowledge and involvement. Even, they had poor comprehension of the concept of green home norms which leads to incomprehensive answers.

CHAPTER II

REVIEW OF LITERATURE

A comprehensive review of literature is necessary in any research endeavor. It shows 'what' and how much work has already been done in the area of present problem. This section deals with a brief review of researches which are related directly or indirectly to the present problem. Relevant references from literature and research studies were collected from books, research articles and research papers from scientific journals. Keeping in view the objective of present study the available relevant literature which sets as a guideline for this investigation has been grouped under following subheads:

2.1 Deteriorating environment and their concern for preserving it.

2.2 Adoption of green homes norms in the modern houses.

2.3 Constraints in adoption of green homes norms in the modern houses.

2.1 Deteriorating environment and their concern for preserving it.

Fischer (2010) in his study on green building and the federal response: an introduction found that green building was being inculcated in green concept where the objective of building was to make it environment friendly by having least impact on degrading the environment through green architecture, highly efficient performance techniques, sustainable development projects. He proposed that energy building had been shifted to being environment friendly as compared to the earlier used standardized building techniques.

Abidin (2010) conducted an investigation on the awareness and application of sustainable construction concept by Malaysian developers. The results derived depicted that environmental degradation is a major issue in Malaysia especially because of construction industry. Sustainability objectives require proactive actions from developers through a change in construction approach. The study determined the awareness level and level of adoption of sustainable building approach by the constructors. The pace of adoption is slow because of less knowledge about the benefits of the adoption of sustainable building system.

Song *et al* (2012) convicted the residents' behaviors, attitudes, and willingness to pay for recycling e-waste in Macau. The study gave the results that Macau has been recorded as a country with high waste generation and lack of adequate disposal methods. As per the survey conducted to know about the attitudes of residents towards e-waste recycling with the objective of environmental protection, it was found that people were less aware about the disposal means. Residents were interested in getting the waste disposed in a systematic manner by the government preferably through telephone reservations. The study showed that the demographics of the individuals impacted their willingness to pay measured through logistic regression model. These results are eventually helpful to various agencies in building

better disposal techniques to protect the ecosystem.

Umar and Khamidi (2012) presented a detailed determined the level of green Building public awareness: supplication and strategies. They were analysis on the awareness of residents about green building and concluded that bringing the change in the building techniques were not only a professional issue rather it was a public issue. Although definite guidelines had been formed for the energy efficient building systems it had been observed that the implementation of these regulations were not efficient. Some sections of these guidelines had not been properly uncovered and understood for the constructors to adopt and apply these techniques. It was also observed that these guidelines have been released to shift the focus towards developing the country in line with the rate of development of the developed countries.

Hwang and Tan (2012) worked on the green building project management: obstacles and solutions for sustainable development. They were found the various alternatives for bringing focus over increasing the adoption of green building by the individuals. These strategies include increasing the horizon of the government initiatives in order to include the green buildings into the list of products under consideration, increasing awareness among the owners about the positive impacts of constructing the green buildings, arranging tours to educate them regarding its benefits, preparing a framework regarding the project management framework, and government subsidies to promote research and development (R&D).

Lin and Huang (2012) examined on the influence factors on choice behaviour regarding green products based on the theory of consumption values. Their factors affecting the choice of green products and the consumption values which the objective of determining whether there exists a difference between the consumption values and choice of customers to use products having environmental concern. It was found that the individuals concerned about the environment are the major supporters of using the green products. The main factors influencing the people to use green products include readiness to learn about the green products, benefits related to such products, responsible buying desire and certain conditions.

Manoj (2013) pointed out the prospects and challenges of green affordable homes: a study with reference to Ernakulam. It was an opportunities and problems on the way of green buildings and homes in his recent study in the area of Kerala concluding that the importance of green building adoption had been increased in Kerala because of the issues and highly affecting problems of the conventional housing. These problems include environment degradation and the high expenditure required to be incurred on building these houses which is not affordable by the people of Kerala.

Plappally (2013) studied the water use and related costs at households in western and northern parts of India. It undertook a number of aspects related the socio-economic position of an individuals, technology used by the people and other processes followed. The results

found that ecosystem is getting degraded because of the unawareness among the people about the policies regulated by the government for the preservation of water. Promotional channels are playing a misguiding approach leading people towards the aesthetics rather than techniques used which are more important for ensuring the positive impacts of the technology used.

Abolore (2013) stated that the comparative study of environmental sustainability in building construction in Nigeria and Malaysia. The conclusions were drawn that the adoption of the green building techniques was dependent upon the level of awareness among the people towards the green buildings which was gained by understanding the needs of the people to gain knowledge, their involvement, actions and level of accepting the principles and regulations established for the adoption of the processes.

Häkkinen and Belloni (2011) were studied on barriers and drivers for sustainable building. They were founded the numerous obstacles and sources for expanding sustainable building and further concluded from his study that the best way to increase the level of adoption of green buildings is through creating the awareness among the individuals about the positive results of the implication of these energy efficient buildings.

Chi *et al* (2014) investigated the e-waste collection channels and household recycling behaviors in Taizhou of China. The research was performed through questionnaire survey. By exploring the sixteen types of wastes disposed of through six types of channels it was found that out of the various alternatives, the best way to collect the household waste is through informal collection. The formal waste like electronics to people having need instead of formal collectors. An integrated system needs to be formulated including a group of collectors and incentive schemes that fits the needs of the Chinese people.

Li *et al* (2014) stated that the green building in China: needs great promotion. Concluded that in the process of increasing the awareness of the green building projects and readiness to adopt and develop the concept of green buildings it had been identified that some factors play a crucial role making it difficult to acknowledge and adopt constructing green buildings. These factors include educating people regarding the degrading condition of the environment, increasing the focus over research and development and formulating policies and regulations.

Arli *et al* (2018) studied the exploring consumers' purchase intention towards green products in an emerging market: the role of consumers' perceived readiness. They analysed the level of awareness among the general public along with the level of adoption of the sustainable energy products. It was found through this study that a number of factors are responsible for determining the intentions of the public to purchase green products. These factors include customers' attitude (ATT), pro-environmental self-identity (PEI), subjective norms, perceived behavioural control (PBC), ethical obligation and consumers' readiness to

be green. Awareness and willingness of customers to be green depends upon these determinants and the perception of customers of taking responsibility towards the environment protection. Further, it worked on the difference between the positive attitudes of people and low adoption of green products in the prospective market.

2.2 To determine the level of adoption of green homes norms in the modern houses.

Vanegas *et al* (1996) studied the sustainable technologies for the building construction industry. It was found that environment protection being the most significant goal of the economies can be contributed by the construction industry. The conventional construction business was majorly focused on three objectives which includes: price, time and quality.

OECD (2003) evaluated the concept of Environmentally Sustainable Buildings: Challenges and Policies. Paris: Organization for Economic Co-operation and Development. The results of the study found that sustainable building aided the reduction of the negative impacts of conventional building on the environment while had a positive impact on the buildings, its surrounding area and wider regions. It further outlined the five objectives set for the growth of the green building concept including; energy efficiency, pollution control, resources efficiency, environmental protection and an integrated system by the management.

Chen *et al* (2005) worked on the environmental challenges of post-reform housing development in Beijing and found that the degrading situation of the environment is because of the human technologies that are impacting the whole earth through the increase in the pollution, decreasing reserves of the materials and fossils, increase in the wastage, emission of the greenhouse gases and environmental extractions. Older building techniques contribute to worsen the environmental conditions in the area.

Balaras *et al* (2007) concentrated on the European residential buildings and empirical assessment of the hellenic building stock, energy consumption, emissions and potential energy savings. They were pointed out the benefits of adoption of the green building process. The author concluded through the study that with the use of green technology in the development of green houses, the energy efficient green walls can save 33-60% energy and the windows can save about 14-20% energy in the operations.

Ahn and Pearce (2007) studied on construction experiences, expectations and perception associated with green building. Elaborated survey was held to collect data from three major universities (Auburn, Purdue and Virginia technology). The data was based on current experience level and abilities of companies related to green construction knowledge and skills. The results of this study helped in growing importance of green building in whole construction market.

Mercer *et al* (2007) study was prominently "what is affordable green housing?

analysis of a competition". They were focused on the affordability challenge on construction and acquiring the green houses and found that constructors propose to build sustainable house with the competition of designing an affordable green house. This research determined the factors forming the attitudes of individuals and the judgements based on the modified construction techniques. It stated that people currently are concerned about the environment but are convinced to build the green houses but within the affordable range.

Hoang *et al* (2009) studied green materials for ozone layer such as UV-coated bamboo, natural cork wall covering, sunflower board, wheat board, unglazed ceramic tile and UV-coated sunflower board. The research found that green materials were durable, environment friendly, recyclable with minimal chemical emissions. It was found that wheat board, perlite-based ceiling tile and natural cork wall covering were harmful for the ozone layer.

Ali and Saba (2009) developed a green building assessment tool for developing countries. For study purpose, they took Jordan developing country and they used international green building assessment tools such as Comprehensive Assessment System for Built Environment Efficiency, *Building Research Establishment Environmental Assessment Method* and others. They discussed with various stakeholders and experts were in sustainable development. The results showed that SABA green building assessment tool was a suggested to the Jordanian. It was computer based program.

Potbhare *et al* (2009) emphasized on the water use and related costs at households in western and northern parts of India. The conclusions drawn for the study gave the benefits and the cost related to the construction of the green buildings, organizing the seminars, workshops and conferences for promoting the awareness of importance of environment protection, building an institutional framework for execution of the guidelines to the owners, educating the constructors, government, policy making institutions on the required level of adoption of green building projects.

Tang and Fan (2010) attempted to the reflections on flexible integration of intelligent building and green building. Emphasize on the combination of the green building and smart building techniques and concluded through the study that the application and adoption of the green building technology can be beneficial as it may improve the environmental conditions, save the energy for the society and also help the economy to strive for sustainable development.

Qian and Chan (2010) detailed about the government measures needed to promote building energy efficiency (BEE) in China. It was found that the various practices which are undertaken for the efficient building of the green development projects included the introduction of the various green certifications, labelling systems, rating systems which include Leadership in Energy and Environmental Design (LEED) of US, Green Mark Scheme

of Singapore, Green Star of Australia, and Building Research Establishment Environmental Assessment Method (BREEAM) of UK. It had been pointed out that these rating scales and programs will eventually work for the emergence of the green building projects.

Chang *et al* (2011) elaborated the evaluation the feasibility of zero-carbon green building in Taiwan. They were concluded from his study that adoption of the green buildings has become the most popular concept as it results into zero carbon emissions. The level of energy consumption by the buildings came down to 70% only through the implication of the three techniques; constructing a building in the area where low air conditioning was required, using the appliances with high star energy efficiency and change in the habits of the individuals to be more environment protective.

Hsieh (2011) discussed the trend of smart sensing technology in houses for example arglory land development offered a sustainable and smart building for the senior citizens. The results were that security and hazard prevention, energy-saving and comfort, health care were three major things which were consider in smart houses. Smart houses not only give rise to a market opportunity but also make proactive sensing, smart determination, automatic control and advanced sensor fusion possible.

Sadineni *et al* (2011) investigated the passive building energy savings: a review of building. They were enveloped the components of energy procurement techniques for buildings and the results showed that a number of energy efficient techniques can be applied for improving the building strategies. More focus had been put on changing the lighting, cooling, heating and ventilation methods to more efficient ones. Apart from these, constructing a new technology building envelope in order to individualize the outer and inner environment was considered as an efficient technique. It helps to improve the indoor environment by reducing the impact of the outdoor factors. Thus, the variables which form a hurdle and require attention of the constructions while building energy efficient buildings include the walls, foundation, ceilings, thermal heating systems, insulation systems and the shading techniques.

Kamana and Escultura (2011) objectified the building green to attain sustainability. They were researched on the attempts for proper execution of sustainability building and the resulted derived the techniques to reduce the environmental issues which have come into existence by the building practices as one of the reasons and to understand the possible alternatives to secure practices to save the planet from getting deteriorated and making it a clean and energized place for the next generations to live in.

Zhang *et al* (2011) attempted on research on the localization strategy of green building. They were found the rising environmental issues, the urgent need to improve the environmental conditions, the introduction of the concept of green buildings into the system, the evaluation of the positive impacts of the green building projects, and the policies and

regulations for the promotion of the green buildings and its growth. Green building concept was a strategy to build the constructions in manner which leads to sustainable development and adapts to the local conditions and the time factor.

Xing *et al* (2011) emphasized on the zero carbon buildings refurbishment-a hierarchical pathway alignment. The results showed that the demand of energy by the buildings was being increased at a fast pace all over the world and it was almost half of the total energy consumption in the European countries. There was an indispensable use of the energy resources, the impact of the overuse of which had been realized sooner or later. The dependency over the fossil fuels was required to be reduced in the building process and it was considered that there exists a great scope for the introduction of the better concepts in the building process. It had been evaluated that buildings can be constructed with zero-carbon emissions although it was critical to reduce the use of fossil fuels and handle the overuse of energy resources. Henceforth, this concept was crucial to of followed and adopted.

Hong (2013) conducted a study in Malaysia on satisfaction and inspiration of homeowners towards sustainable homes and to determine how homeowners were satisfied with their sustainable homes. The outcomes showed that homeowners were most satisfied with the sustainable home features. Sustainable home features like double-glazed panel glass doors and windows, landscaped parks with facilities, low-flow water fixtures, rain water harvesting system and solar panel system. On the other side, there were some homeowners which were least satisfied with the green features. Four motivators were found that describe households' belief about sustainable homes: 'Financial Incentives', 'Healthy and Sustainable Environment', 'Energy Efficiency' and 'Liveability'. It also depends on what motivates homeowners to accept sustainable homes. One thing also noted that house buyers not just want a house to live in but they want sustainable home features in their homes so that they did not destroy the environment.

Estep *et al* (2013) studied inexpensive house builder demand for eco-friendly and certified wood products. The study evaluated the demand for (CWPs) certified wood products and green-labeled wood products in the central Appalachian affordable housing sector in 2011. The study also identified price premiums that affordable home builders were willing to pay for CWPs (certified wood products) and green-labeled wood products. Results indicated that 50 percent of affordable housing respondents were planning future CWP purchases and some type of green building standard followed by affordable housing respondents were 62%.

Gou *et al* (2013) compared between the green and non-green buildings. This study held in China and for survey they made questionnaires for comparison between green and non-green buildings. A standard questionnaire used to benchmark the buildings through an international database research found that the green building users were more satisfied and comfortable than the non-green building users.

Hammad *et al* (2014) conducted a study in Aman on green building design solution for a kindergarten. Kindergarten was redesigned with green features and that design studied the use of installed solar water heater, installed insulation for walls and floors, installed grid PV power system to generate free solar electricity and heat recovery ventilators. Also, a suitable economic evaluation criterion was used to estimate the payback period of all systems applied. The outcome showed that fluorescent lamps reduce the heating load up to 10% and reduce the energy use by about 15%. Furthermore, suitable energy conversion using solar systems were sufficient to cover the domestic hot water heating demand to reach zero of domestic hot water heating energy in sunny days. 11.7 ton of carbon dioxide emission was annual reduction.

Liang *et al* (2014) conducted a study on the comparison of the conventional and green homes on variety of aspects of Indoor Environmental Quality at the time of active air-conditioning. This study held in Taiwan. The green homes certification system established Indoor Environmental Quality criteria was developed by green home certification system for evaluation of lighting, ventilation and decoration of the building. Overall Indoor Environmental Quality satisfaction as well as the proportion of residents choosing green homes for satisfaction were both higher than the ordinary homes. Residents in green homes were more satisfied with the overall environmental quality. Green buildings supply better quality in illumination, temperature, CO_2/VOC concentration.

Radwan *et al* (2014) aimed to review the literature on IEQ (Indoor Environmental Quality) in green buildings. The literature was analyzed based on parameters such as the literature's country of origin, year of publication, type and sample of buildings and specific IEQ aspects studied. The review showed the consensus among researchers on how green buildings improved air quality and worsened acoustics. It also found that the green building occupants were more comfortable or satisfied with air quality than occupants in conventional buildings.

Biswas and Roy (2014) witnessed the green products: an exploratory study on the consumer behavior in emerging economies of the East. They were progressed in the level of consumption of green products by the general public specifically focusing on east countries. Putting focus over the effects of consumption on the environment, the study found the relationship between consumer's readiness to buy green products and the environmental issues in India. The study revealed that although consumer is ready to buy green products price is the most crucial aspect and social responsibility proves to be the most convincing factor to practice green purchase behaviour. Different individuals hold different values affecting their conviction to adopt green consumption holding higher values for those experiencing green notion.

Garas *et al* (2015) conducted a study on sustainability analysis of green and

conventional materials. More green or eco-friendly building materials should be used during construction because these materials provide no harm to our environment. This study presents comparison between conventional and eco-friendly or green building materials using sustainability measures. For example two storeys was constructed and for construction they used eco-friendly or green building materials. Green building materials like wools bricks, solar tiles, rice straw bales, paper insulation, triple-glazed window and plain concrete. For measurement Sustainable Decision Support System were used. Sustainable Decision Support System basically is a technique to evaluate the sustainability of materials. The outcomes showed that the eco-friendly system had better sustainability which is 67% than conventional materials i.e. 56%. This means green materials had better eco-friendly rank than the conventional materials.

Verma and Tiwari (2015) in their study on assessment of design techniques and rating system for green buildings chiefly in India had reported that the present work was attempted to spread awareness of the benefits of eco-friendly or green buildings to communities, general public for sustainable environmental management and development. Now-a-days green buildings is widely used in an architecture. Designing of green buildings is a vital focus of building possessors and even governments worldwide. In the Past few years in India, world class green buildings had been constructed, but till now the concept of green buildings is in early stage.

Ahmad (2016) developed a green-building design approach by selective use of systems and technique. He was designed the approach towards green structures using different methods and techniques. Furthermore, it found that it was the undoubted and easy acceptance of the green building process that resulted into the efficient and development of the green building practices. Eventually, it was bringing sustainability in the environment through the environment friendly techniques.

Balaban and Jose (2016) assessed the co-benefits of green buildings in Japan. The idea of the green building was a recent reaction to deal with the problems that stem from the building sector. Green buildings could generate co-benefits and barriers to push green building agenda forward. The outcome indicated that sustainably rebuild buildings gave significant advantages with regard to CO_2 and energy reduction, cost or money savings, and improved health problems for building users. The best two performances were found through case study to achieve 38% and 32% reduction in CO_2 emissions intensity and 33% and 26% reduction in energy use intensity in comparison to benchmark values.

Wong *et al* (2016) worked on facilitating effective green procurement in construction projects: An empirical study of the enablers and concluded that green building projects can be popularized and adopted at a fast rate by the constructors and the developers by following the

guidelines and the regulations formulated by the government, the fulfillment of the requirements set by the government and the non-government institutions and the adoption and implication of the standards formed by the government.

Wang *et al* (2016) purported through the study willingness and behavior towards e-waste recycling for residents in Beijing city of China. The behavior of the local people was analyzed through questionnaire survey. The results derived out of the research through logistic regression model showed that there existed four major factors determining the response or actions of the residents of Beijing towards the effects of e waste and recycling of e waste. These determinants include; recycling habits of individuals, the financial profits through adoption of these processes, residential conditions and benefits associated with recycling sources.

Pérez-Urrestarazu *et al* (2016) elaborated the vertical greening systems and sustainable cities. It was concluded that technological development of the cities stands as a major reason for the degradation of environment but the fresh greening concepts for urban cities are initiated meant to bring sustainability. The new concept of vertical greening allows vegetation on the interior walls of buildings. Being a lesser known concept, it possesses scope of growth. The public has an increased interest in this concept as it showcases a prominent improvement in the green infrastructures. The further results of the study describe the various systems to be followed to make sustainability building a usual concept for public and the benefits associated these green infrastructure systems.

Hwang *et al* (2017) focused on the green business park project management: Barriers and solutions for sustainable development. Further resulted that a number of alternatives are required to be used for increasing the ratio of adoption of green building among the residents. Government intervention by the way of formulating policies, enabling regulations, providing incentives and funding to the green development projects, contributing into the research centers and firms was a significant way and the most feasible solution of overcoming the barriers for promoting green business parks.

Narayanan (2017) reported that Brisbane Fortitude valley had been recognized as the champion of green building by the World Green Building Council in 2016. The building produces fifty three percent less carbon dioxide than other buildings. The roof mounted solar photovoltaic system set off twenty eight percent of the building's final operational energy.

2.3 Constraints in adoption of green homes norms in the modern houses.

Zachariah *et al* (2002) defined that what makes a building green?. They were founded the various terms and definitions related to the green buildings which included the terms like 'green building', ecological design' and 'sustainable architecture' as a practice to introduce environment friendly projects, forming the communities which will operate for the healthy construction and operation of these projects. But the major constraint over this was that these

statements were quite ambiguous and vague for the implementation of the concept practically.

Alnaser and Flanagen (2007) highlighted the need for sustainable buildings construction in the kingdom of Bahrain. It was concluded that exercising energy efficient building techniques required the initiation by the architects and the constructors by unfolding the problems of adoption. In the study of Bahrain, it was revealed that sustainable construction can be done through adoption of solar and wind energy. But there has been some barriers in the adoption of these energy sources including; less availability and less economical in the rural areas, problems of the education and experience of the trainers, less awareness among the public towards the benefits of using these energy sources, especially about the Kwh cost value having no taxation in Bahrain, specifically the consumption pattern and its environmental impact with no future plans and regulations.

Hankinson and Breytenbach (2012) focused on the barriers that impact on the implementation of sustainable design. They were concluded through their study that although guidelines and regulations had been formulated but the implication of these designs in the Unites States of America (USA) in not fast. It had been observed that a number of problems were faced while implementing the sustainability projects specifically stating; knowledge about the material, time and cost to be incurred on collecting these resources were high, proper training to the technicians were required, proper information, limited material selection and the suppliers, proper tools used for implication. The barrier son the part of the clients includes; demands and awareness among clients, knowledge about the tools, recovery term period, insurance regulations, fee structure, awareness about the regulations formulated and less communication among stakeholders about environment.

Editorial (2012) stated the implications of a changing climate for buildings. It was found that the crucial areas having an impact include the use of energy resources and the resultant impact, problems occurring because of overloading, and problems faced in the process of shifting the operations. The environmental issues related even stretch to electrical grid failures which may pose serious issues for the building in proper working conditions.

Critical appraisal of review

The above stated review of the studies on the sustainable building have given a clear purview of the present situation. Not much work has been done on green buildings. It has been reviewed that the pre-eminence of eco structures has been observed around the globe. Various articles, journals, conference papers, books studied have shown that although efforts have been initiated on shifting the older building methods into green building techniques but adoption is not acquired at good pace. The conclusions derived shows that the implementation of sustainable building design is scarce because of unawareness and cost related issues. Further, research has been performed on justification of the objectives undertaken.

CHAPTER III

MATERIALS AND METHODS

The most important criteria for judging the value of any scientific study is undoubtedly the methods and procedures followed in investigating the problem. This consciousness truly helped the investigator design and conducts the study in hand, on scientific lines. In this chapter, the research methodology followed for carrying out the present investigation has been discussed under the following categories:

3.1 FIELD SURVEY

3.1 Locale of the study

3.2 Sample selection

3.3 Development of research instrument

3.4 Pre-testing of the instruments

3.5 Collection of data

3.6 Analysis of data

3.7 Statistical analysis of data

3.8 Operational definitions

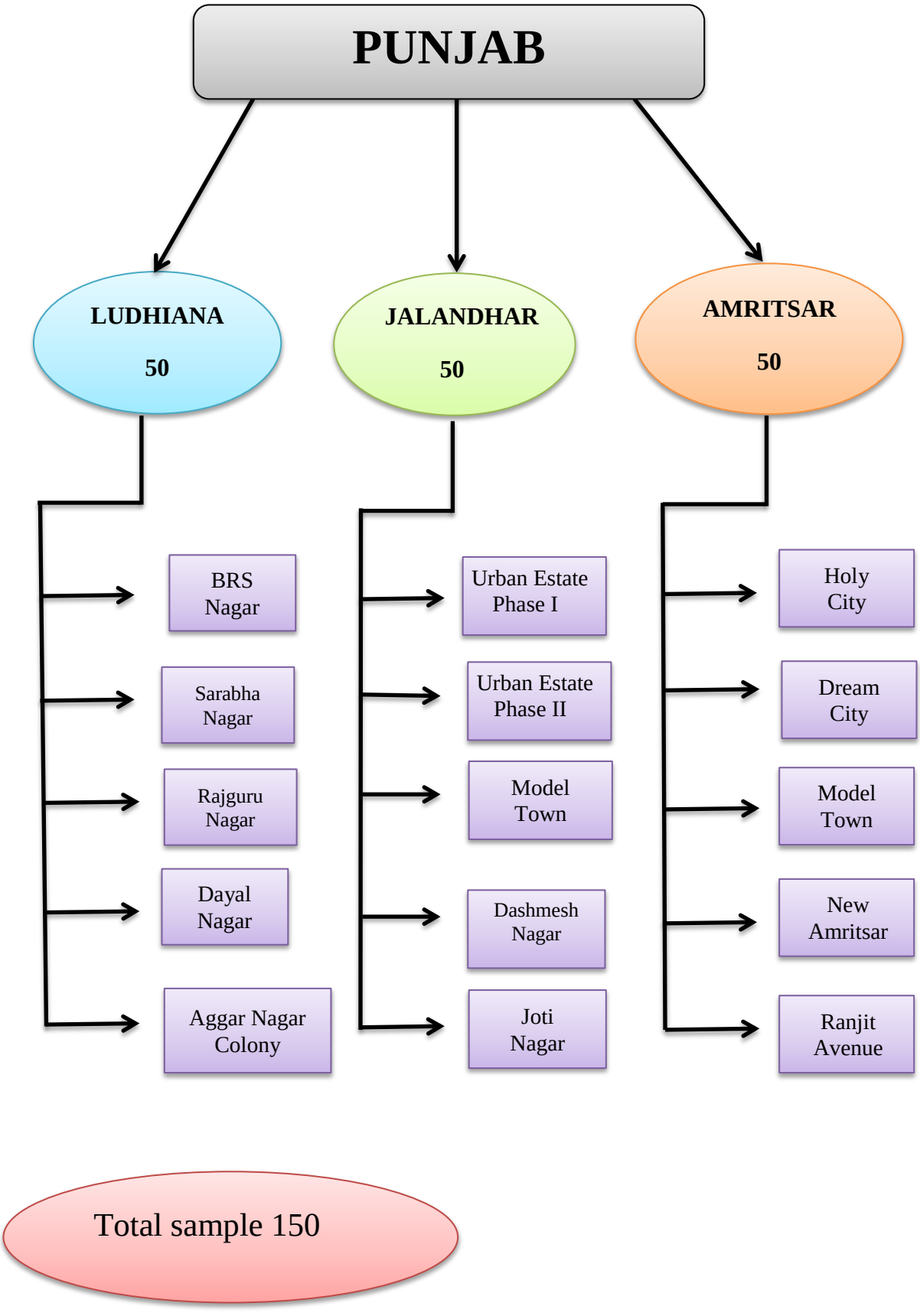
3.1 Field survey

3.1 Locale of study

The study was conducted in three smart cities of Punjab viz. Ludhiana, Jalandhar and Amritsar. From Ludhiana B.R.S Nagar, Sarabha Nagar, Raj Guru Nagar, Dayal Nagar and Aggar Nagar Colony areas were selected. Similarly from Jalandhar Urban Estate-phase I, Urban Estate-phase II, Model Town, Dashmesh Nagar and Joti Nagar areas were selected and from Amritsar Dream city, Model Town, Holy City, New Amritsar and Ranjit Avenue localities were selected.

3.2 Selection of the sample

Randomly fifty homes, which were constructed after 2015 were taken from posh localities of each of these cities comprising a total sample of 150. The localities were selected by knowing their reputation from local residents, architects, interior designers etc. The female in the family having major role in family decisions was taken as the respondent (based on some introductory talk with the family). The data got supplemented from male members of the family who had active role in house construction, architects and interior designers.


PUNJAB
LUDHIANA
50
JALANDHAR
50
AMRITSAR
50
BRS Nagar
Sarabha Nagar
Rajguru Nagar
Dayal Nagar
Aggar Nagar Colony
Urban Estate Phase I
Urban Estate Phase II
Model Town
Dashmesh Nagar
Joti Nagar
Holy City
Dream City
Model Town
New Amritsar
Ranjit Avenue
Total sample 150

3.3 Development of research instrument

A structured interview schedule was used to collect the relevant information from the respondents i.e dwellers of various localities. It consisted of two parts:

3.3.1 General Information

The first part of the interview schedule was focused on collecting the background information of the respondents like age, education, income, type & size of family and basic information about their house construction.

3.3.2 Specific Information

A structured interview schedule was developed to obtain the specific information to assess the adoption of green home norms in modern houses and the constraints faced by them in adoption of green home norms.

Part I: It was designed to derive information regarding the level of awareness of the respondents regarding the deteriorating environment and their concern for preserving it.

The questions were framed to know the level of awareness of the respondents about the environment in term of quality parameters of atmosphere, hydrosphere, lithosphere and biosphere.

Part II: It was designed to derive the information regarding adoption of green home norms in the modern houses.

The green home norms developed by the IGBC (The Indian Green Building Council) exclusively for residential sector were taken which are based on accepted energy and environmental principles and strikes a balance between known established practice and emerging concepts. The level of adoption of eco-friendly norms were studied in terms of, effective use of site resources, water conservation, energy efficiency, handling of household wastes, optional material utilization, design for healthy, comfortable and environment friendly homes.

Part III: It dealt with information regarding constraints in adoption of green home norms in the modern houses.

The appropriate questions were framed around initial cost of the green home technologies, level of awareness of respondents about these technologies, availability of materials or other related technologies for green homes in the Indian conditions, attitude of home owners about environment protection etc.

3.4 Pre-testing for research instrument

Prepared interview schedule was pre-tested before using it for actual data collection. The nine homes were selected from non-sampled houses to determine its suitability and accuracy. After pre-testing of interview schedule, necessary modification were made and final interview schedule was prepared.

3.5 Collection of data

Data were collected by personal interview and observation method through a structured interview schedule. Special efforts were made to get the appropriate response by explaining the various concepts to the respondents. Supplementary information from other family members was also collected to verify the data.

3.6 Analysis of data

The collected data pertaining to analysis the respondents how much they were aware or concerned about their deteriorating environment and their adopted practices or installment of eco-friendly materials/gadgets in their homes. The analysed data transfer to the master sheet. Their frequency of carrying according to the objective. The responses were ranked depending upon the type of questions**.**

- Three point scale i.e Somewhat, Quite a lot, and too much
- Four point of scale i.e. Don't know, Heard about, Know somewhat and Know in detail.
- Four point scale i.e. Little, Moderate, Acute, and No impact
- Three point scale i.e. Not aware, Aware and Know in details

At last, after analysed the data we found out how much respondents were aware/ concerned about the environment while constructing their house and the efforts were made by them to preserve our environment. The rank should be given to the smart cities on the basis of the respondent's adoption level in each cities.

3.7 Statistical analysis of data

Data were tabulated for systematic analysis. According to the objectives appropriate tables were formulated for moving towards the conclusions. Statistical tool applied were: frequencies and percentage.

3.7.1 Frequency and percentage

Frequency was worked out by calculating the number of the respondents belonging to a particular response category.

$$\frac{\text{Frequency}}{\text{Total number of respondents}} \times 100$$

3.7.2 Frequency distribution

A percentage is a way of expressing a number as a fraction of 100 (*per cent* meaning "per hundred")

3.8 Operational definitions

Green home:- A green home is a type of house designed to be environmentally sustainable. Green homes focus on the efficient use of "energy, water, and building materials". A green home may utilize sustainably sourced, environmentally friendly, and/or recycled building materials.

Energy efficiency:- It is the goal to reduce the amount of energy required to provide products and services.

Sustainable building design:- It refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. Design that seeks to minimize the negative environmental impact of buildings by efficiency and moderation in the use of materials, energy, water and indoor air quality.

CHAPTER IV

RESULT AND DISCUSSION

This chapter is devoted to discuss the results obtained by analyzing the data collected from the field. The result of the study have been presented and discussed under the four major headings:

4.1 General information of the respondents

4.2 Awareness regarding deteriorating environment and concern for preserving it.

4.3 Level of adoption of green homes norms in the modern houses.

4.4 Constraints in adoption of green homes norms in the modern houses.

4.1 General information of the respondents

This section includes socio-economic characteristics of the selected respondents. The entire data is presented in Table 4.1-4.3.

4.1.1 Socio-economic characteristics

It relates to information regarding socio-economic characteristics of the respondents which includes age, family type, education, occupation and annual income.

4.1.1.1 Age

Age is one of the most important characteristics which impacts one's decisions. Data in Table 4.1 depicts that majority (55.34 %) of the respondents belong to age group above 50 years followed by 39.33 per cent of the respondents who belong to age group in between 40-50 years and 5.33 per cent respondents who belong to age group in between 30-40 years.

4.1.1.2 Education

Decisions related to adoption of green home norms directly get influenced by one's educational level. Data related to educational level of respondents is presented in table 4.1. Majority (62%) of the respondents were educated up to Post Graduation followed by graduate (12.67%) while (25.33%) were doctorate.

4.1.1.3 Occupation

Business was the major occupation for most of the selected families. Majority of the families (65.33%) were engaged in business while some of the families (34.67%) had their jobs.

4.1.1.4 Family type

Majority of the respondents (60.67%) belonged to joint families and 39.33 percent of respondents belonged to nuclear families.

4.1.1.5 Annual Income

Income plays an important role in shaping the economic conditions of family. It was observed that 71.33 per cent of the families earned their annual income in between Rs. 1400000-1700000 followed by 18.67 percent earned their income up to Rs. 1300000 and 10 per cent of the families earned between Rs 1800000-2100000 annually.

Table 4.1: Distribution of the respondents on the basis of their socio-economic characteristics (N=150)

Sr.no	Socio-personal characteristics	Category	Frequency (F%)
1	**Age (Years)**	30- 40	8(5.33)
		40-50	59(39.33)
		More than 50	83(55.34)
2	**Education**	Doctorate	38(25.33)
		Post Graduation	93(62.00)
		Graduation	19(12.67)
3	**Occupation**	Service	52 (34.67)
		Business	98 (65.33)
4	**Family type**	Nuclear	59(39.33)
		Joint	91(60.67)
5	**Annual income (Rs.)**	Up to 1300000	28(18.67)
		1400000-1700000	107(71.33)
		1800000-2100000	15(10.00)

(Figure in parentheses depicts percentage)

4.1.1.6 Respondents according to the housing requirements

Respondents (39.33%) had 4001-4500 square feet of total area of plot and mostly were constructed their area 2501-3500 square feet (52.67%). The majority (56%) of house were taken which were two or in between three year old and majority (64%) of house had double storey building. All respondents were hired architects but with that most (52%) of the respondents were also hired the designers . Mostly (60%) water supplied by municipal in their houses but both provision were also there. Most (60.67%) of the respondents had 750 liters water storage capacity. Respondents (9.33%) had water tank overflow alarm.

Table 4.2: Distribution of the respondents according to their housing requirements

(N=150)

Sr.no	Housing requirements	Category	Frequency (%)
1	**Total area of plot (Sq.feet)**	3500-4000	38(25.33)
		4001-4500	59(39.33)
		4501-5000	53(35.33)
2	**Constructed area (Sq.feet)**	1500-2500	15(10.00)
		2501 -3500	79(52.67)
		3501-4500	52(34.67)
		More than 4500	4(2.66)
3	**Age of the house (years)**	Less than 1	19(12.67)
		1-2	47(31.33)
		2-3	84(56.00)
4	**No. of floors**	Single	54(36.00)
		Double	96(64.00)
5	**Professionals hired**	Architect	150(100.00)
		Interior designer	78(52.00)
		Landscape designer	28(18.67)
		Energy planner	0(0.00)
		Green building consultant	0(0.00)
		Vastu experts	7(4.67)
6	**Source of water supply**	Underground	0(0.00)
		Municipal	90(60.00)
		Both	60(40.00)
7	**Water storage capacity (liters)**	500	8(5.33)
		750	91(60.67)
		1000	51(34.00)
8	**Mechanism to stop over flow of water**	Water Tank overflow alarm	14(9.33)
		Wireless water level indicator	0(0.00)

(Figure in parentheses depicts percentage)

4.2 Level of awareness of the respondents regarding deteriorating environment and their concern for preserving it.

4.2.1 Perception about changes in environment

Knowledge and awareness level of an individual about the phenomena and severity of change in any system motivates him/her to contribute for the betterment of that system. Perception of respondents about the level of change in the environment was studied and relevant data presented in table 4.3.

Table 4.3: Distribution of respondents according to their perception about changes in environment (N=150)

Parameters	Perception about change in environment		
	Somewhat (F%)	Quite a lot (F%)	Too much (F%)
Level of increase of pollution			
Air pollution	4(2.67)	65(43.33)	81(54.00)
Water pollution	9(6.00)	55(36.67)	86(57.33)
Soil pollution	7(4.67)	59(39.33)	84(56.00)
Noise pollution	15(10.00)	77(51.33)	58(38.67)
Health problem have increased	9(6.00)	74(49.33)	67(44.67)
Change in extreme temp. in different season	17(11.33)	78(52.00)	55(36.67)

(Figure in parentheses depicts percentage)

The examination of data reveals that majority of the respondents (54%, 57.33%, 56%) were finding the level of air, water and soil pollution alarmingly high respectively and were found to be geared up for their efforts for protecting the environment. Some of the respondents (38.67%) reported the menace of noise pollution due to traffic and high pitch of music during social events. About forty nine per cent respondents perceived the level of health problems due to environmental impact ‘quite high’, whereas fifty two per cent respondents informed that the change in extreme temperature in both the season was quite evident and disturbing.

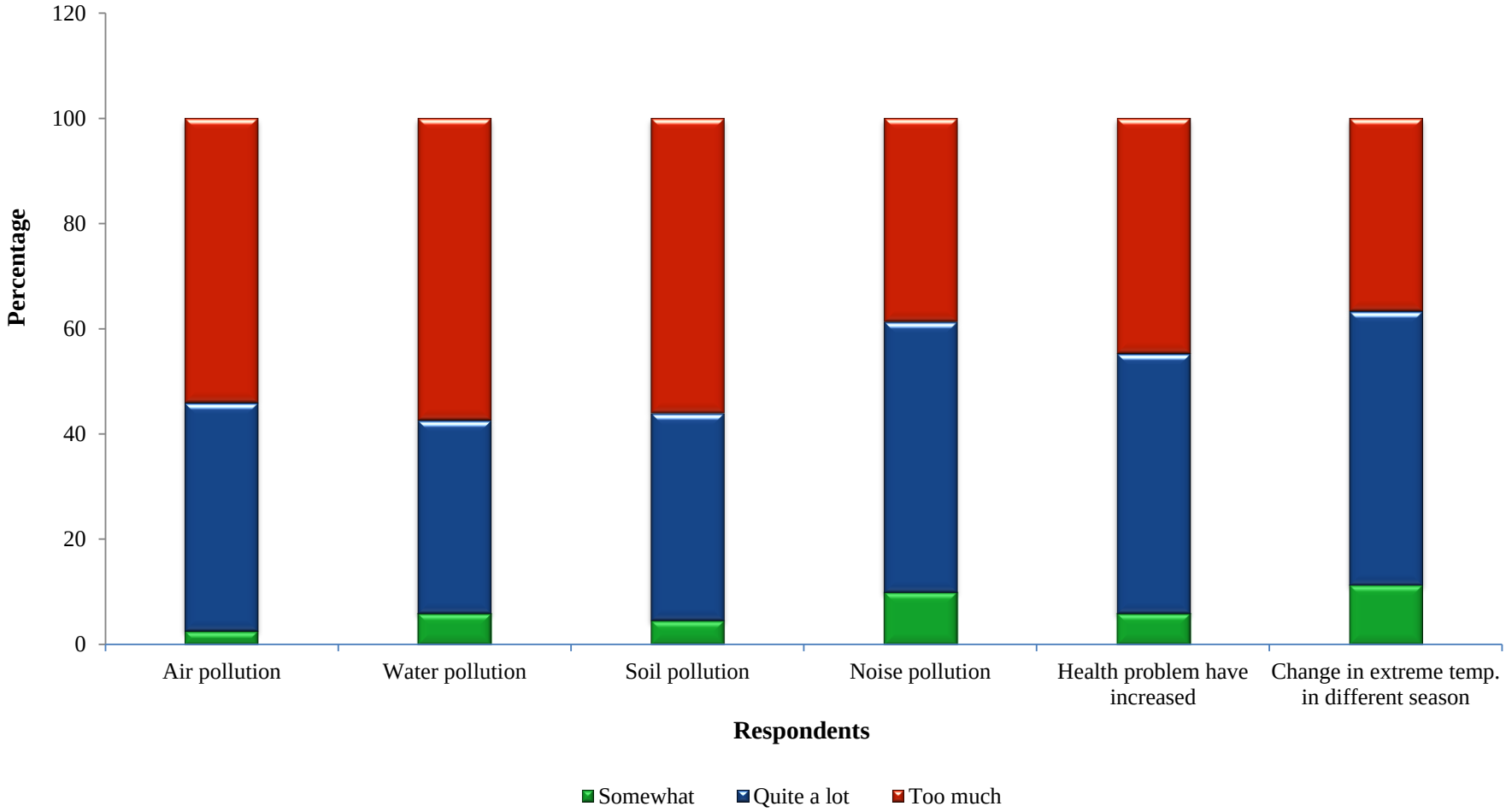


Fig 1: Awareness level of the respondents regarding deteriorating environment and their concern for preserving it

4.2.2 Opinion about the causes of pollution

Actions originate from opinions. So what were the opinions of respondents about the causes of environmental pollution were enquired about of and relevant data presented in table 4.4.

Table 4.4: Distribution of respondent according to their opinion about the causes of pollution (N=150)

Cause of pollution	Ranking given by respondents				
	1 F(%)	2 F(%)	3 F(%)	4 F(%)	5 F(%)
Agricultural operations	80(53.33)	70(46.67)	0(0.00)	0(0.00)	0(0.00)
Industry	50(33.33)	79(52.67)	20(13.33)	1(0.67)	0(0.00)
Housing	0(0.00)	0(0.00)	1(0.67)	114(76)	35(23.33)
Transportation	20(13.33)	1(0.67)	129(86.00)	0(0.00)	0(0.00)
Consumptive style of living	0(0.00)	0(0.00)	0(0.00)	35(23.33)	115(76.67)

(Figure in parentheses depicts percentage)

Majority of respondents (53.33%) found agricultural operations, especially burning of straw as the main culprit of air pollution followed by exhaust from industrial house chimneys and disposal of effluents in water streams (52.67%). Respondents (86%) opined that exhaust from vehicles during transportation was the third major cause of pollution.

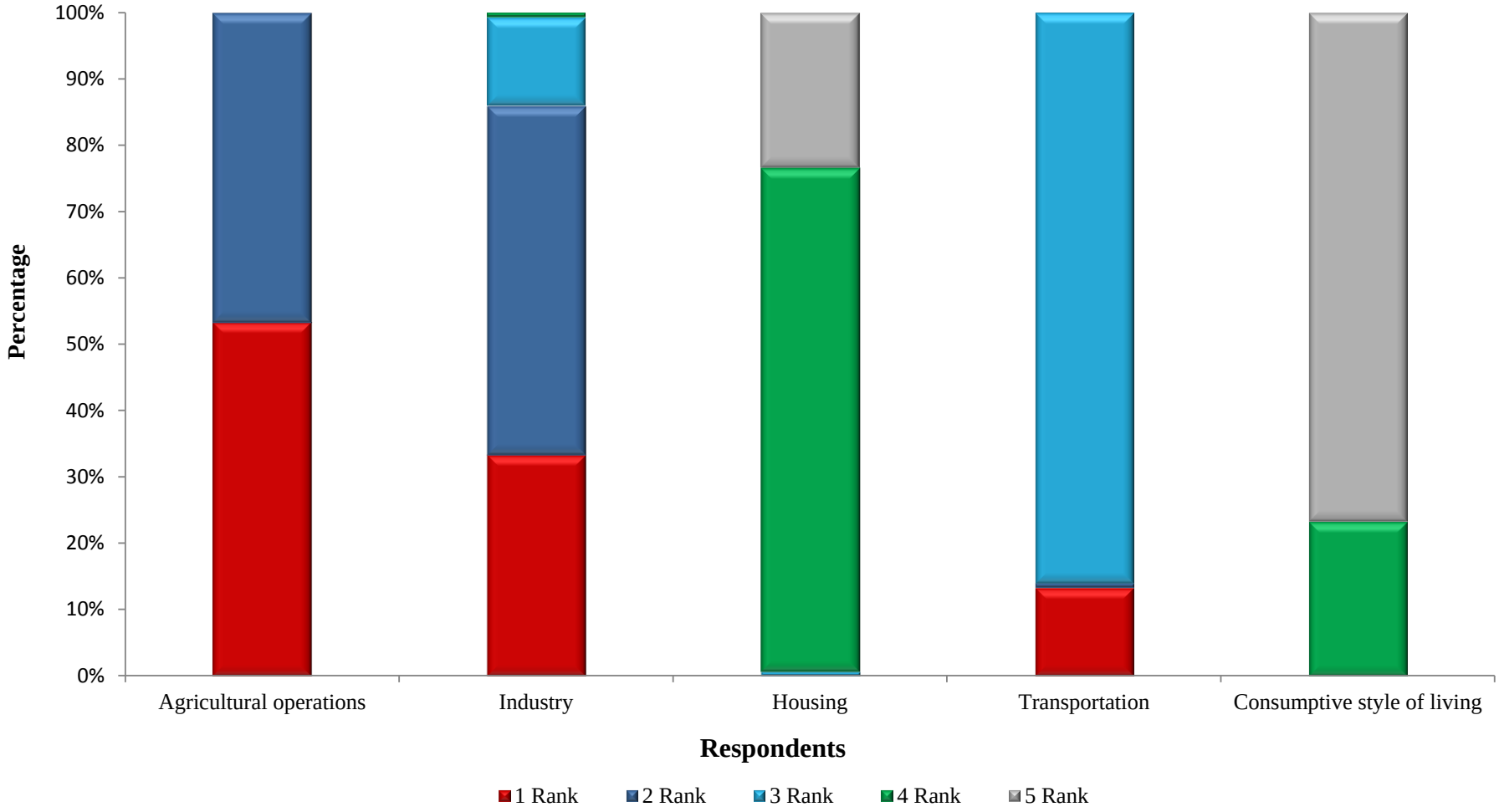


Fig 2: Opinion of the respondents about the causes of pollution

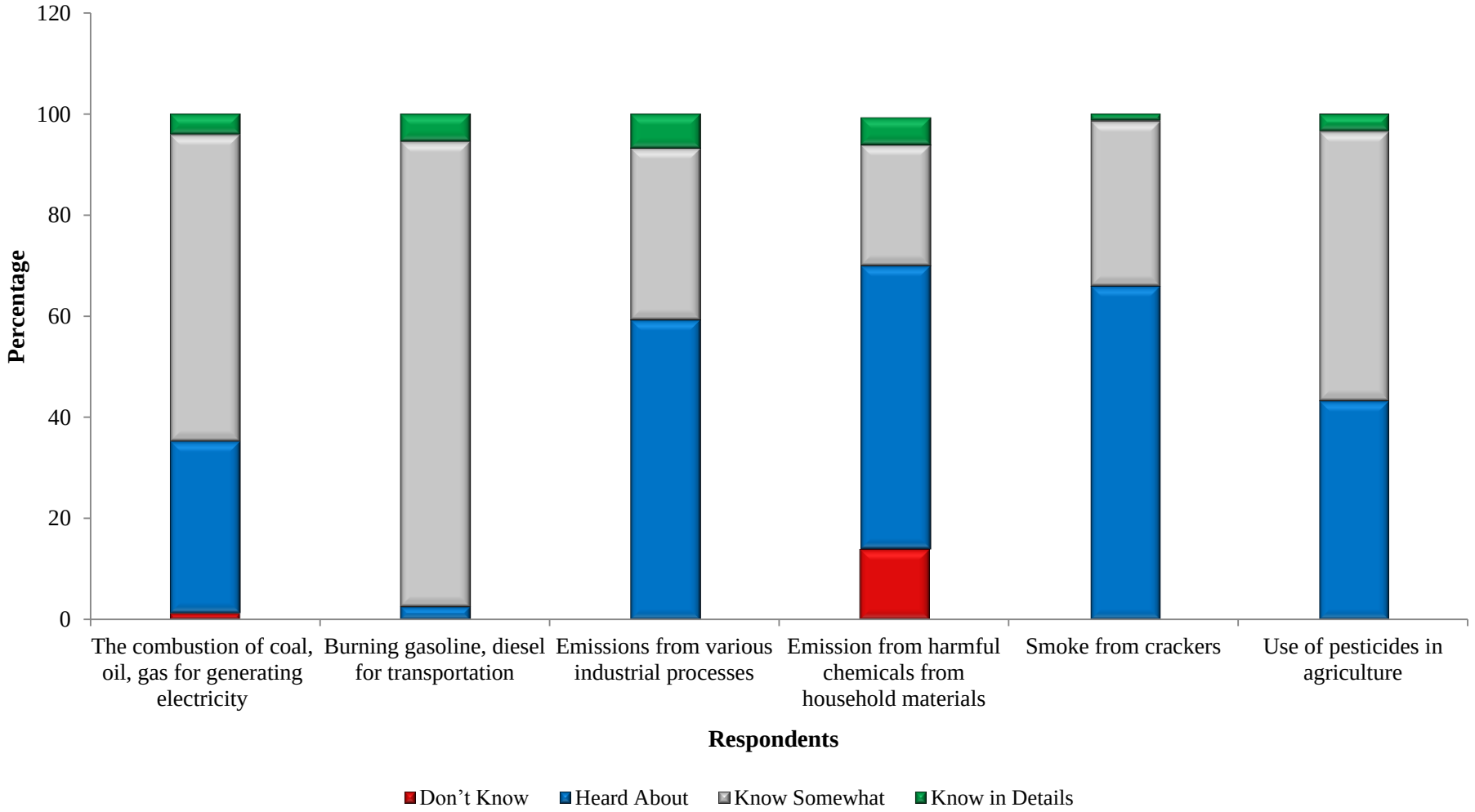
4.2.3 Level of awareness about major causes of pollution

A deep knowledge of an issue prompts action in the mind of an individual to work for it. The level of awareness of respondents about the causes of different types of pollution was studied and presented in table 4.5.

Table 4.5: Distribution of respondents according to their level of awareness of major causes of pollution

Causes	Level of awareness			
	Don't Know (F%)	Heard About (F%)	Know Somewhat (F%)	Know in detail (F%)
Air pollution The combustion of coal, oil, gas for generating electricity	2(1.33)	51(34.00)	91(60.67)	6(4.00)
Burning gasoline, diesel for transportation	0(0.00)	4(2.67)	138(92.00)	8(5.33)
Emissions from various industrial processes	0(0.00)	89(59.33)	51(34.00)	10(6.67)
Emission from harmful chemicals from household materials	21(14.00)	84(56.00)	37(24.00)	8(5.33)
Smoke from crackers	0(0.00)	99(66.00)	49(32.67)	2(1.33)
Use of pesticides in agriculture	0(0.00)	65(43.33)	80(53.33)	5(3.33)
Water pollution Release of Industrial waste into water bodies	5(3.33)	81(54.00)	60(40.00)	4(2.67)
Release of untreated Sewage and waste water	31(20.00)	64(42.67)	50(33.33)	5(3.33)
Marine dumping	14(9.33)	60(40.00)	68(45.33)	8(5.34)
Excessive use of Chemical fertilizers and pesticides in agriculture	0(0.00)	53(35.33)	90(60.00)	7(4.67)
Presence of underground heavy metals	2(1.33)	76(50.67)	66(44.00)	6(4.00)
On-site sanitation systems	20(13.33)	75(50.00)	51(34.00)	4(2.67)
Eutrophication	116(77.33)	30(20.00)	3(2.00)	1(0.67)
Accidental spills	18(12.00)	75(50.00)	53(35.55)	4(2.67)
Soil pollution Direct discharge of industrial wastes to the soil	19(12.67)	53(35.33)	72(48.00)	6(4.00)
Discharge of sewage sludge	14(9.33)	83(55.33)	44(29.33)	9(6.00)
Landfill and illegal dumping	2(1.33)	94(62.67)	47(31.33)	7(4.67)
Construction activities	10(6.67)	83(55.33)	46(30.67)	11(7.33)
Some Agricultural practices	6(4.00)	83(55.33)	47(31.33)	14(9.33)
Accidental spills	16(10.67)	73(48.67)	52(34.67)	9(6.00)
Noise pollution Industrial sources	10(6.67)	81(54.00)	49(32.67)	10(6.67)
Transport vehicles	0(0.00)	45(30.00)	89(59.33)	16(10.67)
Household appliances	44(29.33)	92(61.33)	10(6.67)	4(2.67)
Agricultural machinery	2(1.33)	109(72.67)	37(24.67)	2(1.33)
Construction works	1(0.67)	92(61.33)	54(36.00)	3(2.00)
Public functions	0(0.00)	81(54.00)	62(41.33)	7(4.67)

The perusal of data reveals that majority of the respondents i.e. 92%, 60.67%,53.33% had just a casual knowledge about burning gasoline, diesel for transportation, the combustion of coal, oil, gas for generating electricity and use of pesticides in agriculture as a cause of air pollution respectively. Only one to seven per cent respondents knew good detail about the various causes of air pollution. Majority of the respondents (60%) were found to be somewhat aware about the excessive use of chemical fertilizers and pesticides in agriculture, but more than half of the respondents were there who had a poor knowledge about the various causes of water pollution and maximum respondents did not know about the eutrophication. Most of the respondents (62.67%, 55.33%, 55.33%) were found to be heard about the landfill and illegal dumping, some agricultural practices and construction activities. Only a few respondents knew somewhat or in detail about the various causes of soil pollution. Majority of the respondents (72.67%) blamed the agricultural machinery to generated the noise pollution. Only few respondents were there who had good knowledge about the various causes of noise pollution. There were poor per cent of respondents who know in detail about the major causes of pollution i.e (10.67%, 9.33%, 6.67%).


120
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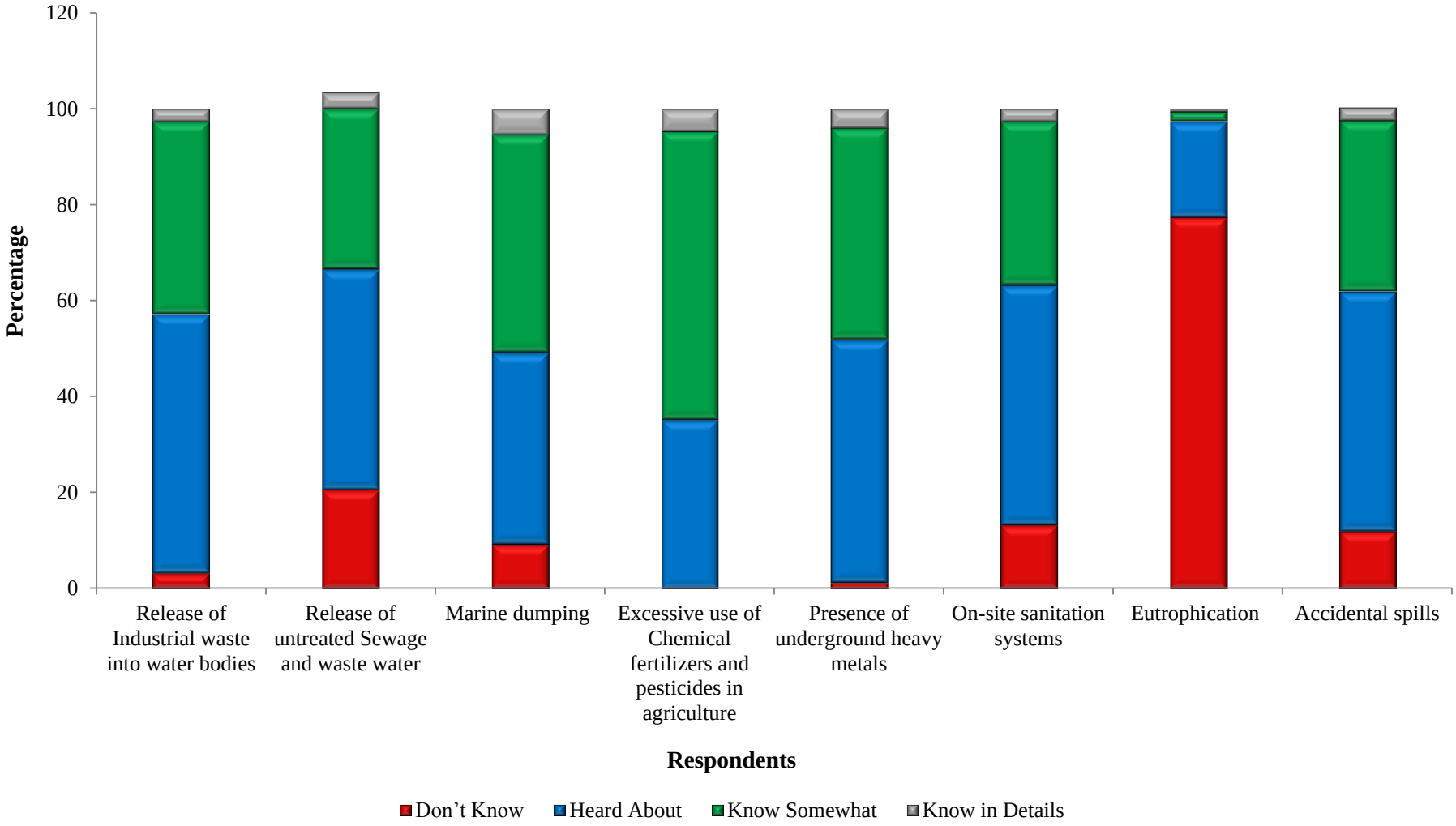
Percentage
The combustion of coal, oil, gas for generating electricity
Burning gasoline, diesel for transportation
Emissions from various industrial processes
Emission from harmful chemicals from household materials
Smoke from crackers
Use of pesticides in agriculture
Respondents
Don't Know
Heard About
Know Somewhat
Know in Details


120
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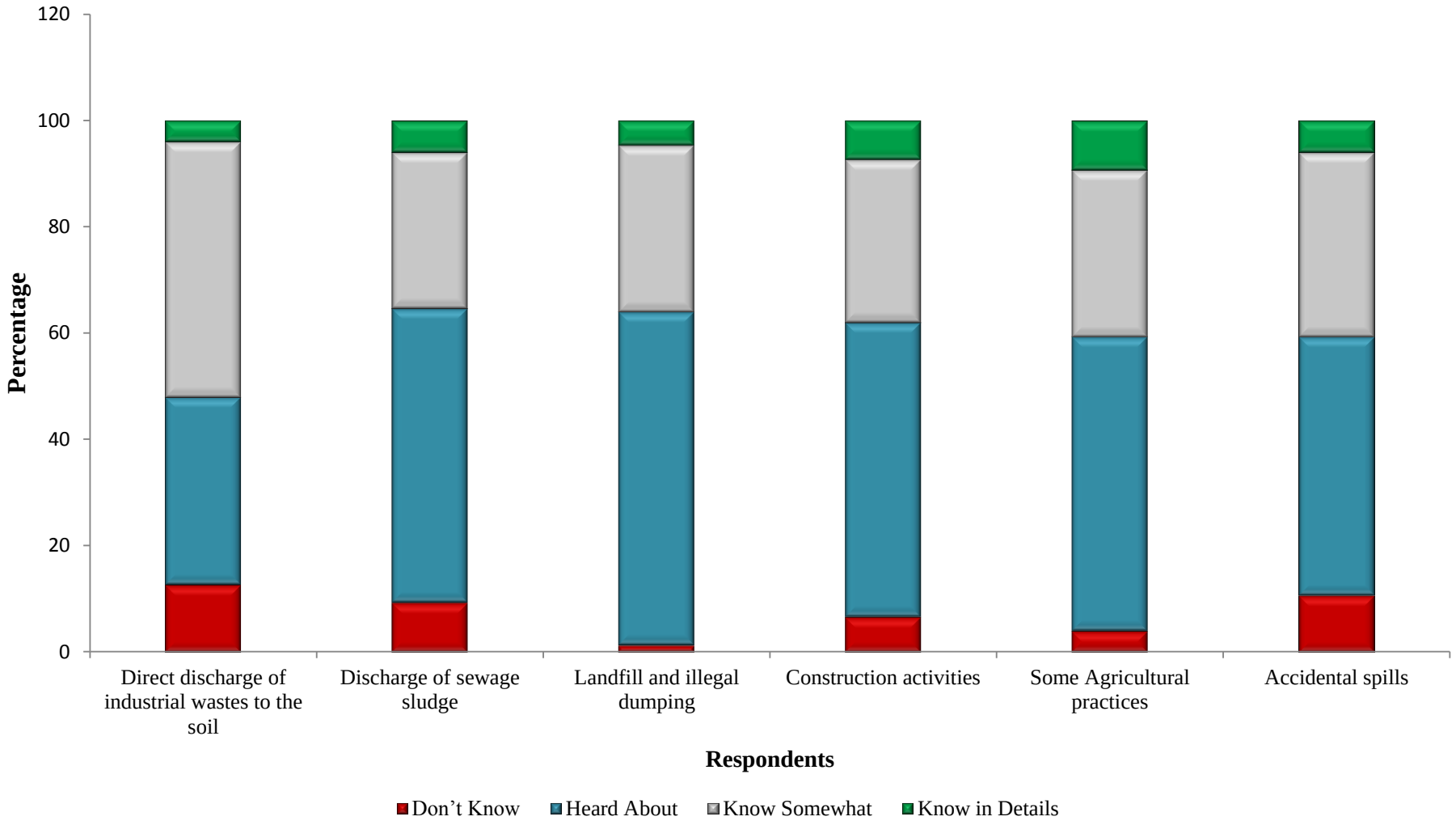
Percentage
Release of Industrial waste into water bodies
Release of untreated Sewage and waste water
Marine dumping
Excessive use of Chemical fertilizers and pesticides in agriculture
Presence of underground heavy metals
On-site sanitation systems
Eutrophication
Accidental spills
Respondents
Don’t Know
Heard About
Know Somewhat
Know in Details


120
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Percentage
Direct discharge of industrial wastes to the soil
Discharge of sewage sludge
Landfill and illegal dumping
Construction activities
Some Agricultural practices
Accidental spills
Respondents
Don't Know
Heard About
Know Somewhat
Know in Details

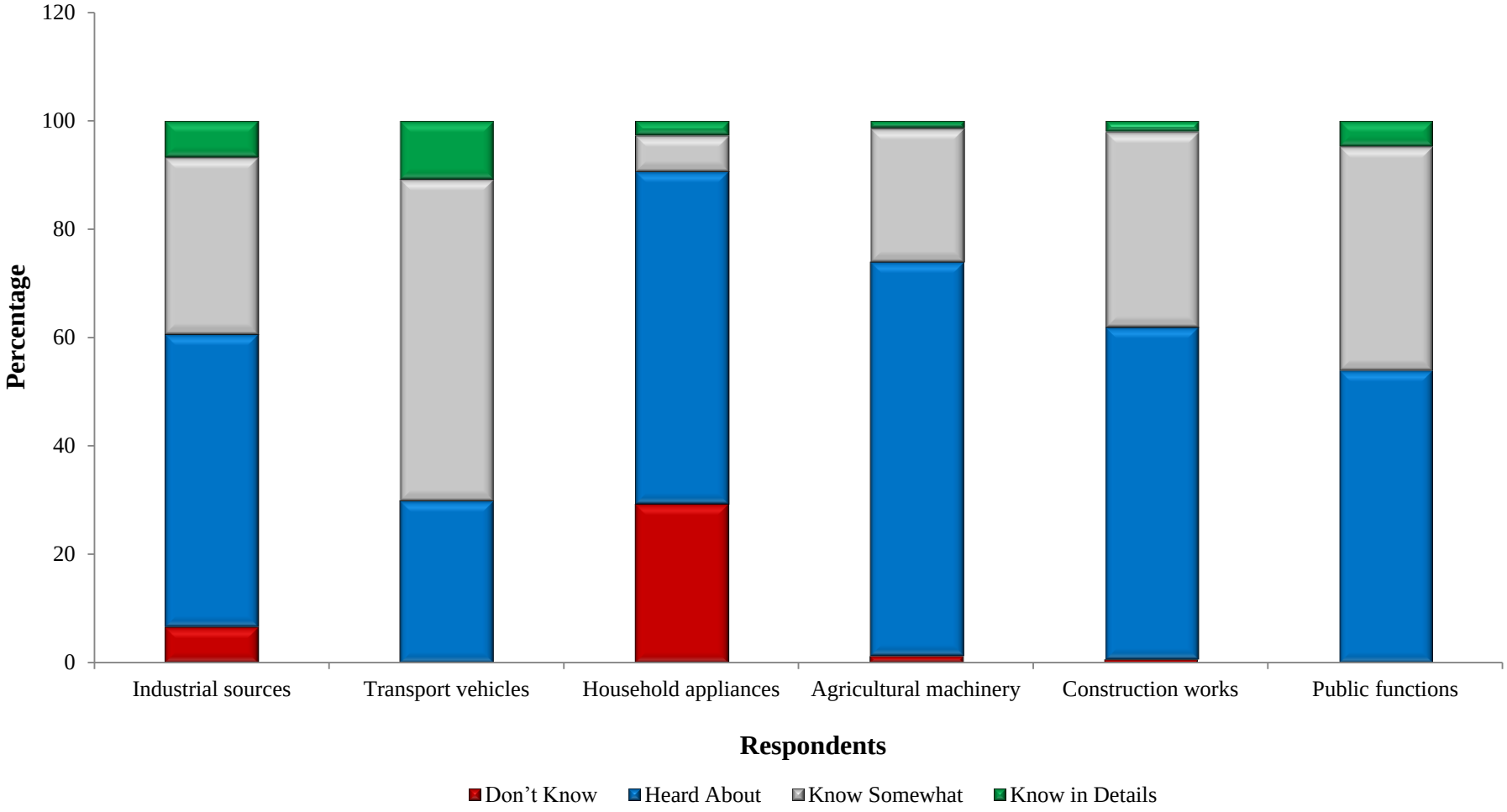

Fig 3: Awareness level of the respondents according major causes of pollution

4.2.4 Impact of deteriorating environment on the their health

Deteriorating environment is impacting human health in many ways, Data were collected to check the experience of the respondents about the impact of changing environment on their psychological and physical health and presented in table 4.6.

Table 4.6: Distribution of respondents according to their experience of impact of deteriorating environment on the their health (N=150)

Impact on health	Level of impact of deteriorating environment on their health			
	No Impact F(%)	Little F(%)	Moderate F(%)	Acute F(%)
Psychological health				
Insomnia	72(48.00)	40(26.67)	28(18.67)	10(6.67)
Depression	1(0.66)	130(86.67)	19(12.67)	0(0.00)
Physical health				
Asthma	148(98.67)	0(0.00)	2(1.33)	0(0.00)
Allergies	55(36.67)	25(16.67)	70(46.67)	0(0.00)
Cancers	150(100.00)	0(0.00)	0(0.00)	0(0.00)
Skin diseases	43(28.67)	40(26.67)	67(44.67)	0(0.00)
Lung diseases	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Hearing impairment	0(0.00)	0(0.00)	0(0.00)	0(0.00)

(Figure in parentheses depicts percentage)

The perusal of data revealed that psychological health of most of the respondents has not yet been much impacted with little signs of depression and Insomnia in case of 86.67% and 26. 67% respondents. Whereas more serious effects on physical health in the form of asthma (98.67% respondents facing different levels of asthma attacks during crop residue burning times) was reported. Incidentally, none of the respondents reported Skin diseases (26.67%). Some respondents had moderate health issues level like allergies (46.67%) and skin diseases (44.67%) because of pollution and their bodies is not adapting. Only 6.67 per cent respondents were suffering from acute insomnia.

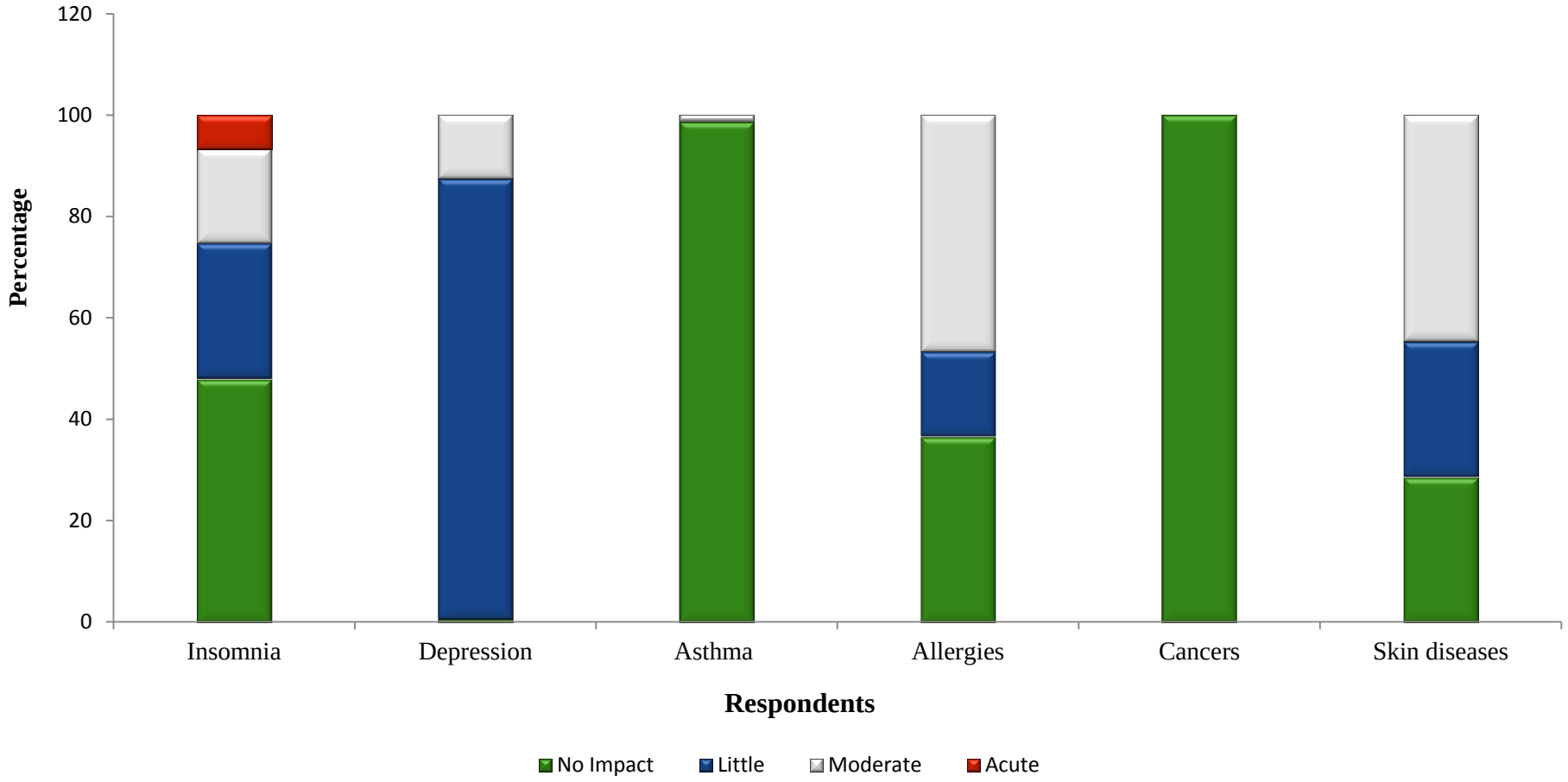

Fig 4: Impact of deteriorating environment on the respondents' health

4.2.5 Knowledge about contribution of pollution by the household use of products

Awareness about the problem is the first step for combating it. So data were collected to assess the level of awareness of respondents about the contribution of various household products like air fresheners, household cleaners, polishing agents, detergents, insect repellents and refrigerants in polluting the environment and their efforts to avoid the use of harmful chemicals.

Table 4.7: Distribution of respondents according to their level of knowledge about contribution of pollution by the use of household use of products

(N=150)

Household Product	Level of awareness			
	Don't know (F%)	Know the constituent chemicals of the product F(%)	Know general impact of chemical on health/env. F(%)	Do efforts to avoid use of harmful chemicals F(%)
Air fresheners	76(50.00))	9(6.00)	46(30.67)	19(12.6)
Household Cleaners	123(82.00)	12(8.00)	15(10.00)	0(0.00)
Polishing agents	129(86.00)	7(4.67)	14(9.33)	0(0.00)
Detergents	90(60.00)	9(6.00)	51(34.00)	0(0.00)
Insect repellents	40(26.67)	8(5.33)	71(47.33)	31(20.67)
Refrigerants	0(0.00)	30(20.00)	41(27.33)	80(53.33)

(Figure in parentheses depicts percentage)

The perusal of data reveals that only a few respondents knew about the chemical constitution of various products like air fresheners (6%), household cleaners (8%), polishing agents (4.67), detergents (6%), insect repellents (5.33%) and refrigerants (20%). Majority of the respondents don't know about the constituent chemicals of the household products and general impact on health or environment for example household cleaners (82%), polishing agents (86%), detergents (60%) and air fresheners (50%). Some of the respondents know about the general impact of chemical on health or environment and only few respondents made efforts to avoid use of harmful chemicals which is presented in table 4.7.

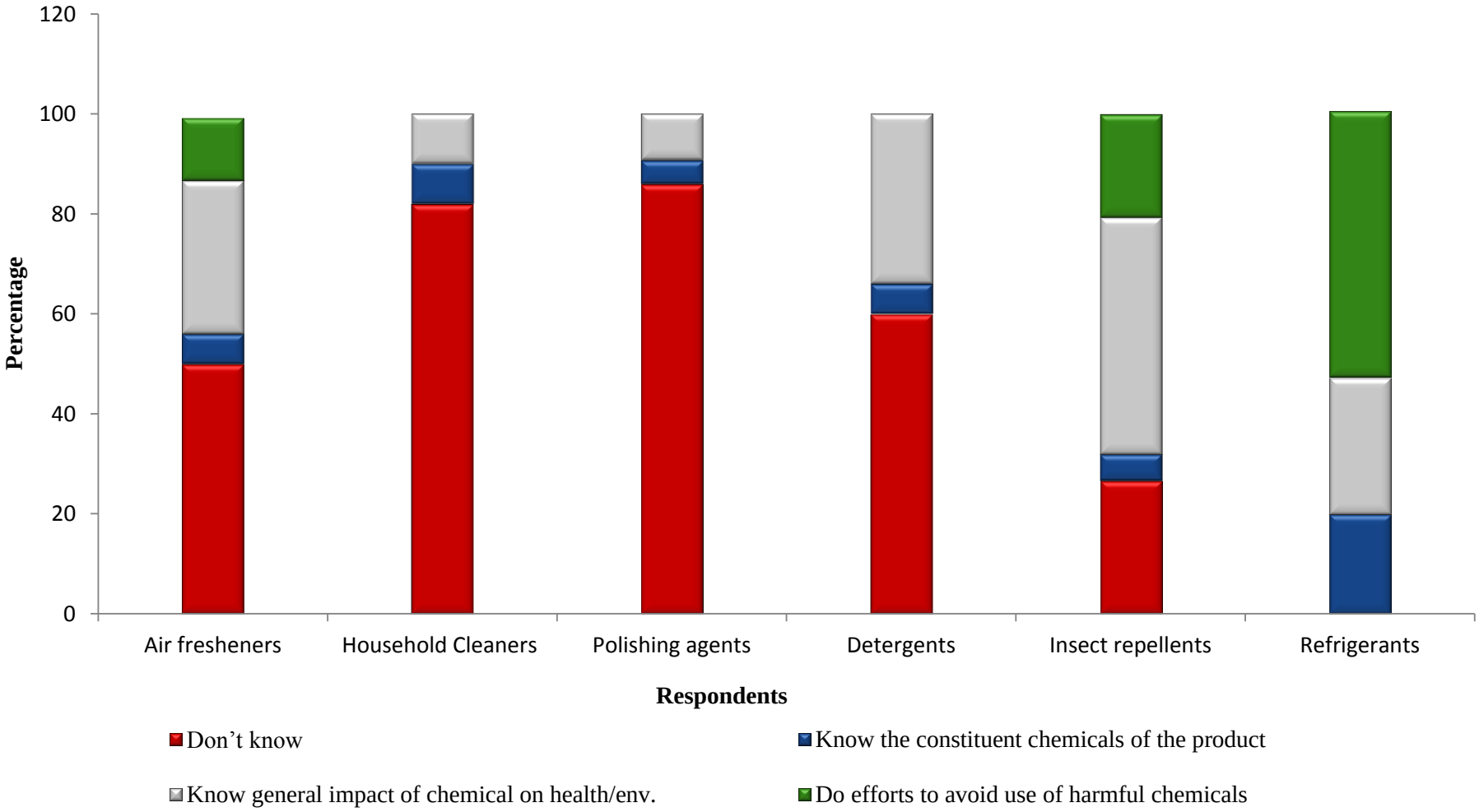

Fig 5: Knowledge level of the respondents in contribution of pollution by the use of household products

4.2.6 Level of awareness about role of plants in conserving environment

The data were collected to check the awareness level of the respondents regarding the role of the plants in conserving environment.

Table 4.8: Distribution of respondents according to their level of awareness about role of plants in conserving environment (N=150)

Role of plants	Level of awareness		
	Heard about F(%)	Experienced the effect F(%)	Know good detail F(%)
Outdoor plants			
Reduce carbon dioxide levels	0(0.00)	111(74.00)	39(26.00)
Increase humidity causes rain	0(0.00)	129(86.00)	21(14.00)
Reduce level of certain pollutants	0(0.00)	133(88.66)	17 (11.33)
Keep air temperature down	0(0.00)	139(92.67)	11(7.33)
Prevent soil erosion	0(0.00))	89(59.20)	61(40.67)
Reduce stress level	15(10.00)	125(83.33)	10(6.67)
Absorb noise	3(2.00)	129(86.00)	18(12.00)
Indoor plants			
Lends pleasing surrounding	0(0.00)	140(93.33)	10(6.67)
Help to detoxify the air	0(0.00)	119(79.00)	31(20.67)
Provide oxygen	0(0.00)	0(0.00)	150(100.00)
Reduce air pollution by absorbing capacity	0(0.00)	140(93.33)	10(6.67)

(Figure in parentheses depicts percentage)

The data revealed that almost all respondents were aware of the role of plants in reduce carbon dioxide levels, increase humidity causes rain, reduce level of certain pollutants, keeping the air temperature down, prevent soil erosion, reduce the stress level, absorb noise, lends pleasing surrounding, help to detoxify the air, provide oxygen, reduce air pollution by absorbing capacity. The perusal of data reveals that only a few respondents were having the good knowledge about the role of plants like reducing carbon dioxide levels (26%), increasing humidity causes rain (14%), reducing level of certain pollutants (11.33%), keeping air temperature down (7.33%), prevent soil erosion (40.67%), reduce stress level (6.67%), absorb noise (12%), lends pleasing surrounding (6.67%), help to detoxify the air (20.67%) and reduce air pollution by absorbing capacity (6.67%). Majority of the respondents had experienced that the role of indoor plants helps to reduce the indoor air pollution by absorbing capacity followed by almost all the respondents were aware about the role of indoor plants i.e. lends pleasing surrounding (93.33%) and helps to detoxify the air (79%). Whereas, 20.67 per cent of the respondents had detail knowledge about the role of indoor plants which helps to detoxify the air and reduce air pollution by absorbing capacity (6.67%). Some of respondents were not aware, which is presented in table 4.8.

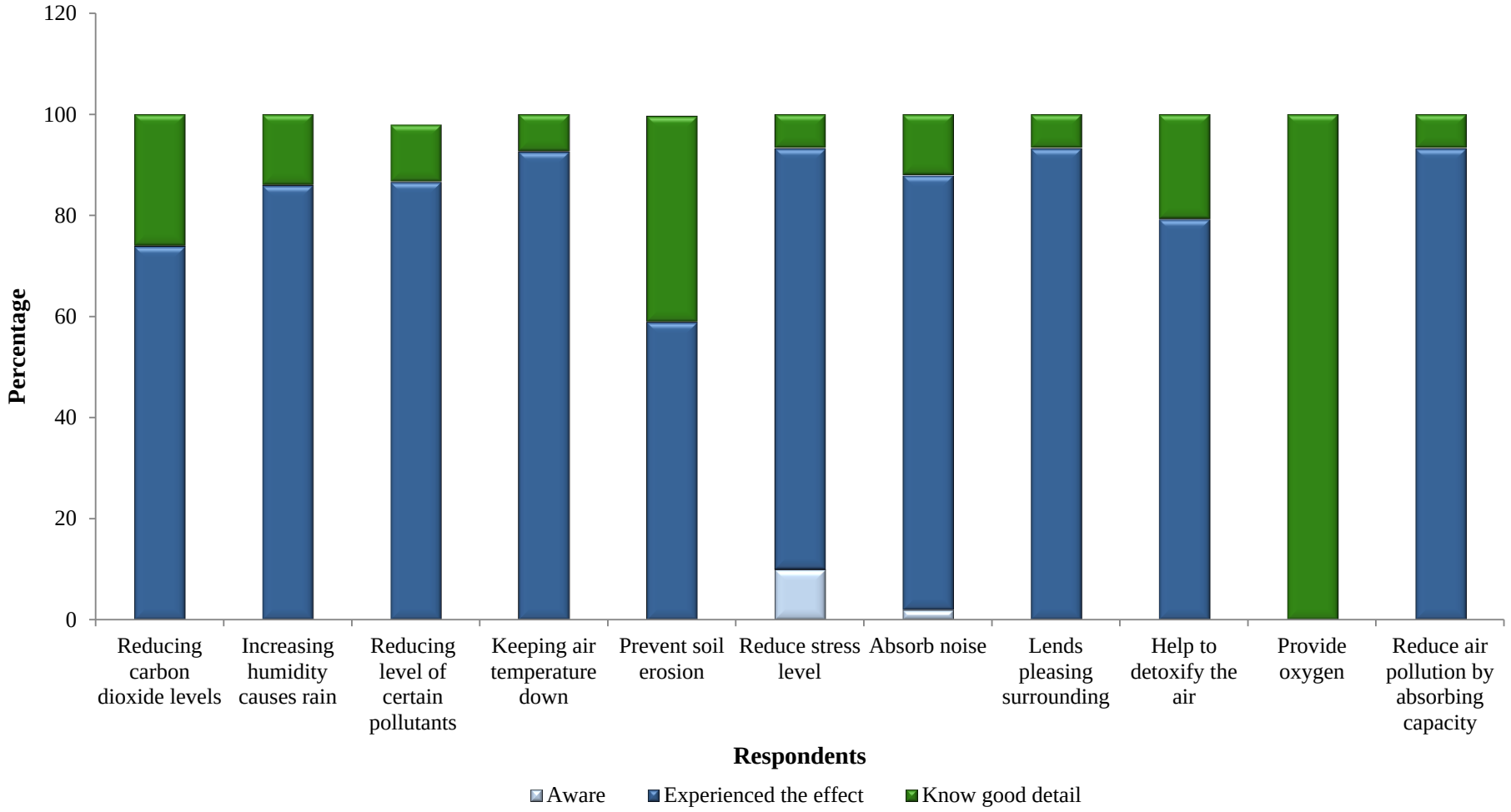

Fig 6: Awareness level of the respondents in role of plants in conserving environment

4.2.7 Level of concern about conserving environment through their efforts

The conservation of the environment has increasingly become a vital concern. People need to take interest in being "green". So data were collected to assess the level of awareness of the respondents about the practices like putting off the air conditioner and bear hot weather, prefer to travel by public transport, go for shopping with due arrangement to avoid use of plastic bags, refrain from using plastic (use and throw) crockery, prefer to keep family celebrations simple, prefer to share special feelings with others through gestures or digital messages rather than gifts, avoid wrapping of gifts with non-biodegradable materials and dispose household waste after due segregation and believe in the philosophy of re-use and recycle with a concern to save environment.

Table 4.9: Distribution of respondents according to their level of concern about conserving environment through their efforts (N=150)

I follow the following practices with a concern to save environment	Level of concern		
	Always F(%)	Sometimes F(%)	Never F(%)
Put off the air conditioner and bear hot weather	6(4.00)	62(41.33)	82(54.66)
Prefer to travel by public transport	4(2.67)	70(46.67)	76(50.67)
Go for shopping with due arrangement to avoid use of plastic bags	39(26.00)	83(55.33)	28(18.67)
Refrain from using plastic (use and throw) crockery	15(10.00)	86(57.33)	49(32.67)
Prefer to keep family celebrations simple	7(4.67)	109(72.67)	34(16.00)
Prefer to share my special feelings with others through gestures or digital messages rather than gifts	3(2.00)	94(62.67)	53(35.33)
Avoid wrapping of gifts with non-biodegradable materials	3(2.00)	19(12.67)	128(85.33)
Dispose household waste after due segregation	7(4.67)	85(56.67)	58(38.67)
Servicing electric appliances regularly to conserve energy	0(0.00)	150(100.00)	0(0.00)
Attend any green consumerism awareness organization and camp	0(0.00)	4(2.67)	146(97.33)

(Figure in parentheses depicts percentage)

The data revealed that majority of respondents were never efforts to conserve their environment for example putting off the air conditioner and bear hot weather (54.66%), prefer to travel by public transport (50.67%) and avoid wrapping of gifts with non-biodegradable materials (85.33%). Respondents, “sometimes” put off the air conditioner and bear hot weather (4%), prefer to travel by public transport (2.67%), go for shopping with due arrangement to avoid use of plastic bags (26%), refrain from using plastic (use and throw) crockery (10%), prefer to keep family celebrations simple (4.67%), prefer to share my special feelings with others through gestures or digital messages rather than gifts (2%), avoid wrapping of gifts with non-biodegradable materials (4.67%). Only few respondents were always efforts to conserve their environment like putting off the air conditioner and bear hot weather (4%), prefer to travel public transport (2.67%), go for shopping with due arrangement to avoid use of plastic bags, refrain from using plastic (use and throw) crockery (10%) , prefer to keep family celebrations simple (4.67%), prefer to share special feelings with others through gestures or digital messages rather than gifts, avoid wrapping of gifts with non-biodegradable materials, dispose household waste after due segregation. Some (4.67%) of the respondents made efforts sometime to conserve their environment, which is presented in table 4.9.

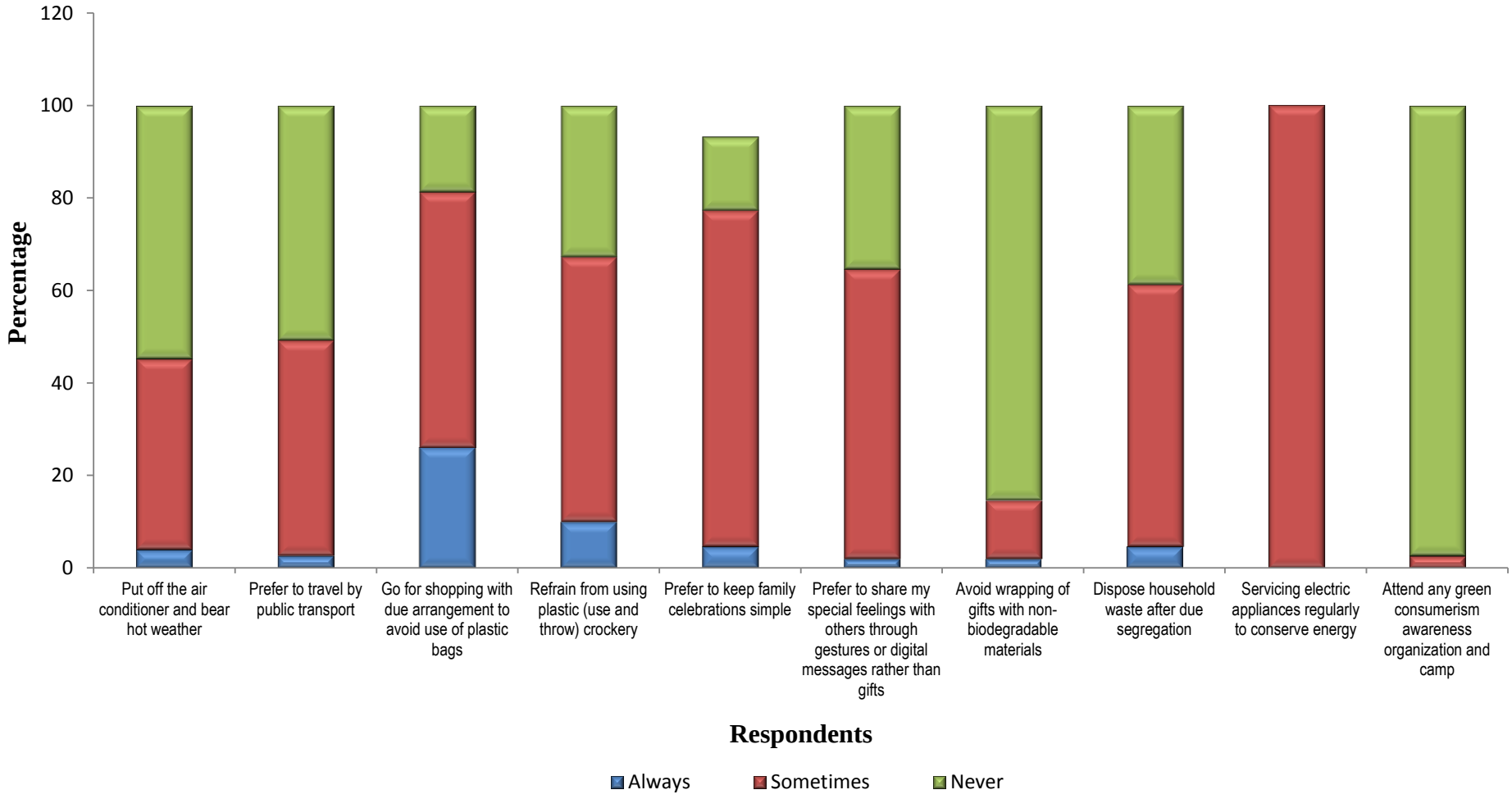

Fig 7: Concern level of the respondents in conserving environment through their efforts

4.3 To determine the level of adoption of green homes norms in the modern houses.

4.3.1 Level of adoption of green home norms related to site selection and planning of house

Selection of an appropriate site for house construction is indispensable and fundamental to a green building. Consideration for level of ground, quality of underground water, proximity to civic amenities, appropriate outside configuration of the house, approval of building plan, soil erosion control measure, stockpiling fertile top soil for reusing in landscape, convenient design for differently abled, basic facilities for construction workers etc. are valuable considerations at the time of selection of site for house construction which were studied and relevant data presented in table 4.10

The perusal of data reveals that majority of respondents (93.33%) considered the level of the ground while selecting the site for the house construction partially meaning thereby that they thought about this aspect but were not much fixed about based on this consideration for their final decision. Similarly ninety three per cent of the respondents partially took care about the type of soil of the site of the house as they were concerned about raising a kitchen garden and develop aesthetic landscape. All the respondents were greatly concerned about the quality of underground water at their house construction site. A good number of respondents (52%) could not choose a site having close proximity to civic amenities in order to reduce the use of automobile in their endeavour to construct a green building due to non-availability of such sites at reasonable cost. Respondents (42%, 27.33%,14% and 44%) were found resorting to online shopping for fast moving consumer goods, payment of utility bills, banking services & booking of various services respectively in order to curtail the use of automobile and save their time and botheration also, hence making their contribution towards green thought. About sixty per cent respondents' houses had a regular outside configuration thus contributing towards better thermal control conditions inside the building due to less exposure of external walls to the outside environment. This may be due to concern of the architects of these houses about creating green buildings though majority of the house owners were not found aware about the fact of conserving electrical energy in cooling/ heating the rooms through appropriate outside building configuration. All the respondents got their house plans approved and also obtained occupancy certificates from the local civic bodies as it was mandatory in all the locations by their respective local bodies. All respondents managed the soil erosion in the pre-construction phase while eighty eight per cent respondents showed little concern in controlling the soil erosion during construction phase. All the respondents partially concern about the soil erosion in the post construction phase. Sixty per cent respondents partially stockpiled the top soil to be used in landscape later. Only 6.67 per cent respondents showed any concern in conserving the natural topography / vegetation while constructing their house. Majority of respondents (83.33%) did

not pay any heed to offsetting heat island effect from the roof area as either they were not aware of the technologies of reducing heat island effect from roof area or there are a few viable technologies for the purpose or the high installation cost of these technologies is keeping them away. Comparatively a good per cent of respondents (84.67%) managed the heat island effect in non-roof area by way of planting trees, hedges, climbers, grass etc. around the building. About sixty six per cent respondents did not provide any parking facility for the visitors due to shortage of space. All of the respondents showed lack of interest in using electric vehicles running in the region. Somewhat differently abled person were found in the respondents' families however they showed scant concern for the visiting differently abled guests with 54.67 per cent respondents having an easy access to the main entrance, 13.33 per cent having non slippery ramps, all respondents having adequate entrance door width for wheel chair users but not for other rooms and 92.67 per cent having just partial adoption of uniformity in floor levels for the convenience for differently abled persons. Better adoption of green home norms related to selection of site and planning in homes was found by respondents of Amritsar followed by Jalandhar and Ludhiana.

Table 4.10: Distribution of respondents according to their level of adoption of green home norms related to site selection and planning of house.

(N=150)

Green home norms related to site selection and planning	Level of adoption											
	Ludhiana			Jalandhar			Amritsar			Overall		
	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)
Consideration for site selection												
Level of ground	4 (8.00)	46 (92.00)	0 (0.00)	3 (6.00)	47 (94.00)	0 (0.00)	3 (6.00)	47 (94.00)	0 (0.00)	10 (6.67)	140 (93.33)	0 (0.00)
Type of soil	3 (6.00)	47.00 (94.00)	0 (0.00)	2 (4.00)	48 (96.00)	0 (0.00)	4 (8.00)	46 (92.00)	0 (0.00)	10 (6.67)	140 (93.33)	0 (0.00)
Condition of underground water	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)
Proximity to civic amenities	0 (0.00)	13 (26.00)	37 (74.00)	0 (0.00)	19 (38.00)	31 (62.00)	4 (8.00)	36 (72.00)	10 (20.00)	4 (2.67)	68 (45.33)	78 (52.00)
Basic amenities accessible by safe convenient pedestrian pathways	0 (0.00)	3 (6.00)	47 (94.00)	4 (8.00)	7 (14.00)	39 (78.00)	20 (40.00)	30 (60.00)	0 (0.00)	24 (16.00)	40 (26.67)	86 (57.33)
Online shopping												
Fast moving consumer goods	0 (0.00)	17 (34.00)	33 (66.00)	0 (0.00)	19 (44.00)	31 (62.00)	0 (0.00)	27 (54.00)	23 (46.00)	0 (0.00)	63 (42.00)	87 (58.00)

Payment of utility bills	3 (6.00)	13 (26.00)	34 (68.00)	1 (2.00)	14 (28.00)	35 (70.00)	3 (6.00)	14 (28.00)	33 (66.00)	7 (4.67)	41 (27.33)	102 (68.00)
Banking services	0 (0.00)	7 (14.00)	43 (86.00)	0 (0.00	5 (10.00)	45 (90.00)	0 (0.00)	9 (18.00)	41 (82.00)	0 (0.00)	21 (14.00)	129 (86.00)
Booking of various services	1 (2.00)	20 (40.00)	29 (58.00)	1 (2.00)	26 (52.00)	23 (46.00)	2 (4.00)	24 (48.00)	24 (48.00)	4 (2.67)	66 (44.00)	80 (53.33)
Appropriate Outside configuration of house	0 (0.00)	26 (52.00)	24 (48.00)	2 (4.00)	32 (64.00)	16 (32.00)	3 (6.00)	30 (60.00)	17 (34.00)	5 (3.33)	90 (60.00)	55 (36.67)
Approval of building plan												
Obtaining occupancy certificate	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)	0 (0.00)
Soil erosion control measure												
Pre-construction	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)	0 (0.00)
During-construction	0 (0.00)	42 (84.00)	8 (16.00)	0 (0.00)	41 (82.00)	9 (18.00)	0 (0.00)	49 (98.00)	1 (2.00)	0 (0.00)	132 (88.00)	18 (12.00)
Post occupancy	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)
Stock piling fertile top in landscape	0 (0.00)	25 (50.00)	25 (50.00)	0 (0.00)	29 (58.00)	21 (42.00)	4 (8.00)	36 (72.00)	10 (20.00)	4 (2.67)	90 (60.00)	56 (37.33)
Conserving natural topography or vegetation	0 (0.00)	3 (6.00)	47 (94.00)	0 (0.00)	4 (8.00)	46 (92.00)	0 (0.00)	3 (6.00)	47 (94.00)	0 (0.00)	10 (6.67)	140 (93.33)

Offsetting heat island effect (non-roof area)	0 (0.00)	42 (84.00)	8 (16.00)	0 (0.00)	39 (78.00)	10 (20.00)	0 (0.00)	46 (92.00)	2 (4.00)	0 (0.00)	127 (84.67)	20 (13.33)
Offsetting heat island effect (roof area)	0 (0.00)	7 (14.00)	43 (86.00)	0 (0.00)	4 (8.00)	46 (92.00)	0 (0.00)	9 (18.00)	41 (82.00)	0 (0.00)	25 (16.67)	125 (83.33)
Parking facilities for visitors	0 (0.00)	12 (24.00)	38 (76.00)	0 (0.00)	20 (40.00)	30 (60.00)	0 (0.00)	19 (38.00)	31 (62.00)	0 (0.00)	51 (34.00)	99 (66.00)
Electric charging facilities for vehicle	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Design for differently abled												
Easy to access to main entrance	29 (58.00)	21 (42.00)	0 (0.00)	34 (68.00)	16 (32.00)	0 (0.00)	19 (38.00)	31 (62.0)	0 (0.00)	82 (54.67)	68 (45.33)	0 (0.00)
Non-slippery ramps with handrails	4 (8.00)	5 (10.00)	41 (82.00)	2 (4.00)	7 (14.00)	41 (82.00)	5 (10.00)	8 (16.00)	37 (74.00)	11 (7.33)	20 (13.33)	119 (80.00)
Adequate width of doors	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)
Uniformity in Floor level	0 (0.00)	46 (92.00	4 (8.00)	0 (0.00)	48 (96.00)	2 (4.00)	0 (0.00)	45 (90.00)	5 (10.00)	0 (0.00)	139 (92.67)	11 (7.33)
Basic facilities for construction workers	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)

(Figure in parentheses depicts percentage)

4.3.2 Level of adoption of green home norms related to water use efficiency in their homes

Concern for enhancing water use efficiency in homes is one of the prime content of green home norms. Every single drop of water saved is important for the sustainability of our environment. The data related to level of adoption of practices related to water use efficiency in homes was collected and given in table 4.11.

Upon critical examination of data it is evident that almost all of respondents (99.33%) were not at all concerned about the need of conserving rain water either through roof top rain water harvesting system or capturing the rain water run-off by some other means since they were neither much aware of the importance to harvest rain water nor aware of rain water harvesting technologies and agencies to install them. The practice of saving water through installation of water use efficient plumbing fixtures i.e. by installing dual flush was adopted by 87.33% respondents. However the practice of saving water by installing faucets with a flow of eight liters per minute and bidet with a flow of eight liters per minute by 92 and 70.67 percent respondents respectively. Sixty three percent respondents did not install aerators on kitchen taps to shape water stream coming out of the tap to bring more efficiency in flow rate. All of the respondents showed scant interest for saving water in maintaining their landscape area as none of the respondents were found aware about the importance of planting drought resistant plant species whereas majority of respondents (91.33%) limited their turf area due to difficulties in maintaining grassy turf during summer due limited municipal water supply. None of the respondents were found adopting the practice of segregating turf and bedding area based on watering requirements since they were not sensitive to conserving water to that extent. Similarly no one was found having the facility of drip irrigation for irrigating lawns which may have high contributions in saving water as they were not facing any shortage of water due to their dependence on underground water source of their own. Fifty two percent respondents were found having the facility of sprinkling irrigation system for their lawns. None of the respondents were found adopting modern technologies like moisture sensor, water pressure regulating device or time based water controllers for conserving water for irritating landscape area as they neither heard of these technologies nor they were finding any pressing need to conserve water through these technologies. Swimming pools and fountains were not found in any of the respondents' homes. Eighteen per cent respondents were found washing their cars by adopting good water use practices. Better adoption of green home norms related to water efficiency in homes was found by respondents of Amritsar followed by Jalandhar and Ludhiana.

Table 4.11: Distribution of respondents according to their level of adoption of green home norms related to water use efficiency in their homes

Water use efficiency	Level of adoption											
	Ludhiana			Jalandhar			Amritsar			Overall		
	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)
Provision of rainwater harvesting system	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	1 (2.00)	49 (98.00)	0 (0.00)	1 (0.67)	149 (99.33)
Fixtures												
Dual flush	44 (88.00)	6 (12.00)	0 (0.00)	46 (92.00)	4 (8.00)	0 (0.00)	41 (82.00)	9 (18.00)	0 (0.00)	131 (87.33)	19 (12.67)	0 (0.00)
Faucet (8LPM)	4 (8.00)	46 (92.00)	0 (0.00)	8 (16.00)	42 (84.00)	0 (0.00)	10 (20.00)	40 (80.00)	0 (0.00)	22 (14.67)	128 (92.00)	0 (0.00)
Bidet (8LPM)	13 (26.00)	37 (74.00)	0 (0.00)	13 (26.00)	37 (74.00)	0 (0.00)	18 (36.00)	32 (64.00)	0 (0.00)	44 (29.33)	106 (70.67)	0 (0.00)
Kitchen tap's aerators	6 (12.00)	11 (22.00)	33 (66.00)	1 (2.00)	13 (26.00)	36 (72.00)	8 (16.00)	16 (32.00)	26 (52.00)	15 (10.00)	40 (26.67)	95 (63.00)
Shower head (10LPM/8LPM)	0 (0.00)	21 (42.00)	29 (58.00)	0 (0.00)	19 (38.00)	31 (62.00)	0 (0.00)	25 (50.00)	25 (50.00)	0 (0.00)	65 (43.33)	85 (56.67)
Hand held spray (10LPM/8LPM)	0 (0.00)	21 (42.00)	29 (58.00)	0 (0.00)	16.00 (32.00)	34.00 (68.00)	0 (0.00)	29 (58.00)	21.00 (42.00)	0 (0.00)	66 (44.00)	84 (56.00)

Landscape design												
Plant drought resistant Species	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Limit turf area	0 (0.00)	43 (86.00)	7 (14.00)	0 (0.00)	48 (96.00)	2 (4.00)	0 (0.00)	46 (92.00)	4 (8.00)	0 (0.00)	137 (91.33)	13 (8.67)
Efficient landscape of irrigation system												
Install central shut off valve	0 (0.00)	40 (80.00)	10 (20.00)	0 (0.00)	43 (86.00)	7 (14.00)	0 (0.00)	46 (92.00)	4 (8.00)	0 (0.00)	129 (86.00)	21 (14.00)
Segregate turf and bedding based on watering Needs 50% area drip – irrigated	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Installation of sprinkler irrigation system for turf	0 (0.00)	23 (46.00)	27 (54.00)	1 (2.00)	26 (52.00)	23 (46.00)	5 (10.00)	29 (58.00)	16 (32.00)	6 (4.00)	78 (52.00)	66 (44.00)
Use of pressure regulating device to maintain optimal pressure	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Install moisture sensors	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Install time/ based controller	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Efficient car washing Practices	0 (0.00)	9 (18.00)	41 (82.00)	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	17 (34.00)	33 (66.00)	0 (0.00)	27 (18.00)	123 (82.00)

(Figure in parentheses depicts percentage)

4.3.3 Level of adoption of green home norms related to energy efficiency of house

Homes are the 2nd largest consumers of energy after industry world over. Small savings in energy consumption through careful planning and adoption of judicious practices helps to save a lot of energy. Here, the concern is to reduce the amount of energy consumption leading to green environment plus saving the pockets of consumers. So data were collected to check the adoption level of energy conserving practices by respondents in their homes and showed in table 4.12.

Upon critical examination of data it is evident that all of the respondents used CFC free household equipment like A.Cs and refrigerators but were not conscious for this norm in other household appliances. Majority of respondents (80.66%) were not at all concerned about the halon-free fire suppression systems. The practice of saving electricity through installation of star rated (BEE 5 rating) i.e. by installation of efficient fans was adopted by 27.33% respondents. However the practice of saving energy by installing 5 star air conditioner fully (20%) and partially (80%) adopted by respondents, light fittings were adopted by fully (26.67%) and partially (73.33%) motors and pumps were adopted by 27.33 percent respondents respectively. Sixty percentages of respondents partially orientated theirs room. Majority of respondents (64%) selected light colors for their rooms but with the combination of the dark colors walls. All respondents partially adopted the proper management of the window treatment like appropriate selection and operation of window treatments. Majority of respondents did not adopted the sun shading of windows by growing plants (66.67%), efficient fenestration (85%). Only 12.67% and 16% respondents were found who adopt the solar water heater system and solar garden lights respectively. None of the respondents were found adopting solar generators. Better adoption of green home norms related to energy efficiency in homes was found by respondents of Amritsar followed by Jalandhar and Ludhiana. Balars *et al* (2007) concluded through the study that with a use of green technology in the development of green houses, the energy efficient green walls can save 33-60% energy and the windows can save about 14-20% energy in the operations.

Table 4.12: Distribution of respondents according to their level of adoption of green home norms related to energy efficiency in their homes

(N=150)

Energy efficiency practices	**Level of adoption**											
	Ludhiana			**Jalandhar**			**Amritsar**			**Overall**		
	Full F(%)	**Partial F(%)**	**Not adopted F(%)**	**Full F(%)**	**Partial F(%)**	**Not adopted F(%)**	**Full F(%)**	**Partial F(%)**	**Not adopted F(%)**	**Full F(%)**	**Partial F(%)**	**Not adopted F(%)**
Use CFC free household equipment	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)
Halon-free Fire Suppression Systems	0 (0.00)	6 (12.00)	44 (88.00)	0 (0.00)	10 (20.00)	40 (80.00)	0 (0.00)	13 (26.00)	37 (74.00)	0 (0.00)	29 (19.33)	121 (80.66)
Installation of star rated appliances (BEE 5 rating) Fans	3 (6.00)	9 (18.00)	38 (76.00)	4 (8.00)	13 (26.00)	33 (66.00)	9 (18.00)	19 (38.00)	22 (44.00)	16 (10.67)	41 (27.33)	93 (62.00)
Air conditioners	14 (28.00)	36 (72.00)	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	17 (34.00)	33 (66.00)	0 (0.00)	30 (20.00)	120 (80.00)	0 (0.00)
Refrigerators	38 (76.00)	12 (24.00)	0 (0.00)	47 (94.00)	3 (6.00)	0 (0.00)	45 (90.00)	5 (10.00)	0 (0.00)	69 (46.00)	81 (54.00)	0 (0.00)
Light fittings	14 (28.00)	36 (72.00)	0 (0.00)	7 (14.00)	43 (86.00)	0 (0.00)	19 (38.00)	31 (62.00)	0 (0.00)	40 (26.67)	110 (73.33)	0 (0.00)
Motors and pumps	0 (0.00)	11 (22.00)	36 (72.00)	0 (0.00)	12 (24.00)	31 (62.00)	0 (0.00)	18 (36.00)	27 (54.00)	0 (0.00)	41 (27.33)	109 (72.67)

Building envelope												
Proper orientation of the room	3 (6.00)	29 (58.00)	18 (36.00)	1 (2.00)	30 (60.00)	19 (38.00)	5 (10.00)	32 (64.00)	13 (26.00)	9 (6.00)	91 (60.67)	50 (33.33)
Select light colours for the room's walls	8 (16.00)	36 (72.00)	6 (12.00)	8 (16.00)	31 (62.00)	11 (22.00)	12 (24.00)	29 (58.00)	9 (18.00)	28 (18.67)	96 (64.00)	26 (17.33)
Appropriate selection and operation of window treatments	2 (4.00)	5 (10.00)	43 (86.00)	0 (0.00)	10 (20.00)	40 (80.00)	4 (8.00)	10 (20.00)	36 (72.00)	6 (4.00)	25 (16.67)	119 (79.00)
Sun shading of windows by awnings etc.	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)
Sun shading of windows by growing plants	0 (0.00)	13 (26.00)	37 (74.00)	0 (0.00)	17 (34.00)	30 (60.00)	0 (0.00)	20 (40.00)	43 (86.00)	0 (0.00)	50 (33.33)	100 (66.66)
Efficient fenestration	0 (0.00)	6 (12.00)	44 (88.00)	0 (0.00)	5 (10.00)	45 (90.00)	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	22 (14.67)	128 (85.00)
Installation of on-site renewable energy systems												
Water heaters	0 (0.00)	5 (10.00)	45 (90.00)	0 (0.00)	6 (12.00)	44 (88.00)	0 (0.00)	8 (16.00)	42 (84.00)	0 (0.00)	19 (12.67)	131 (87.33)
Solar garden Lights	0 (0.00)	9 (38.00)	41 (82.00)	0 (0.00)	8 (16.00)	42 (84.00)	0 (0.00)	7 (14.00)	43 (86.00)	0 (0.00)	24 (16.00)	126 (84.00)

(Figure in parentheses depicts percentage)

4.3.4 Level of adoption of green home norms for building materials and resources

Sustainable building materials and resources help to reduce dependence on materials that have associated negative environmental impacts and help to maintain the building strength for life long period. The data related to use of environment friendly materials in the construction of the house were collected and presented in table 4.13.

The results showed that majority of respondents (90%) did not dispose off waste of building material in a segregated way and at an appropriate place due to non-availability of this disposal facility and lack of their interest in systematic disposal adopted. Respondents (58.67%) partially used building materials like bricks, sand etc. which were manufactured within 400 km distance. Respondents (57.33%) partially used fifty per cent wood based material by cost from rapidly renewable source like wooden ply board, wood veneers, batton/ particle boards etc. which are being manufactured locally from the local grown fast growing trees like poplar and eucalyptus. This may be due to the fact that original wood is very expensive or good quality wood products are available at affordable prices in the local market. No respondents used thirty per cent building material from the recycled content as such materials were either not available in the market or their quality was not up to the mark. Majority (93.33%) of respondents did not create the facility for on site waste treatment system for handling fifty percent of organic or landscape waste of the building. Respondents (51.33%) partially used at least five passive or active green building materials, products and equipment (certified by IGBC). Better adoption of green home norms related to building resources and materials in homes was found by respondents of Amritsar followed by Jalandhar and Ludhiana.

Table 4.13 Distribution of respondents according to their level of adoption of green home norms for building materials and resources

(N=150)

Energy efficiency practices	Level of adoption											
	Ludhiana			Jalandhar			Amritsar			Overall		
	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)
Dispose off waste of building material in a segregated way	0 (0.00)	3 (6.00)	47 (94.00)	0 (0.00)	5 (10.00)	45 (90.00)	0 (0.00)	7 (14.00)	43 (86.00)	0 (0.00)	15 (10.00)	135 (90.00)
20% of the total building material (by cost) is manufactured locally	0 (0.00)	25 (50.00)	25 (50.00)	0 (0.00)	29 (58.00)	21 (42.00)	0 (0.00)	34 (68.00)	16 (32.00)	0 (0.00)	88 (58.67)	62 (41.33)
50% of wood based material (by cost) is from rapidly renewable source	0 (0.00)	25 (50.00)	25 (50.00)	0 (0.00)	29 (58.00)	21 (42.00)	0 (0.00)	32 (64.00)	18 (36.00)	0 (0.00)	86 (57.33)	64 (42.67)
30% of total building material (by cost) has recycled content	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Facility of on-site waste treatment system for handling 50% of organic and landscape waste of the building	0 (0.00)	2 (4.00)	48 (96.00)	0 (0.00)	4 (8.00)	46 (92.00)	0 (0.00)	4 (8.00)	46 (92.00)	0 (0.00)	10 (6.67)	140 (93.33)

75% of the waste generated during construction is diverted from landfills for reuse or recycling	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	14 (28.00)	36 (72.00)	0 (0.00)	19 (38.00)	31 (62.00)	0 (0.00)	44 (29.33)	106 (70.67)
Used at least five passive or active green building materials, products and equipment (certified by IGBC)	0 (0.00)	21 (42.00)	29 (58.00)	0 (0.00)	26 (52.00)	24 (48.00)	0 (0.00)	30 (60.00)	20 (40.00)	0 (0.00)	77 (51.33)	73 (48.67)

(Figure in parentheses depicts percentage)

4.3.5 Level of adoption of green home norms for indoor air quality

The quality of the air inside of the house drastically effects on health and it is really very important to have proper ventilated house. The data related to level of adoption of green home norm in table 4.14.

The perusal of data reveals that cross ventilation in rooms was just partially adopted by all the respondents because placement of doors and windows just ensured partial cross ventilation in the rooms because of lack of provision and awareness of the respondents. Similarly 88.67 per cent respondents did not adopt the practice of having adequate operable windows to the exterior. Respondents (40.67%) could not adopt the practice of having unobstructed space beyond windows for free flow of air due to lack of provision. None of the respondent adopted the practice of having separate smoking area because respondents were not much aware about the effects of passive smoking. Moreover smoking cigarettes was not very common among in respondent families. Carbon dioxide sensors were not found installed in any of the houses to have a constant check over the quality of indoor air. All respondents had no provision of separate smoking area, carbon dioxide sensors and adequate operable window area. All respondents had partially provision of adequate outdoor view. Only 26.67 per cent and 27.33 per cent respondents had access to sky or fauna and flora around and provision for minimizing exposure of occupants to hazardous indoor. Only 26.67 per cent respondents fully used paints and coatings with low or no volatile organic compounds content. All respondents did not use adhesives in interiors with permitted level of volatile organic compounds, installed green label carpets and used composite wood and agri-fiber materials for floor paneling respectively. Only 33.33 per cent respondents partially adopted the salvaged wood based materials. Twenty six per cent respondents had facilities to enhance physical, emotional and spiritual well-being. Good adoption of green home norms related to indoor air quality in homes was found by respondents of Amritsar followed by Jalandhar and Ludhiana. Liang *et al* (2014) found that green homes were more satisfying in case of with the overall indoor environmental quality green buildings offer better quality of illumination, suitable temperature, CO_2/VOC concentrations.

Table 4.14: Distribution of respondents according to their level of adoption of green home norms for indoor air quality

(N=150)

Name of Practices	Level of adoption											
	Ludhiana			Jalandhar			Amritsar			Overall		
	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)	Full F(%)	Partial F(%)	Not adopted F(%)
Provision of cross ventilation in rooms	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)
Adequate operable windows in each room to exterior	0 (0.00)	4 (8.00)	46 (92.00)	0 (0.00)	6 (12.00)	44 (88.00)	0 (0.00)	7 (14.00)	43 (86.00)	0 (0.00)	17 (11.33)	133 (88.67)
Unobstructed space beyond windows for free flow of air	0 (0.00)	32 (64.00)	18 (36.00)	0 (0.00)	30 (60.00)	20 (40.00)	0 (0.00)	27 (54.00)	23 (46.00)	0 (0.00)	89 (59.33)	61 (40.67)
Provision of separate smoking area	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Installation of carbon dioxide sensors	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Provision of adequate day lighting in regularly occupied areas	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)
Provision of adequate day lighting in non-regularly occupied areas	0 (0.00)	31 (62.00)	19 (38.00)	0 (0.00)	36 (72.00)	14 (28.00)	0 (0.00)	38 (76.00)	12 (24.00)	0 (0.00)	105 (70.00)	45 (30.00)

Provision of adequate outdoor view	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)
Occupants should have access to sky or fauna and flora around	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	12 (24.00)	38 (76.00)	0 (0.00)	17 (34.00)	33 (66.00)	0 (0.00)	40 (26.67)	110 (73.33)
Provision for minimizing exposure of occupants to hazardous Indoor	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	14 (28.00)	36 (72.00)	0 (0.00)	16 (32.00)	34 (68.00)	0 (0.00)	41 (27.33)	109 (72.67)
Use paints and coatings with low or no VOC content	7 (14.00)	0 (0.00)	43 (86.00)	10 (20.00)	0 (0.00)	40 (80.00)	23 (46.00)	0 (0.00)	27 (54.00)	40 (26.67)	0 (0.00)	110 (73.33)
Use of adhesives in interiors with permitted level of VOCs	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Installation of Green Label carpets only	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Composite wood and agr-fiber materials to be used for flooring paneling etc.	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)	150 (100.00)
Salvaged wood based materials to be used	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	16 (32.00)	34 (68.00)	0 (0.00)	23 (46.00)	27 (54.00)	0 (0.00)	50 (33.33)	100 (66.67)
Facilities to enhance physical, emotional and spiritual well-being of occupants (gymnasium, yoga, meditation etc.)	0 (0.00)	9 (18.00)	41 (82.00)	0 (0.00)	11 (22.00)	39 (78.00)	0 (0.00)	19 (38.00)	31 (62.00)	0 (0.00)	39 (26.00)	111 (74.00)

(Figure in parentheses depicts percentage)

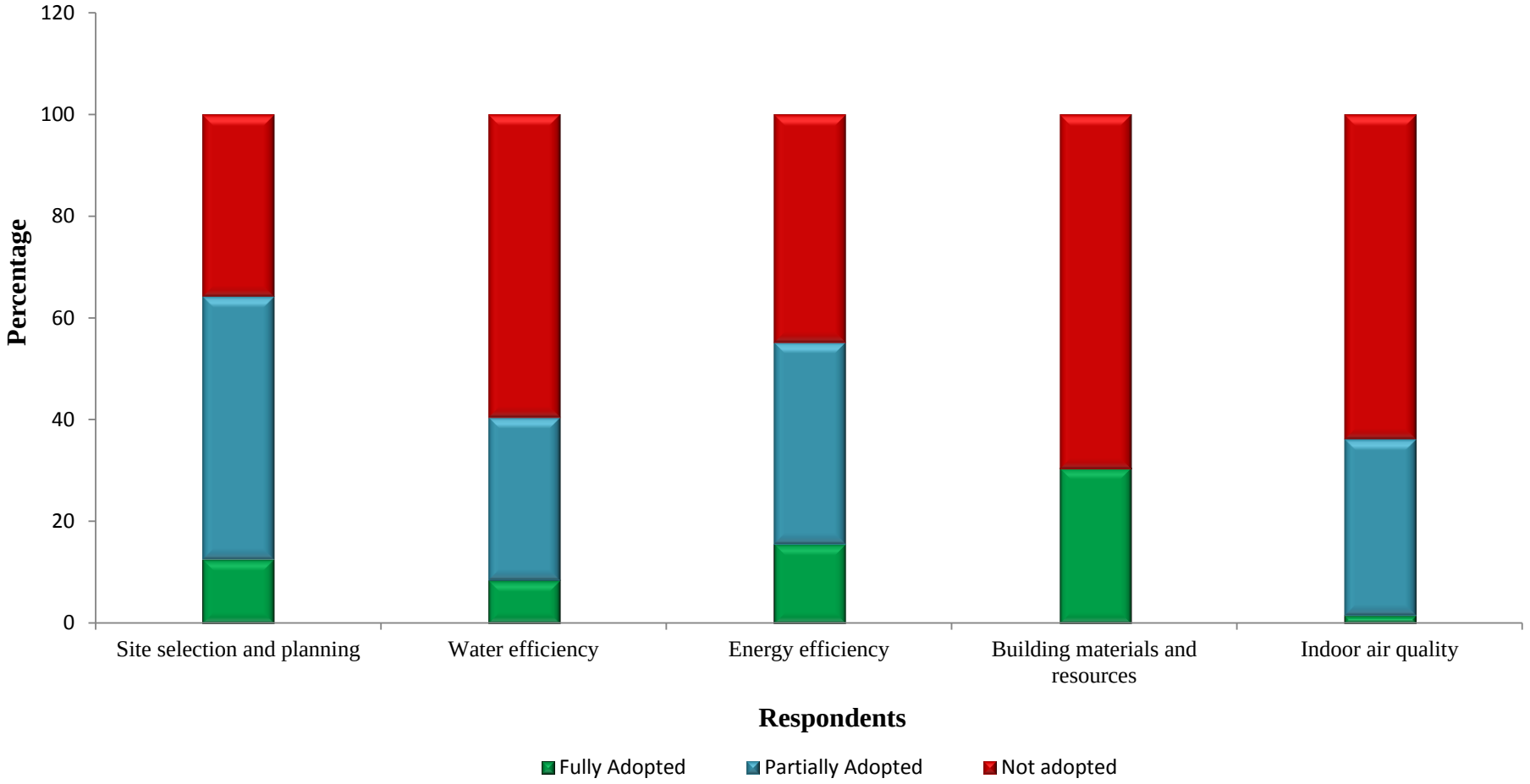

Fig 8: Adoption level of the respondents related to site selection and planning of house, water efficiency, energy efficiency, building materials and resources and indoor air quality

4.4 To explore the constraints in adoption of green homes norms in the modern houses.

4.4.1 Respondents according to the constraints faced by them in selection of site and house planning of green homes

Proper site and plan of a house is the founding idea for any green house as it contributes substantially in the overall economic life of a building. The constraints faced by the respondents in selection of site and house planning of green homes were studied and presented in Table 4.15.

The analysis of the presented data reveals that inadequate and inappropriate parking facilities for visitors was the major constraint due to the high cost of land which inhibited owners to afford to purchase sufficient land for providing parking for the visitors. There were even no public provisions given for the purpose by the municipality or the colonizers which lead to inconvenience and congestion. The futuristic technology of electric vehicles was also not given due consideration and provision for charging such vehicles was not made mainly (95.33%) due to lack of awareness about the quick progress in the field of electronic vehicles and lack of interest with all respondents as they do not visualize that such vehicles are going to be a reality in near future. Lack of interest (96.67%) and lack of awareness (84.67%) was the major constraint for not adopting the practice of appropriate outside configuration of house which helps in maintaining a comfortable indoor temperature. Lack of interest (83.33%) was the major constraint for not adopting the practices to set off the heat island effect. On the whole lack of interest (rank I) was the major constraint for not adopting the practices related to site selection and house planning followed by high cost (rank II), lack of provision (rank III) lack of awareness (rank IV) lack of cooperation from the society (rank V) and lack of skilled of labour (VI). Abidin (2010) reported that the pace of adoption of sustainable building approach by the constructors was slow because of less knowledge about the benefits of the adoption of sustainable building system.

Table 4.15 Distribution of respondents according to the constraints faced by them in selection of site and house planning of green homes

(N=150)

Green home features	**Types of constraints**						**Ranking**
	Lack of awareness F(%)	**Lack of interest F(%)**	**Lack of provision/ availability F(%)**	**Lack of co-operation from society F(%)**	**High cost F(%)**	**Lack of skilled labour F(%)**	
Selection of site							
Level of ground	0 (0.00)	11 (7.33)	0 (0.00)	36 (24.00)	120 (80.00)	61 (40.67)	VII
Type of soil	0 (0.00)	0 (0.00)	140 (93.33)	0 (0.00)	90 (60.00)	0 (0.00)	V
Proximity to civic amenities	0 (0.00)	15 (10.00)	69 (46.00)	0 (0.00)	105 (70.00)	0 (0.00)	IX
Soil erosion control measure	14 (9.33)	0 (0.00)	29 (19.33)	35 (23.33)	46 (30.67)	0 (0.00)	X
Online shopping							
Banking services	91 (60.67)	138 (92.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	VI
Payment of utility bills	89 (59.33)	13 (8.67)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	XI
Heat Island Reduction, Non-roof	21 (14.00)	56 (37.33)	109 (72.67)	12 (8.00)	59 (39.33)	0 (0.00)	IV
Heat Island Reduction, Roof	0 (0.00)	125 (83.33)	0 (0.00)	0 (0.00)	110 (46.00)	4 (2.67)	VIII
Appropriate Outside configuration of house	127 (84.67)	145 (96.67)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	III
Parking facilities for visitors	0 (0.00)	99 (66.00)	150 (100.00)	0 (0.00)	150 (100.00)	0 (0.00)	I
Electric charging facilities for vehicle	143 (95.33)	150 (100.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	II
Ranking	IV	I	III	V	II	VI	

(Figure in parentheses depicts percentage)

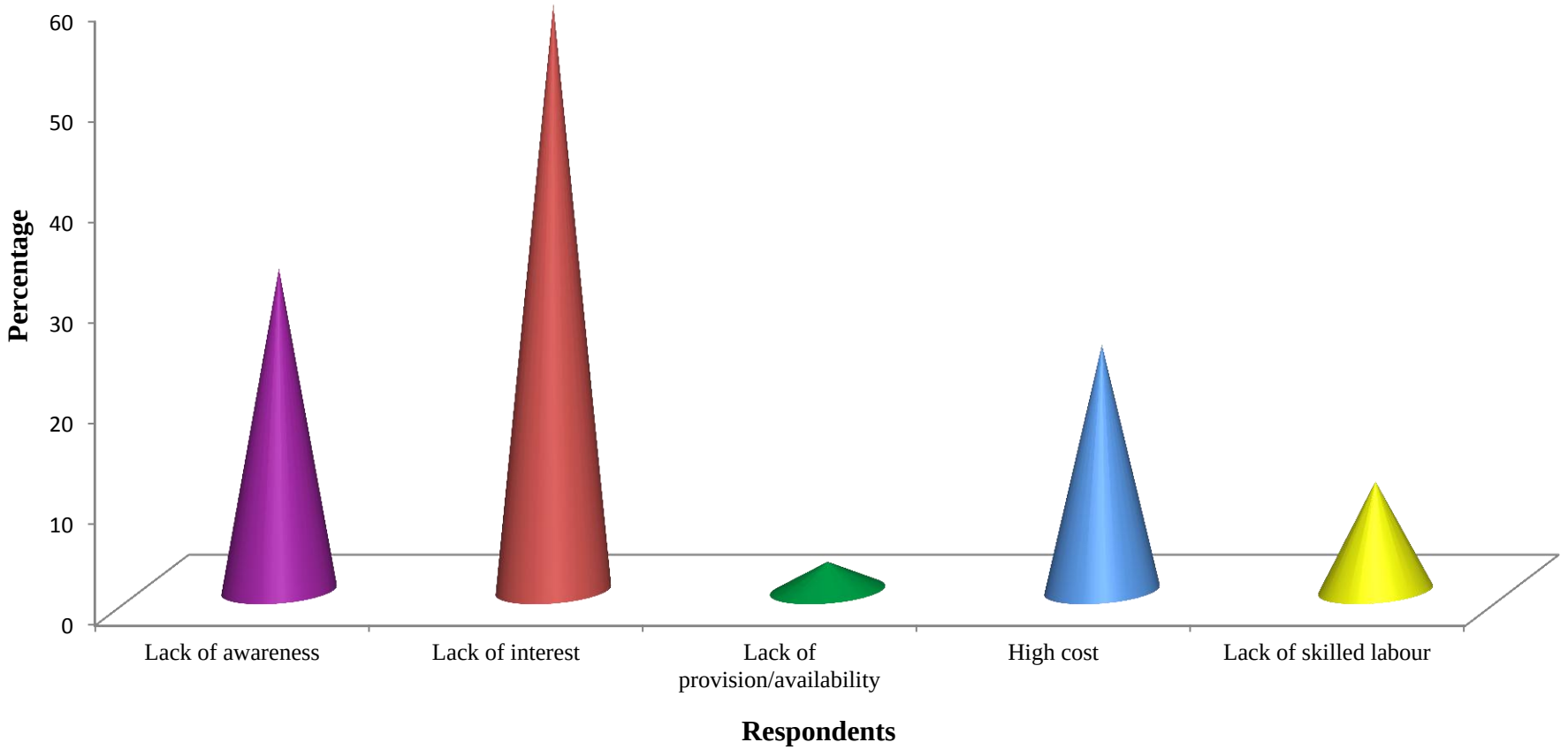

Fig 9: Constraints faced by respondents in adopting green home norms related to selection of site and housing planning

4.4.2 Respondents according to the constraints faced by them in water conservation of green homes

Potable water is going to be the scarcest resource in future if suitable conservation technologies are not adopted in time in its household use. The constraints faced in the adoption of water conservation practices and technologies in green homes were studied and presented in table 4.16.

The examination of the table reveals that the practice of installing rainwater harvesting roof and non-roof area topped the list of practices which had constraints in their adoption mainly due to lack of interest (99.33%) and high cost (39.33%). Similarly the practice of appropriate landscape design i.e. selection of drought resistant plants, segregation on the basis of irrigation requirements etc. could not be adopted by the respondents due to lack of interest (74.67%) and lack of skilled labor who can implement such practices (62.67%). The practice of installing moisture sensors and time base controller gadgets to use irrigation water judiciously was also not adopted mainly due to lack of awareness (93.33%). Lack of interest (98.67%) was the major constraint for not adopting the efficient car washing practices. On the whole lack of interest (rank I) was the major constraint for not adopting the practices related to water conservation followed by lack of awareness (rank II), high cost (rank III), lack of skilled of labour (rank IV) and lack of provision (rank V).

Table 4.16: Distribution of respondents according to the constraints faced by them in conserving water in their homes

(N=150)

Green home practices	**Types of constraints**					**Ranking**
	Lack of awareness F(%)	**Lack of interest F(%)**	**Lack of provision/ availability F(%)**	**High cost F(%)**	**Lack of skilled labour F(%)**	
Selection of water conservation						
Rainwater Harvesting, Roof & Non-roof	24 (16.00)	149 (99.33)	10 (6.67)	59 (39.33)	2 (1.33)	I
Water Efficient Plumbing Fixture	19 (12.56)	26 (17.33)	0 (0.00)	59 (39.33)	18 (12.00)	VII
Landscape Design	0 (0.00)	112 (74.67)	4 (2.67)	29 (19.00)	94 (62.67)	II
Efficient landscape irrigation system	20 (13.33)	119 (79.33)	6 (4.00)	70 (46.67)	0 (0.00)	IV
Use of pressure regulating device to maintain optimal pressure	123 (82.00)	10 (6.67)	0 (0.00)	0 (0.00)	0 (0.00)	VI
Install moisture sensors and time based controller gadgets	109 (93.33)	46 (32.00)	10 (6.67)	60 (26.67)	0 (0.00)	III
Efficient car washing Practices	11 (7.33)	148 (98.67)	0 (0.00)	0 (0.00)	0 (0.00)	V
Ranking	II	I	V	III	IV	

(Figure in parentheses depicts percentage)

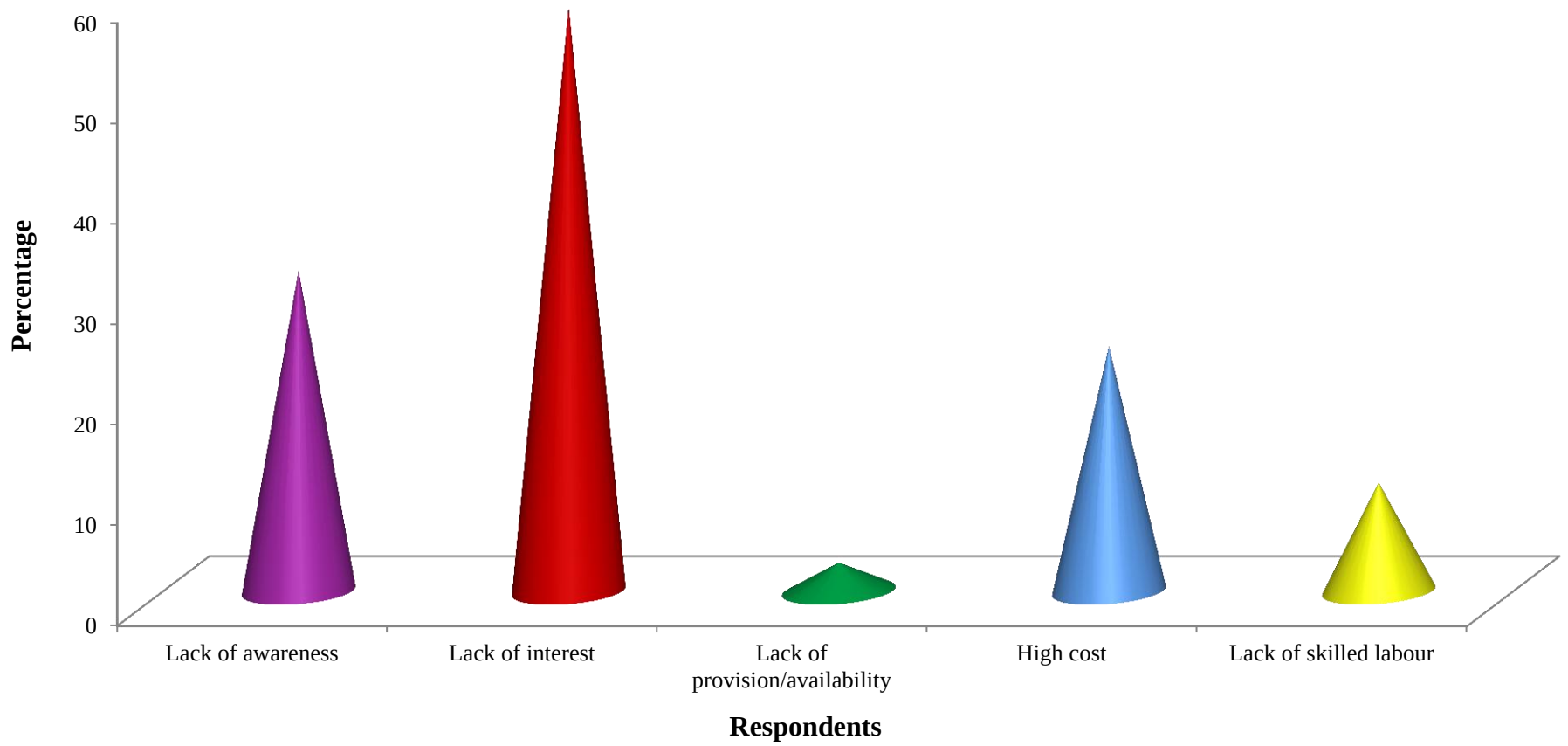

Fig 10: Constraints faced by respondents in adopting green home norms related to conserving water

4.4.3 Respondents according to the constraints faced by them in achieving energy efficiency in their homes

Highly consumption of energy exacerbate the depletion of natural resources in future if suitable practices and technologies are not adopted within time. The constraints faced in the adoption of energy conservation practices and technologies in green homes were studied and presents in table 4.17. The examination of the table reveals that the practice of installing on site solar water heaters were topped the list of practices which had constraints in their adoption mainly due to lack of interest (87.33%) and due to high cost (44%). Similarly the installation of solar garden lights could not be adopted by the respondents due to lack of interest (60%) and again due to high cost (14%). The practice of installing halon-free fire suppression systems was also not adopted mainly due to lack of interest (70%). On the whole lack of interest (rank I) was the major constraint for not adopting the practices related to energy efficiency followed by high cost (rank II), lack of provision (rank III), lack of awareness (rank IV), lack of co-operation from society (rank V) and lack of skilled of labour (VI). Hakkinen and Belloni (2011) reported that the best way to increase the level of adoption of green buildings were through creating the awareness among the individuals about the positive results of the implication of these energy efficient buildings.

Table 4.17: Distribution of respondents according to the constraints faced by them in achieving energy efficiency in their homes

(N=150)

Green home practices	**Types of constraints**						**Ranking**
	Lack of awareness F(%)	**Lack of interest F(%)**	**Lack of provision/ availability F(%)**	**Lack of co-operation from society F(%)**	**High cost F(%)**	**Lack of skilled labour F(%)**	
Use CFC free household equipment	14 (9.33)	121 (80.67)	0 (0.00)	0 (0.00)	12 (8.00)	0 (0.00)	IV
Halon-free Fire Suppression Systems	15 (10.00)	105 (70.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	III
Installation of star rated appliances	19 (12.67)	68 (45.33)	7 (4.67)	0 (0.00)	0 (0.00)	0 (0.00)	VI
Building envelope	20 (13.33)	0 (0.00)	61 (40.67)	46 (30.67)	0 (0.00)	0 (0.00)	V
On-site Renewable Energy Solar water heaters	0 (0.00)	131 (87.33)	0 (0.00)	0 (0.00)	66 (44.00)	17 (11.33)	I
Solar garden lights	0 (0.00)	90 (60.00)	20 (13.33)	0 (0.00)	41 (14.00)	0 (0.00)	II
Ranking	IV	I	III	V	II	VI	

(Figure in parentheses depicts percentage)

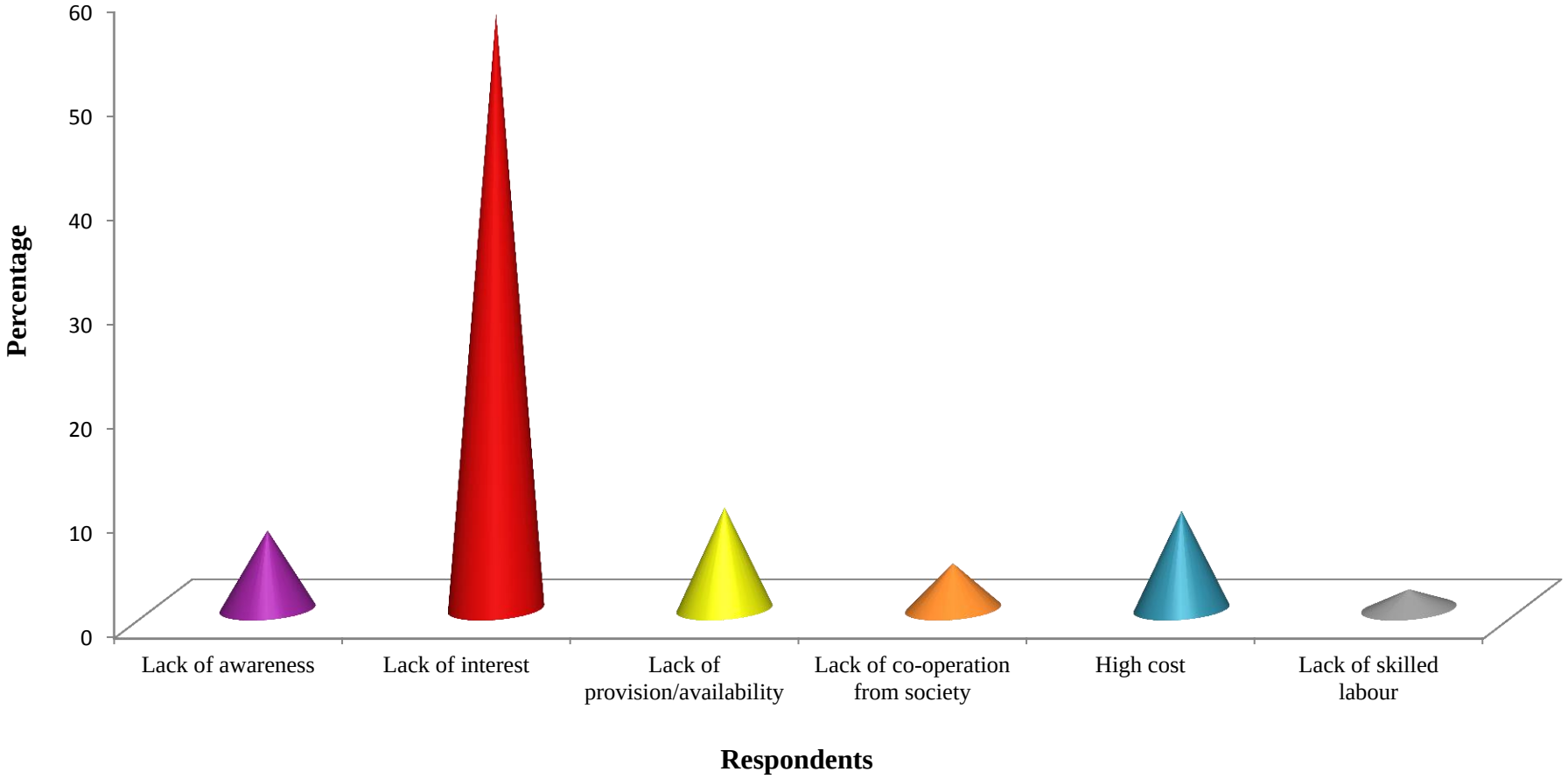

Fig 11: Constraints faced by respondents in adopting green home norms related to energy efficiency

4.4.4 Respondents according to the constraints faced by them in building materials and resources of green homes

Selection of green materials and resources for building is very important to reduce the negative impact on the environment by reducing harmful contaminants such as the harmful gas formaldehyde and carbon dioxide etc. In future, ignorance of the green materials leads to the escalation of the health illness. The constraints faced in the adoption of green building and resources practices in green homes were studied and presents in table 4.18.

The examination of the table reveals that the adoption of thirty per cent of total building material has recycled content was also not adopted mainly due to lack of interest (45.33%). The facility of on-site waste treatment system for handling 50% of organic and landscape waste of the building were topped the list of practices which had constraints in their adoption mainly due to lack of interest (67.33%) and lack of awareness (25.33%). Similarly the practice of dispose off waste of building material in a segregated way could not be adopted by the respondents due to lack of awareness (46%) and lack of interest (38%). On the whole lack of interest (rank I) was the major constraint for not adopting the practices related to green building materials followed by lack of awareness (rank II), lack of provision (rank III), lack of skilled of labour (rank IV), high cost (rank V) and lack of co-operation from society (rank VI). Abolore (2013) concluded that the adoption of the green building techniques were dependent upon the level of awareness among the people towards the green buildings which was gained by understanding the needs of the people to gain knowledge, their involvement, action and regulations established for the adoption of the process.

Table 4.18: Distribution of respondents according to the constraints faced by them in building selecting green materials and resources for their homes (N=150)

Green home practices	Types of constraints						Ranking
	Lack of awareness F(%)	Lack of interest F(%)	Lack of provision/ availability F(%)	Lack of co-operation from society F(%)	High cost F(%)	Lack of skilled labour F(%)	
Selection of building materials and resources							
20% of the total building material (by cost) is manufactured locally	13 (10.67)	40 (30.67)	92 (69.33)	0 (0.00)	0 (0.00)	0 (0.00)	VI
50% of wood based material (by cost) is from rapidly renewable source	0 (0.00`)	35 (23.33)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	VII
30% of total building material (by cost) has recycled content	53 (35.33)	68 (45.33)	28 (18.67)	0 (0.00)	0 (0.00)	9 (6.00)	III
Facility of on-site waste treatment system for handling 50% of organic and landscape waste of the building	38 (25.33)	101 (67.33)	0 (0.00)	0 (0.00)	32 (21.33)	11 (7.33)	I
75% of the waste generated during construction is diverted from landfills for reuse or recycling	23 (15.33)	69 (46.00)	0 (0.00)	0 (0.00)	0 (0.00)	58 (38.67)	IV
Used at least five passive or active green building materials, products and equipment (certified by IGBC)	70 (46.67)	19 (12.67)	0 (0.00)	0 (0.00)	21 (14.00)	38 (25.33)	V
Dispose off waste of building material in a segregated way	69 (46.00)	57 (38.00)	0 (0.00)	44 (29.33)	0 (0.00)	0 (0.00)	II
Ranking	II	I	III	VI	V	IV	

(Figure in parentheses depicts percentage)

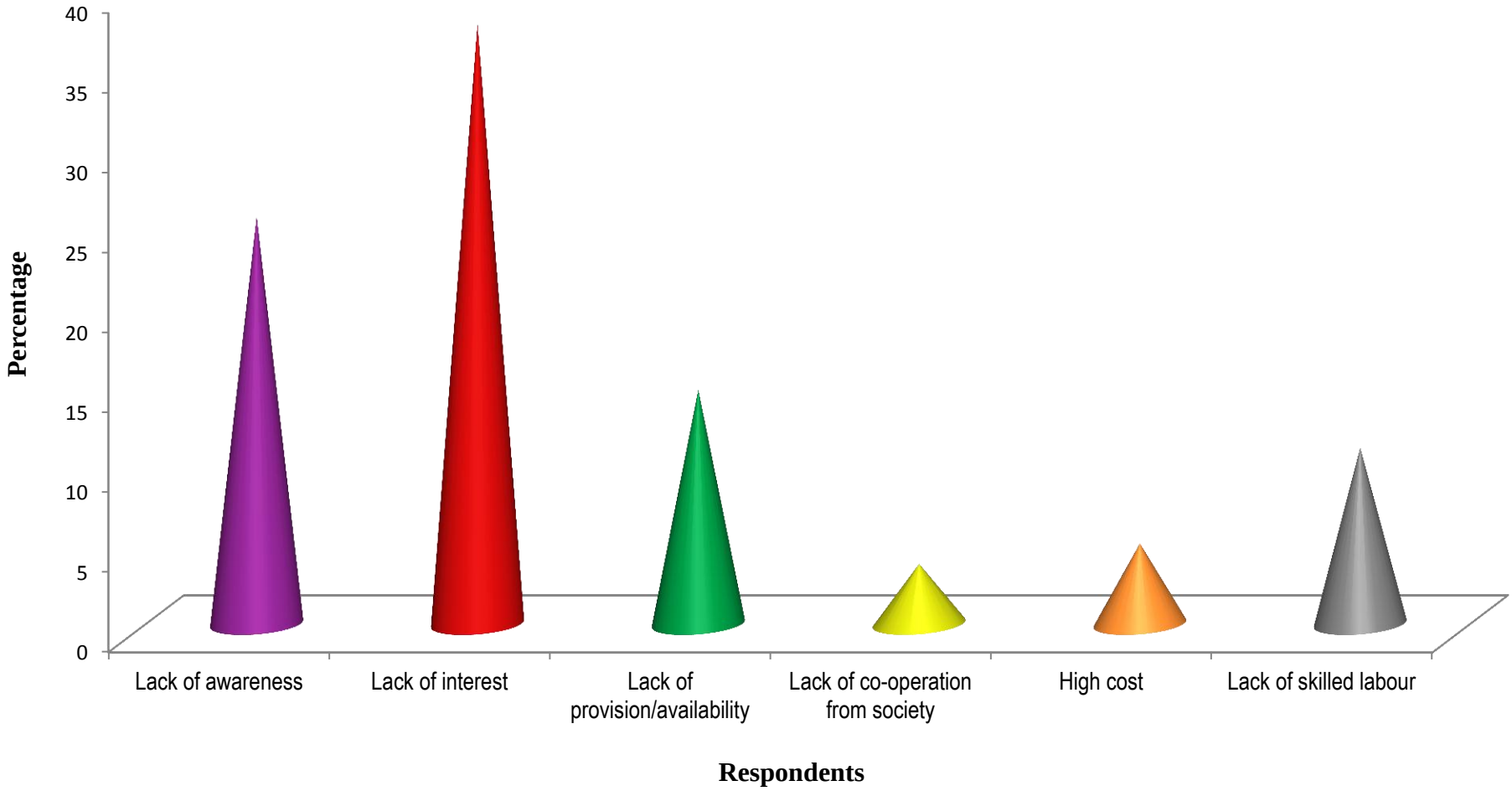

Fig 12: Constraints faced by respondents in adopting green home norms related to building materials and resources

4.4.5 Respondents according to the constraints faced by them in maintaining indoor environmental quality in green homes

Indoor environmental quality affects the health, comfort and well-being of building occupants and poor indoor air quality has been linked to sick of the building occupants in future if suitable practices are not adopted than health issues will also increase gradually. The constraints faced in the adoption of indoor environmental quality practices and technologies in green homes were studied and presents in table 4.19.

The examination of the table reveals that the practice of Installation of CRI Green Label Plus carpets only were topped the list of practices which had constraints in their adoption mainly due to lack of interest (52.67%) and due to lack of awareness (50.67%). Similarly the installation of carbon dioxide sensors could not be adopted by the respondents due to lack of interest (66%) and again due to lack of awareness (34%). The practice of use of adhesives in interiors with permitted level of VOCs was also not adopted mainly due to lack of awareness (67.33%). On the whole lack of interest (rank I) was the major constraint for not adopting the practices related to energy efficiency followed by lack of awareness (rank II), high cost (rank III) and lack of provision (rank IV).

Table 4.19: Distribution of respondents according to the constraints faced by them in maintaining indoor environmental quality for their homes

(N=150)

Green home practices	Types of constraints				Ranking
	Lack of awareness F(%)	Lack of interest F(%)	Lack of provision/ availability F(%)	High cost F(%)	
Provision of cross ventilation in rooms	61 (40.67)	48 (32.00)	41 (27.33)	12 (8.00)	X
Adequate operable windows in each room to exterior	79 (52.67)	71 (47.33)	17 (11.33)	13 (8.67)	V
Unobstructed space beyond windows for free flow of air	61 (40.67)	29 (19.33)	71 (47.33)	0 (0.00)	XI
Installation of carbon dioxide sensors	51 (34.00)	99 (66.00)	0 (0.00)	49 (32.67)	II
Provision of adequate day lighting in regularly occupied areas.	79 (52.67)	71 (47.33)	31 (20.67)	0 (0.00)	IV
Provision of adequate day lighting in non-regularly occupied areas	18 (12.00)	132 (88.00)	0 (0.00)	0 (0.00)	IX
Provision of adequate outdoor views	34 (22.67)	14 (9.33)	85 (56.67)	40 (26.67)	VIII
Provision for minimizing exposure of occupants to hazardous indoor	69 (46.00)	81 (54.00)	0 (0.00)	24 (16.00)	VII
Use paints and coatings with low or no VOC content	82 (54.67)	10 (6.67)	0 (0.00)	18 (12.00)	XII
Use of adhesives in interiors with permitted level of VOCs	101 (67.33)	49 (32.67)	0 (0.00)	43 (28.67)	III
Installation of CRI Green Label Plus carpets only	76 (50.67)	79 (52.67)	0 (0.00)	71 (47.33)	I
Facilities to enhance physical, emotional and spiritual well-being of occupants	0 (0.00)	124 (82.67)	0 (0.00)	51 (34.00)	VI
Ranking	II	I	IV	III	

(Figure in parentheses depicts percentage)

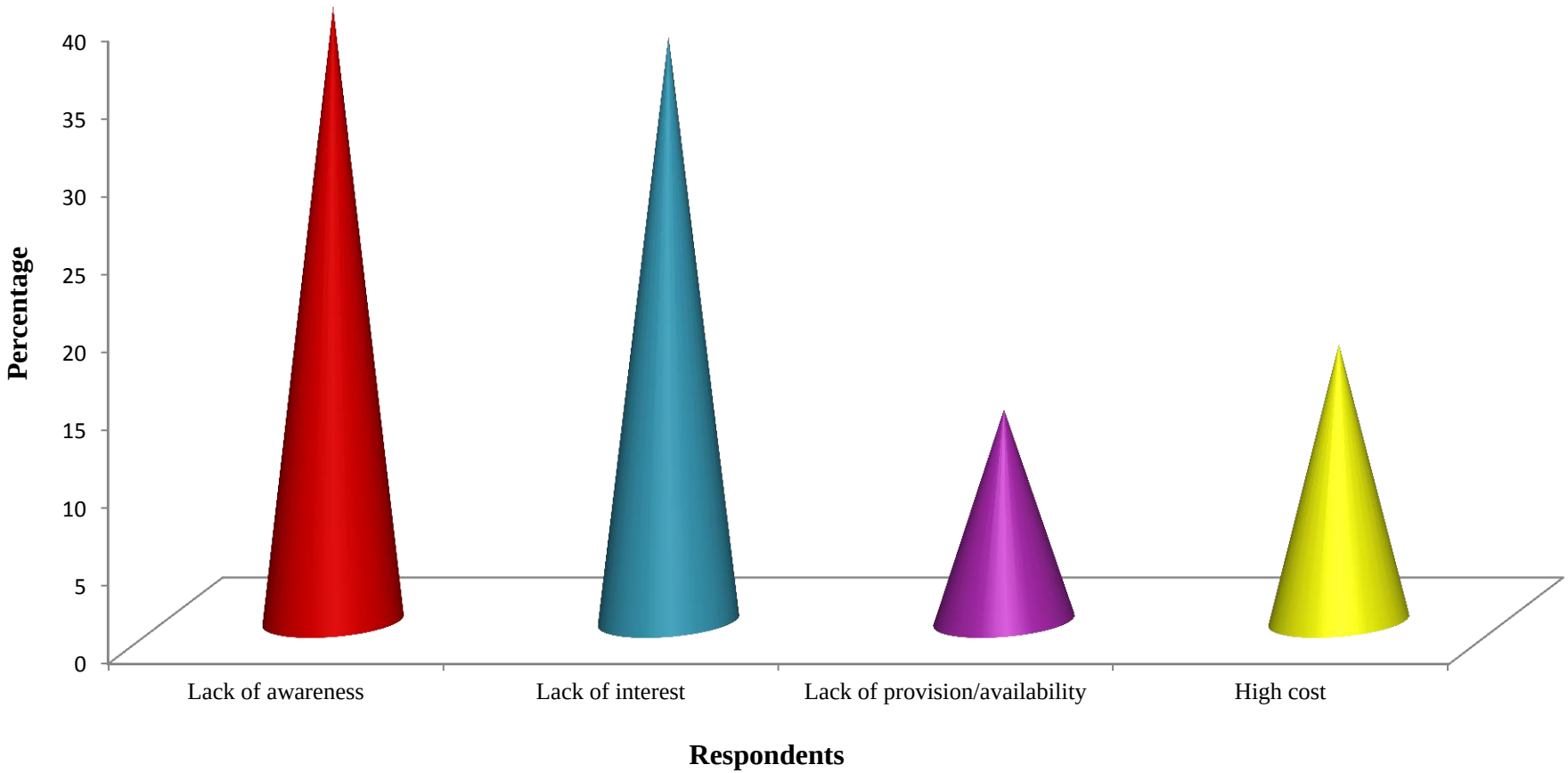

Fig 13: Constraints faced by respondents in adopting green home norms related to indoor environmental quality

4.4.6 Respondents according to the constraints faced by them in innovation and development of green homes.

Respondents create something innovated with their own idea which helps to save resources. The constraints faced by them in innovation and development of green homes were studied and presents in table 4.20.

On the whole lack of ability (92.67%) was the major constraint for not adopting the practices related to innovation and development followed by lack of knowledge (80%),lack of interest (66.67%) and lack of provision (8%).

Table 4.20: Distribution of respondents according to the constraints faced by them in innovation and development of green homes. (N=150)

Green home practices	Types of constraints			
	Lack of interest F(%)	Lack of knowledge F(%)	Lack of ability F(%)	Difficult to manage the time schedule F(%)
Innovation in design process	III (66.67)	II (80.00)	I (92.67)	IV (8.00)

(Figure in parentheses depicts percentage)

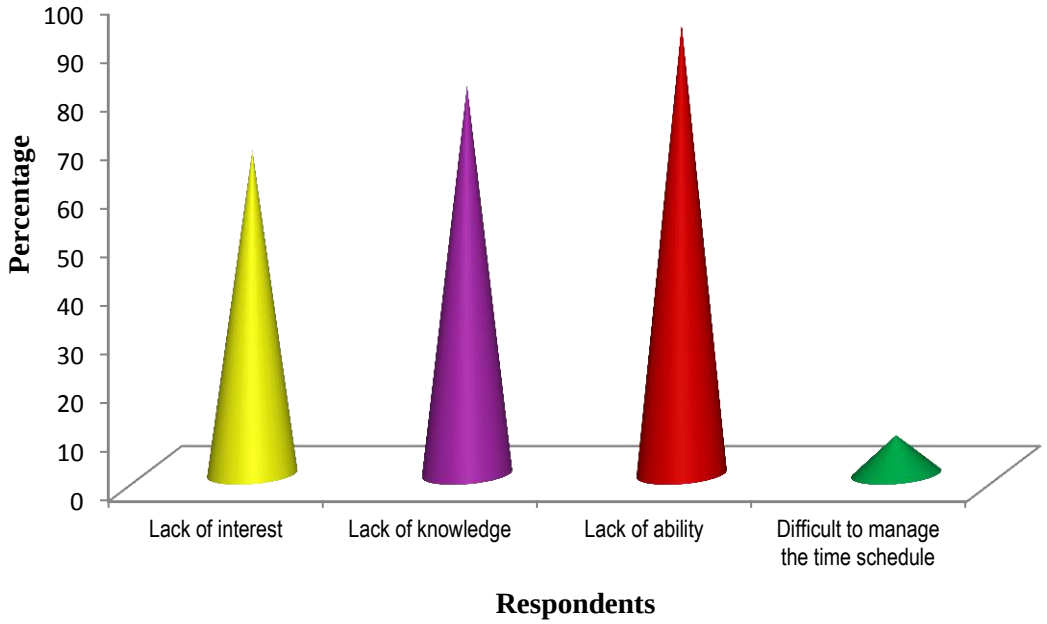

Fig 14: Constraints faced by respondents in adopting green home norms related to innovation and development

CHAPTER V

SUMMARY

Green homes are built or designed in such a way which helps to conserve our environment. Green homes reduce operating costs by saving energy consumption in homes by 30-40 per cent and water saving to an extent of 20-30 per cent over the conventional homes. Occupant productivity in green homes is also improved as about ninety per cent of these houses have adequate day lighting and have enhanced ventilation as compared to conventional houses. Green house also has enhanced asset value resulting in higher profits in their total value. Economic life cycle performance of a green house is optimum and reduce health problems resulting from indoor air quality. They also minimize strain on local utility infrastructure, improve air and water quality, enhance and protect biodiversity & ecosystems, reduce waste streams, conserve and restore natural resources and improve overall quality of life.

It really does not cost extra to develop a green building. It is simple application of conventional wisdom, orientation of the building, concern for our neighborhood and application of mind to minimize use of materials, best described by 'Reduce', 'Reuse', 'Recycle'. A green home needs to address all facets of environmental concerns, be it the site, water and energy conservation, materials, and indoor air quality related aspects. A green home include wall insulation, roof Insulation, day lighting through the use of sun pipes, shading devices, use of salvaged materials, low VOCs (Volatile Organic Compounds) paints, on-site waste water treatment, vermin-composting, roof water harvesting, energy & water sub-metering and the installation of energy efficient appliances, installation of solar panels, star appliances shift from high efficiency water heaters and washing machines to low-flow showerheads, faucets and toilets etc.

In this study possible to evaluate any residential buildings have been evaluated by applying the rating system developed by IGBC using a suitable checklist for meeting all mandatory requirements for a green buildings. The checklist addresses green features under the categories: site selection and planning, water conservation, energy efficiency, material, indoor environmental quality, innovation & design process. The study entitled "Adoption of green home norms in modern houses" has been conducted with the following specific objective:

1. To study the level of awareness of the respondents regarding the deteriorating environment and their concern for preserving it.
2. To determine the level of adoption of green homes norms in the modern houses.
3. To explore the constraints in adoption of green homes norms in the modern houses.

A sample of 150 homes built after 2015 taken from three smart cities of Punjab i.e

Amritsar, Jalandhar and Ludhiana comprising 50 homes from each city was selected. The posh areas of the cities were selected with the help of local people and personal contact with the architects and interior designers.

The study was conducted in three major smart cities of Punjab viz. Ludhiana, Jalandhar and Amritsar. Randomly fifty homes were taken from posh localities of each city. B.R.S Nagar, Sarabha Nagar, Rajguru Nagar, Dayal Nagar and Aggar Nagar Colony areas were selected from Ludhiana. Urban Estate phase-I, Urban Estate phase-II, Model Town, Dashmesh Nagar, Joti Nagar areas were selected from Jalandhar. Holy City, Dream city, Model Town, New Amritsar and Ranjit Avenue were selected from Amritsar. Data collected by personal interview and observation method through a structured interview schedule. The data were transferred to the master sheet. The responses were ranked depending upon the type of questions for example three point scale i.e. Somewhat, Quite a lot, and too much, four point of scale i.e. Don't know, Heard about, Know somewhat and Know in detail, four point scale i.e. little, moderate, acute, and no impact, three point scale i.e. not aware, aware and know in details.Frequency and percentages were calculated to reach to the conclusions.

The major findings of the study are:

- Majority of respondents were in age group of more than 50 years (55.34%), with education up to Post Graduation (62%). Most of the families were in business (65.33%) and most of them belonged to joint family (60.67%). Most (71.33%) of the respondents earned family income Rs. 1400000-1700000 annually.
- The respondents had 5001-4501 square feet of total area of plot (39.33%) and mostly were constructed their area 2501-3500 square feet (52.67%). The majority (56%) of houses were two or in between three year old and majority (64%) of house had double storeys building. All respondents designers hired architects but was being most (52%) of the respondents also hired the interior designers. Mostly water supplied by municipal corporation (60%) in their houses but both provision were also there. Most (60.67%) of the respondents had 750 liters water storage capacity. Nine per cent respondents had water tank overflow alarm.
- Majority of the respondents perceived that there is a lot of deterioration in quality of our environment i.e. 54, 57.33 and 56 per cent respondents felt that air pollution, water pollution, soil pollution due to pollution and temperature peaks have increased too much respectively.
- As per the opinion of the respondents agricultural operations are causing the most pollution (53.33%) followed by industry (33.33%) and transportation (13.33%). They consider housing (86%) and consumptive style of living of people (76.67%) as least responsible for causing different type of pollution.

- Majority of respondents (60.67%) knew that combustion of fossil fuels for generating electricity and transportation is the major cause of air pollution. A few number (6.67%, 5.33%,4%, 3.33% and 1.33%) of respondents knew in detail about the causes of air pollution i.e. emissions from various industrial processes, emission from harmful chemicals from household materials, the combustion of coal, oil, gas for generating electricity, use of pesticides in agriculture and smoke from crackers respectively. Similarly, majority of the respondents just had a heard about the causes of water pollution i.e. 54, 50.67 and 50 per cent. Same was the case with the causes of soil pollution i.e. 62, 55.33 and 55.33 per cent. The detail knowledge about the causes of noise pollution was also known to a few respondents i.e. 10.67, 6.67, 4.67 and 2.67.
- Forty eight per cent respondents reported no impact of any type of pollution on their sleep. But 86.67 per cent respondents reported slight depression due to deteriorating environment. Majority of respondents (1.33%) reported some symptoms of asthma due to air pollution, 46.67 per cent respondents complained about various types of allergies and skin problems due to rising levels of different types of pollution. No one reported any hearing impairments or occurrence of any type of cancer due to faulty environment.
- Majority of the respondents don't know about the constituent chemicals of the household products and general impact on health or environment for example household cleaners (82%), polishing agents (86%), detergents (60%) and air fresheners (50%). Only few respondents made efforts to avoid use of harmful chemicals like 12.6 and 20.67.
- All the respondents knew and had also experienced that plants help to reduce carbon dioxide levels in air, reduce levels of certain pollutants, keeps air temperature cool, prevent soil erosion and helps to absorb noise. Similarly, almost all the respondents were appreciative of role of indoor plants in creating pleasant environment, help to detoxify air and help to reduce indoor pollution.
- Majority of the respondents never concern about the conserving environment through their efforts like avoid wrapping of gifts with non-biodegradable materials (85.33%),put off the air conditioner and bear hot weather(54.66%), prefer to travel by public transport (50.67%).
- Almost all the respondents partially adopted the green norms related to selection of site i.e. they were conscious about choosing a high level of ground, good type of soil and underground water though they were not fully satisfied with the execution of these norms.
- Closer proximity to all the major civic amenities could only be achieved by four seventy percent respondents to reduce the use of automobiles in meeting family needs.
- Similarly very few (37.46%) respondents adopted the online shopping and online arranging utilities and paying bills due their initial hesitation and fear in using these

service to reduce the number of trips- a green norm.

- Regular outside configuration of the building to minimize the exposed wall area to outside environment was found to be partially adopted by 60 percent respondents, others preferred good prospect of the house over the green norm.
- All the respondents fully adopted the green norm of getting house plan approved as it was mandatory in all the cities.
- Almost all the respondents took measures to control soil erosion at the various phases of construction of their house.
- Sixty percent respondents were conscious in conserving the soil nutrients by stockpiling the top soil and using it later for raising successful gardens.
- Ninety three percent respondents could not do any effort in conserving the natural topography and vegetation as they purchased residential plots in already developed colonies but it was found that even colonizers showed scant respect to conserving natural topography and vegetation.
- The green norm of offsetting the heat island effect from non-roof area was adopted by 84.67 percent respondents by way of raising grass turfs and other plants.
- Whereas 16.67 percent respondents partially adopted the green norm of offsetting heat island effect from roof area by giving an insulting layer of mud and straw but not using the modern green technology of installing reflectors on the roof area.
- Thirty four per cent respondents were found to be providing an appropriate parking facility for the visitors and no respondents were found to be charging facilities for futuristic electric vehicles.
- Majority of the respondents partially took care of the needs of differently abled persons in their house design and almost all the respondents also took care of the needs of their construction workers.
- The green norm of conserving water through rain water harvesting system was found to be adopted by one of the respondent.
- A large percent (100%, 92% and 70.67%) of respondents were found to be adopting the green norm of installing water efficient faucets like dual flush system, faucets 8LPM, bidets 8 LPM respectively in their homes.
- But a negligible percentage of respondents were found adopting the efficient water conservation practices for their landscape by way of planting drought resistant plant species, segregating plants on the basis of their water requirements, installing drip irrigation system, moisture sensors for assessing irrigation needs, device to maintain optimal water pressure respectively. Swimming pool and fountains were not found in any of the respondents' homes. Seventy five percent respondents did not care to adopt

efficient car washing practices.

- Overall 55.21% respondents did not adopted the green home norms related to energy efficiency.
- Majority of the respondents did not adopted the green home norms for building materials and resources like hundred, ninety three, ninety and seventy per cent. None of the respondents fully used at least five passive or active green building materials, products and equipment (certified by IGBC).
- All the respondents just had a partial provision of the green practice of maintaining comfortable indoor environment by way of cross ventilation. Eighty eight per cent respondents did not have the provision of adequate operable windows in each room to exterior, unobstructed space beyond windows for free flow of air (8m), all the respondents did not have the provision of separate smoking area, installation of carbon dioxide sensors. All respondents had partial provision of adequate day lighting in regularly area in their homes. Ninety three per cent respondents just had partial access to adequate outdoor view. Seventy two per cent respondents did not have the provision of minimizing exposure of occupants to hazardous indoor. Seventy three respondents were found not using paints and coatings with low or no VOC content. None of the respondents were found using green labelled carpets, composite wood and agr-fiber materials for flooring panelling etc. Majority of the respondents (74%) had facilities to enhance physical, emotional and spiritual well-being of occupants (gymnasium, yoga, meditation etc.)
- On the whole lack of interest (45.57%) was the major constraint for not adopting the practices related to site selection and house planning followed by high cost (41.21%), lack of provision (30.12%) lack of awareness (18.38%) lack of cooperation from the society (5%) and lack of skilled of labour (3.93%)
- Lack of interest (58.09%) was the major constraint for not adopting the practices related to water conservation followed by lack of awareness (29.14%), high cost (26.38%), lack of skilled of labour (10.45%) and lack of provision (2.85%).
- Lack of interest (45.22%) was the major constraint for not adopting the practices related to energy efficiency followed by high cost (11%), lack of provision/availability (9.7%) lack of awareness (7.55%),lack of co-operation from society (5.11%) and lack of skilled of labour (1.88%).
- Lack of interest (37.04%) was the major constraint for not adopting the practices related to green building materials followed by lack of awareness (25.33%), lack of provision (11.24%), lack of skilled of labour (11.04%), high cost (5.04%) and lack of co-operation from society (4.19%)

- Lack of interest (44.67%) was the major constraint for not adopting the practices related to energy efficiency followed by lack of awareness (39.22%), high cost (18.27%) and lack of provision (13.61%).
- Lack of ability (92.67%) was the major constraint for not adopting the practices related to innovation and development followed by lack of knowledge (80%), lack of interest (66.67%) and lack of provision (8%).

Implications of the study

The results of the study imply that urban people are passing the responsibility of pollution due to their lifestyle on other reasons as they lack sound environmental knowledge. The findings of the study also indicate that families lack interest in the implementation of green home norms because of lack of knowledge about the benefits of adoption of sustainable building design and systems.

Recommendations of the study

For extension workers

The concept of green home needs to be popularized among the masses and related misconceptions need to be cleared. There is negligible extra cost of building a green house with less operating cost which just requires the application of conventional wisdom. Constructing green homes is just not a future option but a compulsion for the survival of coming generations. Families should be educated about the benefits of sustainable building designs and life style.

For families

Urban families need to reorient their psyche and appreciate the importance of their small contributions for the gigantic task of environment protection. To lessen the effect of consumptive lifestyle, families should strictly adhere to reduce, reuse and recycle philosophy. They should do extra efforts to dispose off their waste in a scientific way.

For policy makers

Building bye laws for developing new residential colonies and constructing houses should be strictly enforced in order to ensure proper light, ventilation and view facilities for all houses. Traffic lanes in localities should be wide enough to accommodate plantation and safe parking. Roof top rain water harvesting should be mandatory in all homes. Provision of fine for misuse of potable water should be made. Installation of solar energy devices should be made more popular, affordable and convenient. Garbage collection system should be improved.

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APPENDIX-I

INTERVIEW SCHEDULE

A study on adoption of green home norms in modern houses

A. General Information

1. Name of the respondent-

2. Address of the respondent-

3. Phone number:-

4. Type of family-Joint/Nuclear

5. Composition of family:-

Family members	Age	Gender	Education	Occupation
Self				

6. Total family income from all sources (Annually):-

7. Basic housing Information

a) Total area of the plot-

b) Constructed area of the house-

c) Year of construction-

d) Number of floors/storeys-

e) Did you hire any of the following during the construction of your house?

Yes/No No. of meeting

- Architect

- Interior designer
- Landscape designer
- Energy modular
- Green building consultant
- Vaastu experts

Any other_____

f) Source of water supply-Underground/Municipal/both

g) No. of water tanks installed:-

Tanks	Capacity (ltrs)	How many times

h) How much water used per day?

Areas	Amount (ltrs.) approx.	Diameter of the tape
Cleaning of house	_____	_____
Washing of clothes	_____	_____
Bathrooms/Toilets	_____	_____
Gardening	_____	_____

i) Have you installed and maintained the gadget to stop the overflow of water from the tank?

- Yes/No

  If yes, then tick below
- Water Tank Overflow Alarm
- Wireless water level indicator

j) Is there any provision for sub metering water use applications in your house?

- Yes/No

If yes, then tick below which one?

- Bore water consumption
- Municipal water consumption
- Water consumption for landscape requirements

  Any other major source of water consumption_____

k) Status of solar energy devices installed:-

- Yes/No

Devices	Dependence (%)
Solar light system	
Solar water heater	
Solar battery charger/inverters/generator	
Any other _____	

l) What is the status of observances of building bye-laws?

Front area:-

Back area:-

Window area:-

Height of building:-

Materials used:-

m) Have you obtained occupancy certificate by the local authorities?

- Yes/No

n) No of inspections by local municipal committee:-

o) No of vehicles-

No of cars	No of bikes

p) Cooling/Heating system in the house-

No of air conditioners/Heaters	No of heaters	No of hours

B. Specific information:-

(1) What changes have you observed in your environment over last 2-3 decades?

	Somewhat	**Quite a lot**	**Too much**
• Pollution has increased			
1. Air pollution			
2. Water pollution			
3. Soil pollution			
4. Noise pollution			
• Health problems have increased			
• Change in extreme temperature in different season			

Any other_____

(2) What you think are the major sectors causing pollution?

- Agriculture
- Industry
- Housing
- Transportation

  Any other_____

(3) Do you know the main causes of air pollution?

- The combustion of coal, oil, gas and other fuels for generating electricity
- Burning gasoline, diesel and other fuels for transportation
- Emissions from various industrial processes
- Emission from harmful chemicals from households.
- Smoke from crackers
- Use of pesticides in agriculture

  Any other_____

(4) Do you know the main causes of water pollution?

	Aware	**Not aware**
• Release of Industrial wastes to the soil		
• Release of untreated sewage and waste water		
• Marine dumping		
• Excessive use of Chemical fertilizers and		
• pesticides in agriculture		
• Presence of underground heavy metals		
• On-site sanitation system		
• Eutrophication		

Any other_____

(5) Do you know the main causes of soil pollution?

	Aware	Not aware
• Direct discharge of industrial wastes to the soil		
• Discharge of sewage sludge		
• Landfill and illegal dumping		
• Construction activities		
• Some agricultural practices		
• Accidental spills		

Any other_____

(6) Do you know the main causes of noise pollution?

	Aware	Not aware
• Industrial sources		
• Transport vehicles		
• Household appliances		
• Agricultural machinery		
• Construction works		
• Public functions		

Any other_____

(7) Are you suffering from any problems due to deteriorating environment?

	No impact	Little	Moderate	Acute
Psychological issues:-				
• Insomnia				
• Depression				
Physical issues:-				
• Asthma				
• Allergies				
• Cancers				
• Skin diseases				
• Lung diseases				
• Hearing impairment				

Any other_____

(8) Do you know there are harmful chemicals used in household products and appliances?

	Don't Know	Know the constituent/ emitted chemical	Know impact of chemical on health/env.	Do effort to avoid use of harmful chemical
• Air fresheners				
• Household Cleaners				
• Polishing agents				
• Detergents				
• Insect repellents				
• Refrigerants				
• Air conditioners				
Any other_____				

(9) Do you know the role of plants which helps to purify the air?

Role of plants	Heard about	Experienced the effect	Know related facts
<u>Outdoor plants</u>			
Reduces carbon dioxide levels			
Increases humidity			
Reduces level of certain			
Pollutants, such as benzene and nitrogen dioxide			
Keep air temperature down			
Reduce stress level			
Absorb noise			
<u>Indoor plants</u>			
Lends pleasing surrounding			
Help to detoxify the air			
Provide oxygen			
Reduce pollution by absorbing capacity			

(10) Do you know about following concepts?

	Aware/Not aware	Somewhat	No idea
• Ozone layer depletion			
• GHGs			
• Renewable energy			
• Green label marks			
• Green building materials			
• Green consumerism			
• Eco-friendly products			

(11) Have you followed any practices with a concern to save environment?

I follow the following practices with a concern to save environment	**Level of concern**		
	Always	**Sometimes**	**Never**
Put off the air conditioner and bear hot weather			
Prefer to travel by public transport			
Go for shopping with due arrangement to avoid use of plastic bags			
Refrain from using plastic/use and throw rockery			
Prefer to keep family celebrations simple			
Prefer to share my special feelings with others throw rockery			
Avoid wrapping of gifts with non-biodegradable materials			
Dispose household waste after due segregation			
Believe in the philosophy of re-use and recycle			
Servicing electric appliances regularly to conserve energy			
Observe simplicity in family celebrations Attend any green consumerism awareness organization and camp			

(12) What did you consider at the time of site selection of your house?

- Level of ground :-
- Type of soil :-
- Condition of underground water :-

(13) How far are the proximity to civic amenities from your house?

Amenities	Meters/Kilometers
ATM / Bank	
Clinic / Hospital	
Bus stand	
Crèche / School	
Grocery store / Supermarket	
Laundry / Dry cleaners	
Park / Garden	
Pharmacy	
Post office / Courier service	
Restaurant / Cafeteria	
Service apartment / Hotel	
Sports club / Fitness center / Gym	
Theatre	
Utility bill payment center (Electricity / Water)	

(14) Are you aware of the online shopping facilities?

- Yes/No

If yes than tick below

- Fast moving consumer goods
- Payment of utility bills
- Banking services

- Laundry services
- Booking of various services
- Obtaining occupancy certificate
- Approval of building plan
- Outside configuration of house

Any other_____

(15) Have you measured the control of soil erosion?

- Post occupancy :-
- During- construction :-
- Pre-construction :-

(16) Have you adopt any green home norms practices related to site selection and planning?

Site selection and planning	**Full**	**Partial**	**Not adopted**
Stock piling fertile top soil for reusing in landscape			
Conserving natural topography or vegetation			
Offsetting heat island effect (non-roof area)			
Offsetting heat island effect (roof area)			
Parking facilities for visitors			
Electric charging facilities for vehicle			
Basic facilities for construction workers			
Design for differently abled			
Easy to access to maintenance			
Non-slippery ramps with handrails			
Adequate width of doors			
Uniformity in floor level			

(17) Have you adopted any practices of green home norms related to water efficiency of house?

Water efficiency	**Full**	**Partial**	**Not adopted**
Provision of rainwater harvesting system			
Provision of re-use of rainwater Roof tops area (Percentage) 20-25 25-50 50-100			
Non-roof area Percentage) 20-25 25-50 50-100			
Water efficient plumbing **Fixtures** High flush-6LPF Low flush-3LPF Faucet (8LPM) Bidet (8LPM) Kitchen sinks (8LPM) Shower head (10LPM) Hand held spray (10LPM**)**			
Mechanism to stop overflow water			
Landscape design Plant drought resistant species Limit turf area **Management of irrigation** **System** Install central shut off valve Segregate turf and beddingbased on watering needs 50% area drip – irrigated Installation of sprinkler irrigation system for turf Use of pressure regulating device to maintain optimal pressure Install moisture sensors			

Install time/based controller Water conserving practices for swimming pool Water conserving practices for fountain			
Efficient car washing practices			

(18) Have you adopted any practices related to green home for energy efficiency of house?

Energy efficiency practices	**Full**	**Partial**	**Not adopted**
Use CFC free household equipment			
Halon-free Fire Suppression Systems			
Installation of star rated (BEE 5 rating)			
Fans			
Air conditioners			
Refrigerants			
Lighting			
Motors and pumps			
Building envelope			
Management of window glazing			
Proper orientation of the room			
Select light colours for room's walls			
Appropriate selection and operation of window treatments			
Add awnings,shades and shutters to the exterior of your windows			
Sunshading by growing plants			
Efficients fenestration			
Management of solar heat gain by roof			
Water heaters			
Installation of on-site renewable energy systems			
Solar water heaters			
Generators			
Solars garden lights			

(19) Have you adopted any practices related to green home for building materials and resources?

Name of practices	Full	Partial	Not adopted
Dispose off waste of building material in a segregated way			
20% of the total building material(by cost) is manufactured locally(with in distance of 400km)			
50% of wood based material(by cost) is from rapidly renewable source			
30% of total building material(by cost) has recycled content			
Facility of on-site waste treatment system for handling 50% of organic and landscape waste of the building			
75% of the waste generated during construction is diverted from landfills for reuse or recycling			
Used at least five passive or active green building materials, products and equipment (certified by IGBC)			

(20) Have you adopted any practices related to green home for indoor environmental quality?

Name of practices	Full	Partial	Not adopted
Provision of cross ventilation in rooms			
Adequate operable windows in each room to exterior			
Unobstructed space beyond windows for free flow of air			
Provision of separate smoking area			
Installation of carbon dioxide sensors			
Provision of adequate day lighting in regularly occupied areas			
Provision of adequate day lighting in non-regularly occupied areas			

(21) What types of constraints faced by you in selection of site and planning?

Green home features	**Types of constraints**					
	Lack of awareness	**Lack of interest**	**Lack of provision/ availability**	**Lack of co-operation from society**	**High cost**	**Lack of skilled labour**
Selection of site Level of ground						
Type of soil						
Proximity to civic amenities						
Soil erosion control measure						
Online shopping Banking services						
Payment of utility bills						
Heat Island Reduction, Non-roof						
Heat Island Reduction, Roof						
Appropriate Outside configuration of house						
Parking facilities for visitors\						
Electric charging facilities for vehicle						

(22) What types of constraints faced by you in conserving water in your home?

Green home practices	**Types of constraints**				
	Lack of awareness	**Lack of interest**	**Lack of provision/ availability**	**High cost**	**Lack of skilled labour**
<u>Selection of water conservation</u> Rainwater Harvesting, Roof & Non-roof					
Water Efficient Plumbing Fixture					
Landscape Design					
Efficient landscape irrigation system					
Use of pressure regulating device to maintain optimal pressure					
Install moisture sensors and time based controller gadgets					
Efficient car washing Practices					

(23) What types of constraints faced by you in achieving energy efficiency in your home?

Green home practices	**Types of constraints**					
	Lack of awareness F(%)	**Lack of interest F(%)**	**Lack of provision/ availability F(%)**	**Lack of co-operation from society F(%)**	**High cost F(%)**	**Lack of skilled labour F(%)**
Use CFC free household equipment						

Halon-free Fire Suppression Systems						
Installation of star rated appliances						
Building envelope						
On-site Renewable Energy Solar water heaters						
Solar garden lights						

(24) What types of constraints faced by you in building selecting green materials and resources for your home?

Green home practices	**Types of constraints**					
	Lack of awareness	**Lack of interest F(%)**	**Lack of provision/ availability F(%)**	**Lack of co-operation from society F(%)**	**High cost F(%)**	**Lack of skilled labour F(%)**
Selection of building materials and resources 20% of the total building material (by cost) is manufactured locally						
50% of wood based material (by cost) is from rapidly renewable source						

30% of total building material(by cost) has recycled content						
Facility of on-site waste treatment system for handling 50% of organic and landscape waste of the building						
75% of the waste generated during construction is diverted from landfills for reuse or recycling						
Used at least five passive or active green building materials, products and equipment (certified by IGBC)						
Dispose off waste of building material in a segregated way						

(25) What types of constraints faced by you in maintaining indoor environmental quality in your home?

Green home practices	**Types of constraints**			
	Lack of awareness	**Lack of interest**	**Lack of provision/ availability**	**High cost**
Provision of cross ventilation in rooms				
Adequate operable windows in each room to exterior				
Unobstructed space beyond windows for free flow of air				
Installation of carbon dioxide sensors				
Provision of adequate day lighting in regularly occupied areas.				
Provision of adequate day lighting in non-regularly occupied areas				
Provision of adequate outdoor views				
Provision for minimizing exposure of occupants to hazardous indoor				
Use paints and coatings with low or no VOC content				
Use of adhesives in interiors with permitted level of VOCs				
Installation of CRI Green Label Plus carpets only				
Facilities to enhance physical, emotional and spiritual well being of occupants				

(26) What types of constraints faced by you in innovation and development of green home?

Green home practices	**Types of constraints**			
	Lack of interest	**Lack of knowledge**	**Lack of ability**	**Difficult to manage the time schedule**
Innovation in design process				

VITA

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