Comparative Analysis of Environmental Concerns Between Public and Private Housing Industry

By

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It is certified that the contents and form of the thesis entitled

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has been found satisfactory for the requirement of the degree of Masters of Science in Environmental Science

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Dedicated to

My Dearest Daughter Daria Hassan

For her patience, love and understanding

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In the name of Allah, the Most Benevolent and Merciful

All glory is to "Allah"

There is no God but He, the living the everlasting.

He is the High the all Glorious. (Quran)

I feel actuate from with to offer my humblest and sincerest thanks to Almighty Allah who is Merciful and whose Benevolence enabled me to work hard and has given me knowledge and patience to complete my thesis. I am humbled by the blessings and help, received from Almighty Allah throughout this period, and special praise to His last Messenger Hazrat Muhammad (PBUH) who is forever a torch of knowledge and guidance for humanity as a whole.

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Najaf Haider

TABLE OF CONTENTS

LIST OF ACRONYMS

Acronym	Abbreviation
WGBC	World Green Building Council
PGBC	Pakistan Green Building Council
IEE	Initial Environmetnal Examination
EIA	Environmental Impact Assessment
LEED	Leadership in Energy and Environmental Design
UNGBC	United Nations Green Building Council
BREEAM	Building Research Establishment Environmental Assessment Method
CDA	Capital Development Authority
SPSS	Statistical Package for Social Sciences
ANOVA	Analysis of Variance
PHAF	Pakistan Housing Auhority Foundation
OSHA	Occupational Safety and Health
HSE	Health, Safety and Environment
EPA	Environmental Protection Agency
ESA	Environmentally Sensitive Areas
ICT	Islamabd Capital Territory

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Housing is the basic need of human being. In Pakistan rapid unplanned urbanization has left a huge environmental foot prints. Housing industry is consuming 50% of world energy resources and producing 50% of waste out of which 30% is solid waste only. The research study considers comparative analysis of environmental concerns during construction of their projects between Public and Private Housing Industry. For this purpose, four housing schemes were selected in Islamabad and out of these two from each group i.e. public and private schemes. In order to proceed further two types of questionnaires were developed, one for residents and one for builders. The data was obtained from a total no. of sample 204 and analyzed through Multiple Regression, ANOVA and Coefficient of Variance. It is found out that as per the opinion of residents, the public housing schemes have incorporated the environmental concerns more than the private housing schemes however the environmental management is negligible in both the sectors studied. EIA has been conducted in Public Housing Schemes but the Environmental Management Plan has not been implemented. Private housing sector is violating the law by not conducting the EIA/IEE however, their builders have incorporated the environmental concerns better than the builders of Public sector. The only environmental parameter with 100% satisfaction result by residents is Quality of life in Private housing scheme but at the cost of high price. The cost of construction per square feet is almost double in Private housing schemes. The improvement in housing industry can be achieved through introducing the concept of Green Building in Pakistan and by following the legislation, conducting the EIA/IEE and international standards like LEEDS for green building.

Chapter 1

INTRODUCTION

1.1 Background

Industrial revolution brought massive and unplanned development as the industries began limitless exploitation of resources such as fossil fuels, timber, minerals and water. As a result, the adverse impacts of development showed in the form of disasters, energy crisis, water pollution and shortage, air pollution, land degradation and climate change (Roodman *et al*., 1995). With these issues, a new era began which included the environmental dimensions into developemnt discourses. In 1960s, the envionmental movement started as a backlash to environmental exploitation and the paradigm of development was shifted towards environmental friendly approaches. Globalization led to the paradigm of "limits to growth" and the environmental activists around the world raised their voices against the reckless development (Buttel *et al*., 1990). Now the societies and communities are aware and mindful about the environmental concerns. While residents are moving towards high quality of life and environmental friendly living, both private and public housing authorities are striving hard to keep pace with the growing demand of sustainable development (Circo, 2007).

1.2 Housing and Shelter: A Basic Human Need

Housing is an apparent and basic need of human beings without which their survival is not possible. House is both a physical and social structure; physical in terms of material, environment and their interaction, while social with respect to residents, their behaviors, attitudes and socio-economic interactions (Granovetter, 2005). Housing industry is one of the leading industries that uses half of the worlds resources to construct structures thus transforming natural environment into built environment (Fraser and Kick, 2007). Environmental protection is an important concern during housing development these days due to the increasing pressure on land and other natural resources (Howard, 2005). With the increasing population levels, all the cities and towns are expanding to meet the challenging housing needs. This urban sprawl is changing the natural environment. Environmental concerns must be involved in construction process from cradle to grave i.e. during the whole life cycle involving planning, design, construction, operation, maintenance, and refurbishment, and the final destination of the materials after expiry (Chatterjee, 2009).

Housing units range from single unit private houses to multi storied apartments. New residential estates are being developed where multiple housing units are constructed on one plot of land such as high-rise flats. High-rise apartments save the land by utilizing the single tract of land but they intensify the need for energy, water and waste management (Jim and Chen, 2010). Depending upon the socio-political scenario and demand of the housing units, either public or private sectors may provide housing. Housing projects can be of several types:

- Unplanned projects where people convert their private land or space into residential unit. The houses in this case are well-built but there is not planning or proper decision making process. This causes problems afterwards when the environmental and safety implications begin to show up.
- Construction projects owned by government or private owners, in which the proponent conducts proper town planning, constructs the houses and sells them to buyers.
- Construction projects owned by government or private owners, in which the proponent conducts town planning, develop plots and sell them to buyers who construct their own houses on that space (NWFP-EPA, 2004).

1.3 Impacts of Housing development on Environment

The complex interrelationship of housing and environmental sustainability has a variety of impacts. The intensity and type of impacts from housing vary from project to project. New development on virgin sites has more extreme impacts on natural resources and processes then already urbanized land specified for housing because a whole new system has to be established for water supply, sewarage, energy, waste and routing and it also employs huge cost (PEPA, 1997). The local impacts of housing can combine with regional impacts from other sectors and can cause cummulative impacts such as siltation of water bodies during construction can lower the capacity of water channel and cause urban flooding in some other area later during rainy seasons. This urban flooding destroys infrastructure and is cause of poor health conditions thus combining and adding to the impacts. Some impacts are direct such as onsite air and noise pollution during construction while some are indirect such as congestion of traffic patterns in some other area due to construction of housing scheme. Other then negative effects, there are also positive effects of the housing construction projects such as the landscape becomes attractive (Ortiz *et al*., 2010).

1.4 Sustainable Development and Housing

Sustainable development has brought a revolution in industrial arena by introducing environmental mainstreaming (UNCED, 1992). As housing is the main industry, it requires serious assessment to whether the housing units are according to the eco-friendly demand and ensures the well-being and safety of the occupants. Homes should be designed in such a way that the overall impacts on the environment are minimal before, during and after the construction (Ding, 2008). Environmental concerns in housing revolves around three main key concepts:

- The consumption and harvesting of natural resources such as timber, fossil fuels, water and energy to provide as a basis for construction of habitat.
- The impact of construction, operation and inhabitation of residential schemes on over all ecosystem integrity.
- The mutual functioning and management of natural and built environment in order to provide ecological conservation and occupants well-being.

There is a need for sustainable construction because the houses accounts for 40% of world's enrgy use, 50% of resource consumption and 50% of waste production including 30% solid waste and 20% waste water (UNEP). IPCC Report, 2007 reveals that more then 35% of green house gas emissions come from housing sector contributing a lot to climate change. Sustainably designed houses use 30% less enrgy and 20% less water. Sustainable construction involves the application of practices that are cost-effective and ecologically sound. Private builders are generally more keen to involve environment and safety guidelines in ther projects specially in Pakistan but the private schemes are usually expensive. Public sector should also be strengthened to include sustainability in house design (Azhar *et al*., 2008).

Sustainable construction has three main dimensions:

i. Environmental Protection

Through sustainable construction, less resources are consumed such as when the building structure is resilient, then it requires less maintanance. Forests and rangelands are protected from anthropogenic activities and the air, water and land quality is maintained. The energy efficiency saves the energy and reduces the carbon foot print of housing. Water conservation practices ensures the continous supply of water (Nadeem and Hameed, 2008).

ii. Social Well-being

Social well-being involves the quality of life an individual attains which is the determinant of its health. Indoor air-quality, ventialtion, green spaces, parking spaces, access to major roads and transportation stops, aesthetic value and cleanliness all comes under social welfare of the occupants. Sustainable town planning wrap all these concerns together and improves the safety and wellness of the residents (Colbeck *et al*., 2010).

iii. Economic Prosperity

Resilient buildings automatically leads to strong economy (Dainty an Bosher, 2008). When the cost is invested in sustainable construction, it gives long term benefits and saves the whole life operating cost of reconstruction and maintanance in case of natural disasters. Energy and water sector is benefited by conservation of both resources.

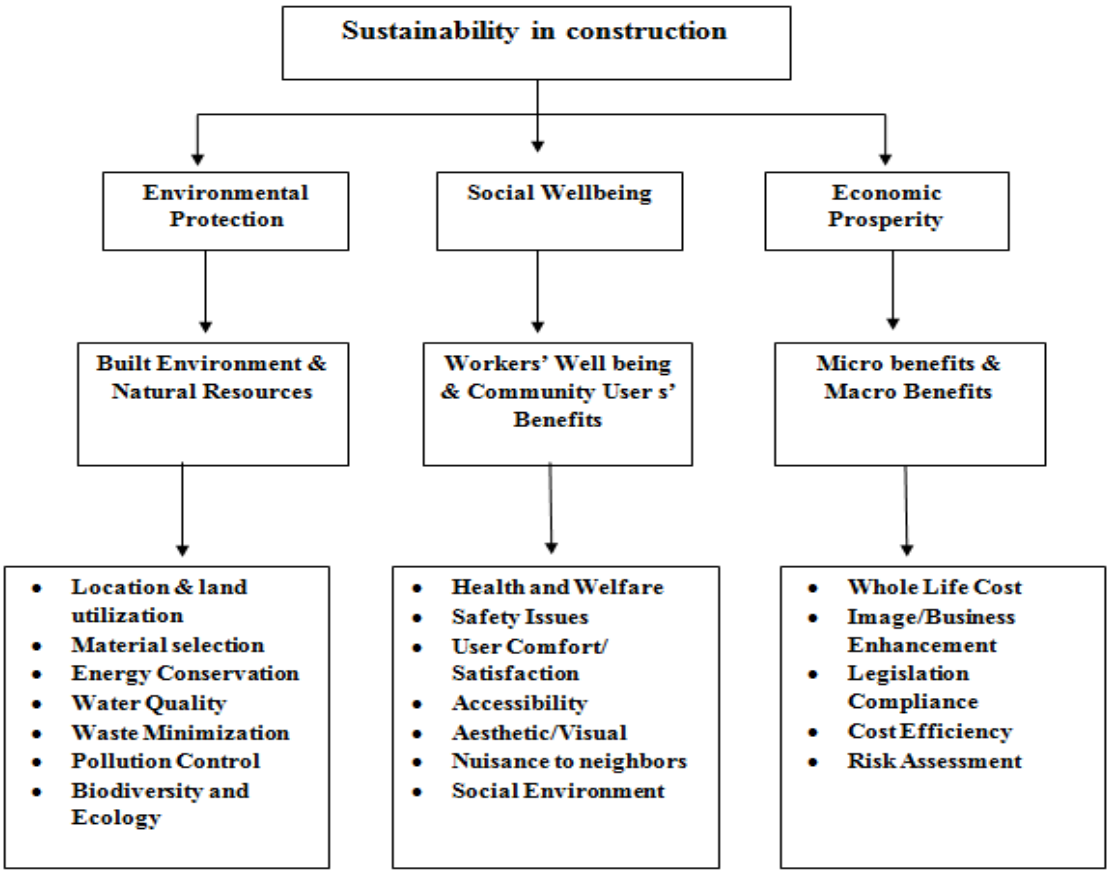

Figure 1.1: Dimensions of Sustainability in Construction

Source: Abidin *et al*., 2010

Sustainabilty should be incorporated into construction on following three levels:

i. Policy

Policies include the guidelines for the relevant housing units but they are not so effective in tackling detailed impacts of the construction activity as they only provide the comprehensive legislation and code of conduct. The housing policy should describe major impacts of construction on environment and propose mitigation strategies and set green housing goals.

ii. Programme

Programmes are launched in reponse to the comittments made in policies. Programmes give authorities and form major bodies to implement the goals and objectives of policy. Under programmes various projects are launched for the achievments of targets.

iii. Project

Projects are the main implementation level where practical implementation of the strategies takes place. IEE and EIA are conducted at a project level where the major and minor impacts related to each project activity is identified and checklist is made. Technical solutions and alternatives are then applied to minimize the negative impacts.

1.5 Green Building

Over the previous decade, green building has risen as a resilient way of development to create environmentally sound and efficient infrastructure that protects both the ecosystem and residents safety and health (Dainty and Bosher, 2008). Green building is supported by United Nations Green Building Council (UNGBC) and the LEED (Leadership in energy and Environmental Design) standard devised by UNGBC which is a standard to evaluate the impacts of planning, construction, design and operation of the buildings (Reeder, 2010). Another leading standard that favors green building is the BREEAM (Building Research Establishment Environmental Assessment Method) (Pulselli *et al*., 2007). The initital cost incurred in the green housing development is high but in a long run its worth the health and environment benefits.

Green building requires the installment and incorporation of environment friendly technologies and material into house design and structure. The main objective of green building is to reduce the effects of built environment and anthropogenic activities on the ecosystem functioning and occupants welfare by adopting the environmental protection measures during following:

i. Site selection

Site selction should be done in such a way that no environmentally sensitive area, land of argricultural importance, cultural heritage site, wetland, bio-diversity reserve or sancturay is destroyed. The replaced community if any should be compensated for land. Land with flooding constraints or waterways,Slope, low lying areas, disaster prone areas and saline lands that increase the cost of construction should be avoided.

ii. Project Design

Detailed investigation studies and base line surveys are required to design the housing project. Traffic and transport issues, provision of water supply, electricity and gas connections, strom water management, telephone networks and proximity to educational institutions and shopping centers should all be considered while designing.

iii. Construction

Construction is the main phase and has a wide range of impacts to handle. The project site is vulnerable and impacts are severe at that time. Major impacts are; soil erosion from uncovered land, siltation of water bodies, flooding from water used in construction, loss of vegetation, air pollution and noise pollution from machinery and construction material, oil spillage from machinery, traffic congestion, construction waste disposal, and workers health and safety.

These impacts can be minimized by creating temporary ponds to avoid siltaion and covering the excavated soil. Trees if cut should be replanted to maximum possible extent. Water sprays and scrubbers to combat dust and pollution and enclosures and mufflers should be used around machineries to minimize noise. Contingency plans for accidents should also be devised before the commencement and temporary sanitaion facility should be provided to workrs.

iv. Operation Stage

Energy efficiency, water efficiency, solid wate management, ventilation System and Indoor Air Quality, resistent and Safe Material, green spaces and public health are the operation stage considerations to be kept.

Green building bounds the proponet of project to consider all the above mentioned environmental aspects and impacts in the construction process.

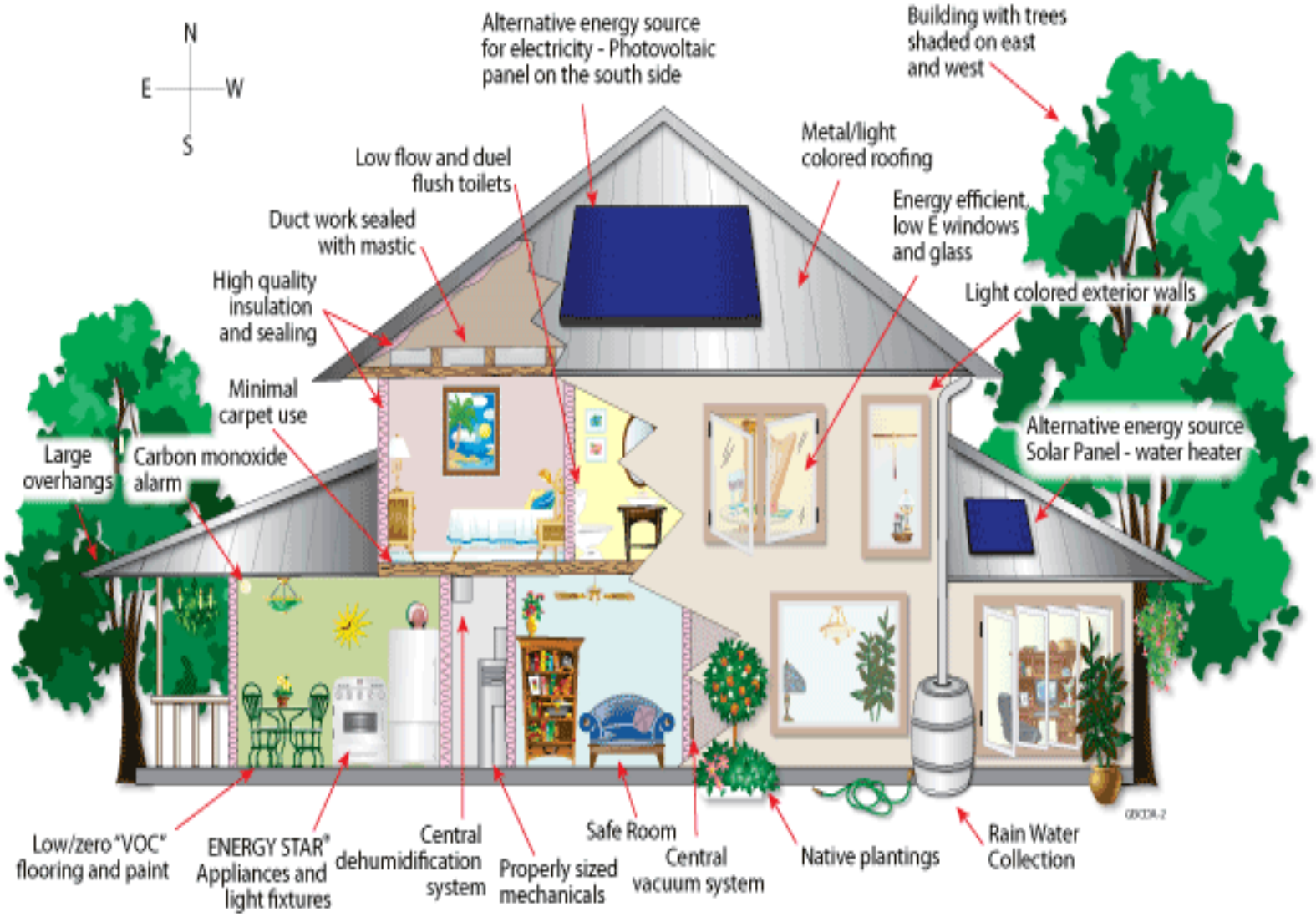

Figure 1.2: A Typical Green Building

Source: Florida Solar Energy Center

1.6 Green Building in Pakistan

Construction and housing has been identified by the government of Pakistan as one of the leading sectors in country's economy (Shiraz and Kazmi, 2016).Pakistan Environmental Protection Agency has devised sectoral guidelines for housing estates and new town development which are applicable on formal housing schemes in both public and private sector (PEPA, 1997). These guidelines address the selection of site, design of the housing units and environmental impacts of construction and operation process. The maintenance and renovation has not been addressed in these guidelines. Pakistan Green Building Council (PGBC) is the unit of World Green Building Council which consists of 98 Countries around the world (Ahmed *et al*., 2016).It has been established to promote sustainable future housing development. In Pakistan, the green building movement has also been initiated by enforcing the EIA and IEE as a pre-requisite in construction which requires the project proponent to identify the major and minor aspects and impacts of the undertaken project and then devise the alternatives and mitigation measures (Rahman, 2009).

1.7 CDA Building Laws

CDA devised Islamabad Residential Sectors Zoning (Building Control Regulation, 1993 for all residential buildings, apartments and flats in ICT. They contain construction guidelines as per the number of storey's, size, height and other specifications including safety of residents and adjacent houses.

Figure 1.3: Multi-story Flats in Islamabad

1.8 Problem Statement

Poor construction strategies and poor housing not only cause the adverse effect on the environment but also threatens the health and well-being of the residents. Identifying the negative short term and long term impacts of construction on environment and health can minimize them or completely mitigate them in some cases. There is no proper evaluation system to assess the environmental responsibility of housing projects so there is a need for evaluation of housing units to check the level of concern given to environmental issues while construction.

1.9 Novelty of Study

This study compares the consideration of environmental concerns in public and private housing schemes. The housing schemes selected for the research are reknowned and have not been previously evaluated in terms of health and environment so this is a new research which has surveyed both builders and residents for assesment of environmental concerns.

1.10 Significance of the study

This research defines specific issues underlying the interrelationship of the natural and built environment, sustainability and environmental protection during green building and also to analyze the construction strategies used to minimize ecological impacts and improve safety by public and private authorities. It will devise the measures that can be taken by the housing development authorities and government to decrease the negative effect on environment.

1.11 Objectives

Present research focuses on the comparative analysis of environmental concern during construction between public and private housing schemes and has following objectives:

1. To assess the awareness of the environmental issues in housing industry.
2. To empirically assess the level of incorporation of the environmental concerns by builders among private and public sector by analyzing their work procedures.
3. To generate useful recommendations/guidelines on the basis of research findings for future housing schemes.

Chapter 2

LITERATURE REVIEW

2.1. Introduction

Environmental protection is an important concern during housing development these days due to the increasing pressure on land and other natural resources (Howard, 2005; Lam *et al*., 2010; Cidell, 2009). Empirical and theoretical evidence from the literature supports this notion that incorporating the concept of sustainability in housing is the need of the hour and the sustainable construction is taking lead in housing sector in many countries (Kibert and Grosskopf, 2007; Ng *et al*., 2008) . The concept of "Green Building" emerged in 1970s (Haapio and Viitaniemi, 2008). (Lawrence, 1995) stated that ecological dimension should be included in construction of houses to improve the overall quality of life. (Pries and Janszen, 1995) analyzed the behavior of companies within the construction sector and their strategic behavior towards environmental concerns. Their study shows that because of the recent green building revolution and ecological unrest, the builders are now incorporating environmental concerns in their housing development projects. Builders have to strive in the construction market and they have to rethink about their potentials in a more innovative way because the impacts of construction, operation and maintenance of houses on the natural environment have to be reduced (Aizlewood and Dimitroulopoulou, 2006).

2.2. Building Standards

Many standards and certifications have been developed by various countries to boost the environmentally sound housing and construction. These standards include BREEAM (UK), LEED (USA), HK BEAM (Hong Kong), CASBEE (Japan), HQE (France), DGNB (Germany), PromisE (Finland), Green Globes (Canada), Green Stars (Australia), BCA Green Mark (Singapore), China Green Building Labels: GBDL, GBL and GOBAS, Korean Green building Label (Chuck and Kim, 2011). These are the environmental assessment methods in construction sector that assess the energy management, waste management, indoor air quality, green spaces and general wellness of the residents (Jacobs *et al*., 2015).

At first, the integration of environmental factors in housing construction was thought only to be considered by private builders but recently government authorities have also include the

environmental dimensions in their construction agendas and guidelines (Edwards and Turrent, 2002). Ecological dimension and safety and health issues are a foremost priority now in sustainable housing paradigm (Kibert, 2008). (Parrot, 1997) conducted a study to explore the interrelationship between natural and built environment and the residents who inhabit those built environments. The study focused on environmental parameters such as construction and design of housing units, water supply, waste management, energy efficiency, and indoor air quality and surroundings environment. (Shiers, 2000) documents that environmentally responsible construction of houses is becoming extremely popular approach in UK.

2.3. Sustainable Housing Schemes

(Kibert*et al*., 2003) explains the construction ecology and states that nature and conservation of natural resources is the basis for green building. (Horwath, 2004) favors the ecological engineering and states that ecological principles should be a basis for the construction and management of houses. (Premius, 2005) proposes in his paper about sustainable housing that this agenda should be included in major policy, plans and construction programs. The way buildings are constructed, operated and maintained has an effect on the overall ecosystem and quality of life of the residents as increased housing density is already altering the natural environment(Stein *et al*., 2005; Jacobs *et al*., 2015). Built environment should not have an adverse affect on the ecosystem integrity so smart, sustainable and green building is essential (Yang *et al*., 2008). (Hezri and Dovers, 2006) identifies some sustainable housing indicators in their research about "ecological economics". They say that the indicators include construction waste management, water and air pollution, workers safety and health during construction and green spaces, water management, solid waste management, indoor air quality and ventilation and resilience during operations. Planning and Implementation are the two key bits of management which have to be done effectively for "eco-homes" (Blengini and Di Carlo, 2010).

(Ali and Al Nsairat, 2009) documented that the cost of green building is high at first but in a long run that cost pays off as the benefits of such houses far exceed the initial cost. Housing is a determinant of health (Lawrence, 1995).Poor housing conditions are associated with a wide range of health conditions, including respiratory infections, asthma, lead poisoning, injuries, and mental health (Yang *et al*., 2008). Addressing housing issues offers public health practitioners an opportunity to address an important social determinant of health (Wolch *et al*., 2014). (Pulselli *et al*., 2009) stated that the concept of green building is being promoted among the residents and contractors as the waves of environmental protection agenda sweeps across

the world. (Crabtree and Hess, 2009) explores the sustainable housing in the major cities of Australia. The researchers suggest that the new technologies for safer environment and environmental friendly building material should be used to build houses. They say that this approach is cost effective in a long run because it protects environment and mitigate the negative consequences both in present and future. (Lam *et al*., 2010) points that half of the worlds resources are utilized to provide shelter and habitat to humans and transforms the natural environment into built environment so the housing industry should include green specifications in their projects. Green specifications not only include minimizing the environmental impacts during construction phase but it involves such planning that the houses undergo sustainable operation in long-term future (Citherlet and Defaux, 2007).

2.4. Statistical Methods

Most of the empirical studies for the assessment of environmental concerns in public and private housing construction and operation involve carrying out the surveys and application of SPSS for analysis of data using multiple and linear regression and much of the researches have derived the co-efficient of variance to check the level of concern for the environmental factors (Shiers, 2000; Howard, 2005; Jim and Chen, 2007; Ng *et al*., 2008; Mohit *et al*., 2010; Omardin *et al*., 2015).

2.4.1. Various Studies for Comparison

(Abidin, 2010) investigated the application of sustainable development concepts in construction of housing units by Malaysian builders by performing a survey and then analyzing the data quantitatively by using SPSS. The results show the mean practicing level of 3.4 out of 5 rating scale and represent the integration of ecological concerns at moderate or low level. The study depicts that builders are not so keen to include the sustainable housing practices in their construction projects as they increase the cost of construction. This study suggests that the main stage for the integration of environmental issues in planning stage to ensure overall effectiveness and implementation. The termed the sustainable construction is now being dubbed as “green construction” (Cidell, 2009; Priemus, 2005).

(Bandara and Tisdell, 2003) provides the empirical evaluation of their survey conducted in private and public housing schemes to check the consideration level of ecological factors and bio-diversity conservation during the operation of housing units. Their results reveal that 86%

of the residents of both public and private schemes do not support the development at the cost of green environment.

(Chuck and Kim, 2011) conducted a study on EIA schemes available for assessing the environmental conditions of housing schemes. They included site location, energy efficiency, indoor air quality and ventilation, and other parameters of the building operation, management and maintenance. They also provided recommendations about how the environmental considerations should be incorporated into construction and design in a cost effective manner and a harmonious relationship should be maintained between natural and built environment during operation of the housing units. (Mohit *et al*., 2010) also provided an empirical environmental assessment of public housing schemes in Kuala Lumpur using multiple regression analysis. They determined the relationship of ten variables including waste management, indoor space, air quality and outdoor environment. Their findings reveal that the satisfaction of the residents is poor regarding the quality of life and environmental concerns and cleanliness.

(Leipziger, 2013) in his study compared the level of energy efficiency and ventilation and other environmental factors between public and private building schemes. His study shows that in Europe, UK and China, the public sector gives more consideration to these environmental parameters in their construction projects and various standards have been devised for the effective implementation, evaluation and monitoring of the building units regarding ecological and safety and health issues. (Deng *et al*., 2012) performed the analysis of green residential building in Singapore using a multiple regression model. They surveyed 590 projects and found that 460 projects have a high level of environmental integration into the design of housing units. Environmental concerns in housing should be the part of overall "holistic approach" to save environment and at the same time maintain the quality of life and well being of the residents and this should be the foremost parameter in planning of any public or private building project both in developed and developing countries (Davies, 2014). (Wolch *et al*., 2014) reviewed the green urban residence of US and Chinese cities and stated that green spaces, vegetation and healthy outdoor environment are a milestone in the well being of community and ecosystem. They suggested that urban planners and decision makers should work together to provide low cost green housing and ensure overall sustainability.

While reviewing the critical factors in success factors in construction projects of Pars Gama Construction Company of Iran (Pakseresht and Asgari, 2012) explained that environmental

protection and health and safety of workers is not the top priority rather financial and economic factors have taken the lead in the construction manual. (Omardin *et al*., 2015) reviewed the level of implementation of environmental sustainability practices in housing construction. Their study concludes that the environmental deterioration and depletion of natural resources have led to the amalgamation of environmental concerns in house building. They stated that many builders are willing to apply green building in their housing projects because unplanned construction has caused an enormous impact on the environment globally. The study also presents the results of survey conducted to find out the willingness and awareness of builders towards resilient and green construction strategies and the statistical analysis show that 46% of builders are well informed about the environmental concerns in housing while others are not so eager to apply those practices or even get fully aware.

2.5. Current Trends in Green Building

Current trends of "sustainable construction" are focused on LCA (Life Cycle Analysis) of the buildings and environmental management systems (Kibert *et al*., 2003; Lam *et al*., 2011). For creating an environmentally sound architecture in housing schemes one has to consider the whole process through which a natural environment is transformed into shelter or built environment (Horvath, 2004; Gauzin-Muller, 2002).LCA of the buildings involve all the phases including planning, design, construction, operation, maintenance, and refurbishment, upgrading and then the final destination of the materials after expiry (Chatterjee, 2009). Environmental management system involves the recurring cycle of continual improvements in the whole process bringing new innovations in design that is best for the environmental protection (Ding, 2008). (Pakseresht and Asgari , 2012) states that nowadays, green building is really challenging because of the large number of aspects and their impacts that builders have to consider both for short term and long term management.

Reduced consumption of resources, protecting ecosystem, vegetation and biodiversity, banish the use of toxic material in all stages of built structure, re-usage of resources, energy efficiency, resident health and safety, and improved air, water and land quality while proper monitoring of all these are the essential requirements to fuse into LCA of the built environment (Low, 2005; Kibert *et al*., 2003; Citherlet and Defaux, 2007). The US Green Building Council (USGBC) was founded in 1993 to change the course of architecture towards sustainability. (Cidell, 2009; Kibert *et al*., 2013) stated that the council has identified the housing industry as one of the major player in environmental degradation and resource exploitation. USGBC

devised a rating system called LEEDS for the evaluation of buildings on the scale of environmental protection (Chuck and Kim, 2011). LEEDS standard has proved to be a major success in advancing eco friendly housing in USA (Blengini and Di Carlo, 2010; Crabtree and Hes, 2009). Moreover, National Institute for Occupational Safety and Health (NIOSH) along with recent developments suggesting increasing interest among NIOSH stakeholders in integrating safety and health into green and sustainable construction approaches (Singh *et al*., 2010). Similarly, UK and European countries have also drifted towards green building in the recent years by devising different standards and certifications (Aizlewood and Dimitroulopoulou, 2006). Green Building Council (GBC) was formed in India in 2006 to catalyze the process of sustainability (Chatterjee, 2009). In Pakistan, the green building movement has also been initiated by enforcing the EIA and IEE as a pre-requisite in construction (Rahman, 2009).Health and safety requirements have been devised and enforced; still there is a need for improvement (Isnin *et al*., 2012; Low, 2005; Mohit *et al*., 2010).

2.6. Future trends

Future trends and development should most particularly focus on the integration of environment, safety and health aspects into construction of houses (Davies, 2014; Abidin, 2010; Jacobs *et al*., 2015). The "green hierarchy" i.e. reduce, reuse, recycle, recover and dispose in an environmentally sound way, will gain momentum in the housing industry for the sustainable use of natural resources and increasing cost-effectiveness (Chatterjee, 2009; Leipziger, 2013). Environmental friendliness is becoming a scale for quality of life and residents are keen to achieve a higher quality of living (Omardin *et al*., 2015; Wolch *et al*., 2014). Builders have to adopt these strategies either willingly or unwillingly due to the demand of green houses and developing legislation by the governments (Chuck and Kim, 2011; Deng *et al*., 2012). Empirical evidence and analytical findings from the rigorous literature review depicts that incorporating and integration of construction with environmental protection principles is the new turn in development.

Chapter 3

MATERIALS AND METHODS

3.1. Introduction

Present research study was carried out for the comparative analysis of environmental concerns during construction between public and private housing industry. An effort has also been made to develop a greater awareness of the environmental issues in the field of housing and to identify the environmental concerns among private and public sector by analyzing their work procedures. In this chapter, the research methodology that has been followed throughout the research in order to achieve the research objectives is described in detail. Main source for data collection is primary data from survey. The study type, population, size of sample, pilot testing, sampling techniques, instrument of study and the procedure of data collection are also discussed in this chapter.

3.2. Study Area

Four housing schemes selected for the study are shown in the map given in Figure 3.1.

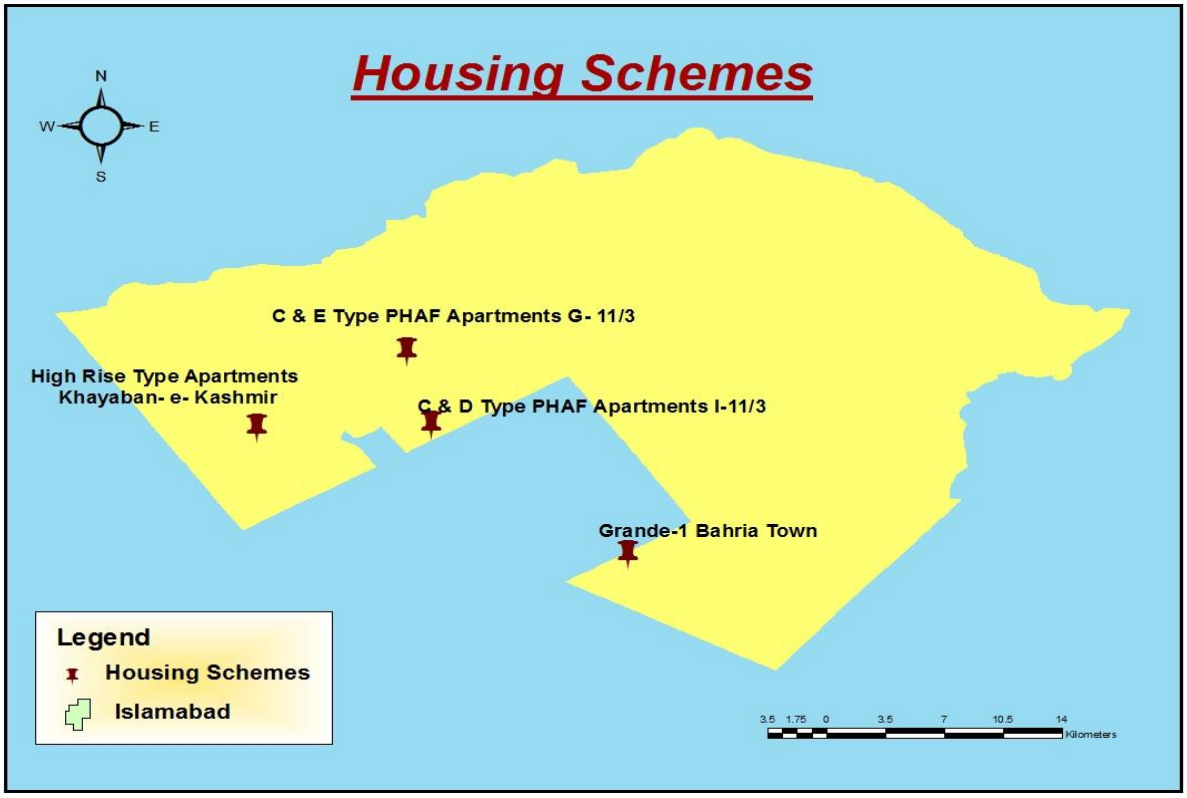

Figure3.1: Locations of Housing Schemes

Detailed description of housing schemes is as follow:

3.2.1. Public Housing Schemes

Two types of public housing schemes were selected. These were:

i. C & E Type PHAF Apartments G- 11/3

This scheme was launched in 2008 while possession was handed over in 2013-14. There are two types of apartments in this scheme i.e. C type apartment (1100 sqft) for general public while E type apartments (700 sqft) are for low grade/low income Federal Government employees of BPS 1-10. There are total 608 with in this scheme including 208 for C type apartments and 400 for E type of apartments. The project is ideal as G-11 Markaz is located very near to it. Moreover it is on a developed plot of CDA.

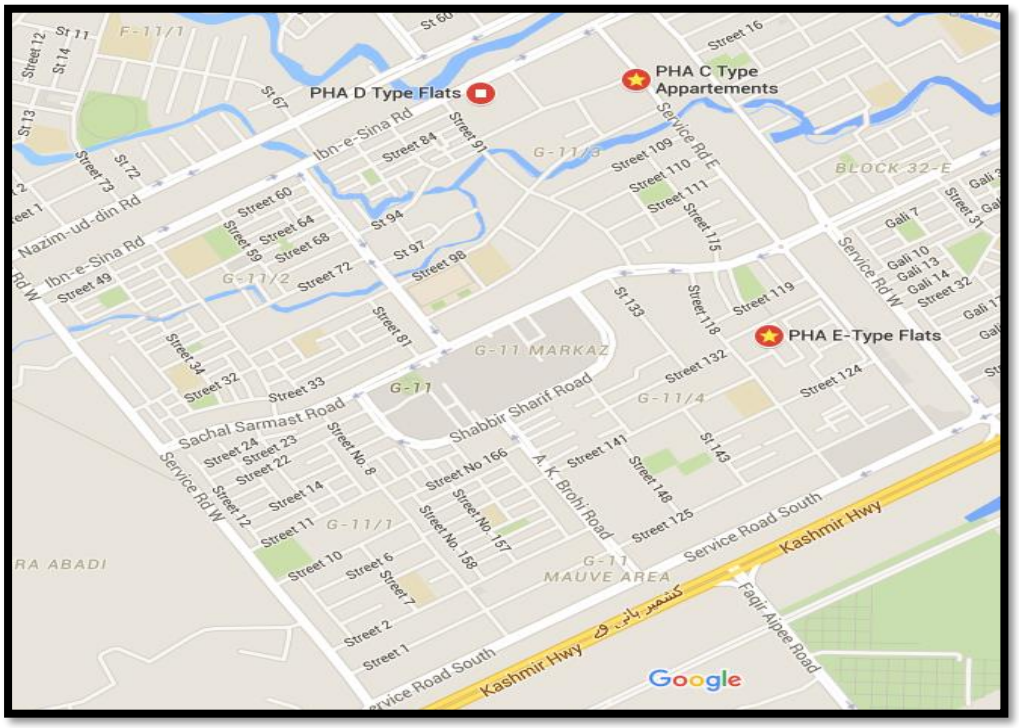

Figure 3.2: C & E Type PHAF Apartments G- 11/3

ii. C & D Type PHAF Apartments I-11/3

This scheme was launched in 2001 and possession was handed over in 2004 .It also consisted of two types of apartments including C type apartment (1035 sqft) and D type apartment (940 sqft). All the apartments are for general public excluding some which were allotted to the PHA foundation's employees. This scheme has total 660 apartments with 252 C type and 408 D type. The location of this scheme is also very ideal as Carriage factory is located near it and it is also on a developed plot of CDA.

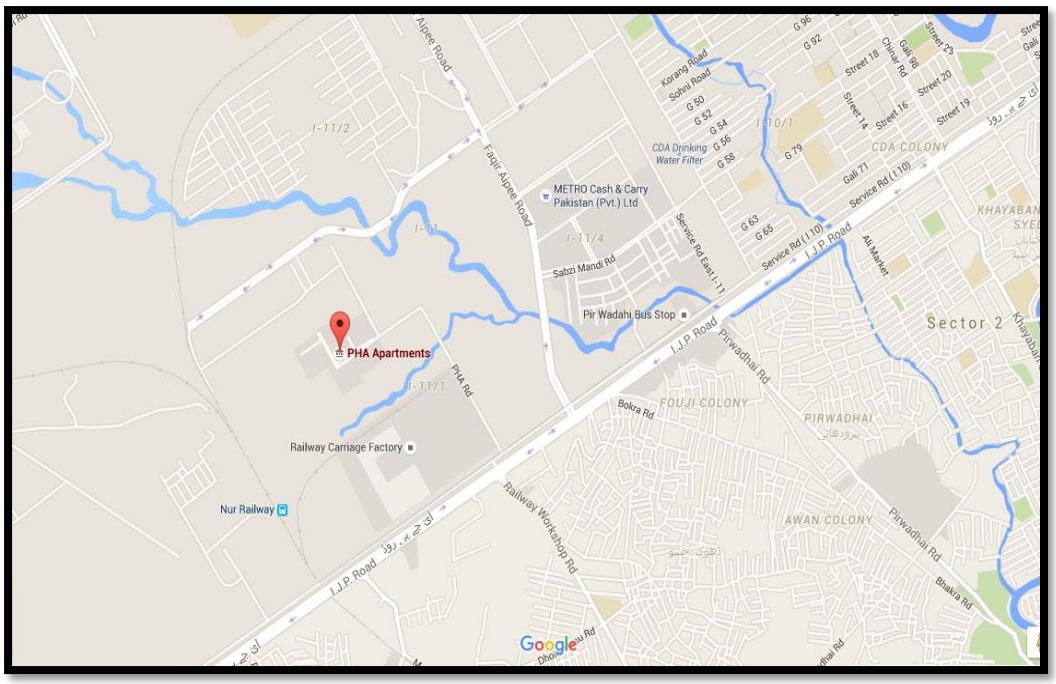

Figure 3.3: C & E Type PHAF Apartments I- 11/3

3.2.2. Private Housing Schemes

Two types of public housing schemes were selected. These were:

i. High Rise Type Apartments at Khayaban- e- Kashmir

High Rise Type Apartments at Khayaban- e- Kashmir are located in the Sector G-15of Islamabad started recently and possession was handed over in 2015. It is an utmost plan of apartments which have been brought in to the market by complex Palomino Properties. It has great value as it is at 10 minute drive distance from zero point.

ii. Grande 1, Bahria Town

Bahria Town (Pvt) Ltd, within Pakistan, is one of the investors and real estate developers. It has establishments in Islamabad, Rawalpindi, Karachi and Lahore. The Grande 1 apartments are located at Phase II of Bahria Town, Islamabad launched two years ago. It has commercial shops and apartments with 24/7 security and maintenance, car parking. It has great value as having many recreational facilities and having Safari club.

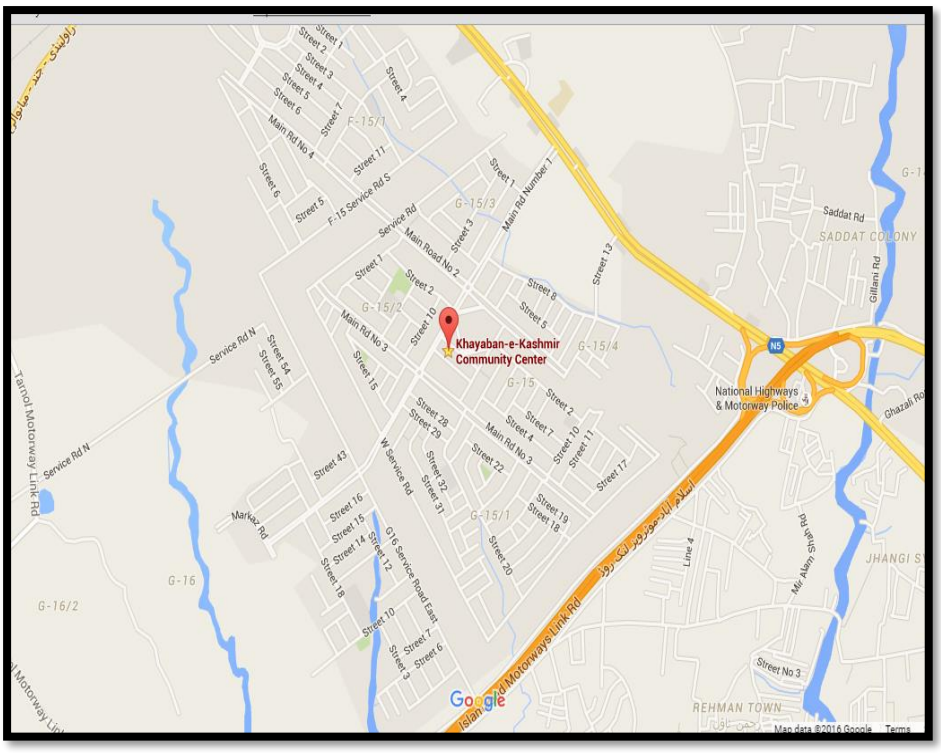

Figure3.4: High Rise Type Apartments, Khayaban- e- Kashmir

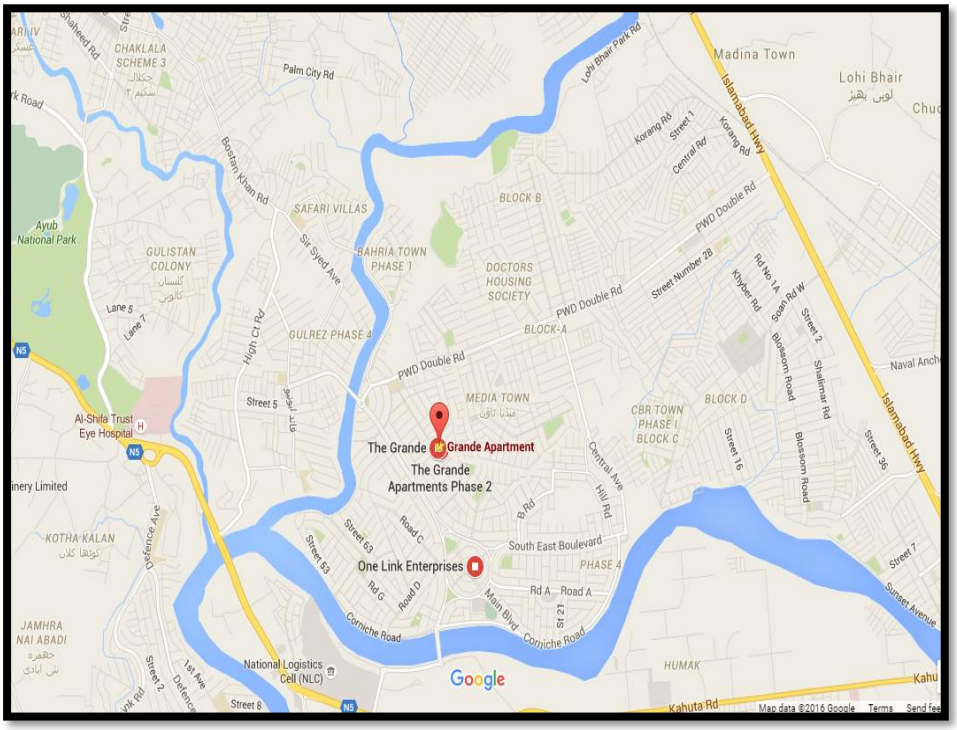

Figure 3.5: The Grande Apartments, Bahria Town

3.3. Research Design

The nature of the current research is comparative and analytical. The methods used are both exploratory and descriptive as both qualitative and quantitative study has been conducted. Descriptive research is suitable method for the testing of hypothesis quantitatively. Survey method tool has been used for descriptive research and questionnaires used for survey were analyzed quantitatively. While descriptive research appears to be moderately simple, as it is limited to some questions to gather information, hence, to explore the situation acutely, some qualitative tools should be involved in the research. Therefore, research is exploratory in the sense that the study also relies on the secondary research including reviewing of literature as well as other qualitative approaches such as informal discussions and interviews with builders and residents.

Present study was carried out to for the comparative analysis of environmental concerns during construction between public and private housing industry. In this research the housing schemes were taken as dependent variable while the environmental factors were taken as independent variables.

This study was accomplished in a sequence of interconnected steps, including selection of the problem, find out the research question and formulation of objectives, exploring the cause of research hypothesis as well as designing the suitable tools in order to collect the data. During the selection of proper tools for the collection of data, it has been found out that there is no apt tool which can be used to achieve the objectives; hence, two indigenous tools were formularized via standardized methods. Validity and reliability of designed tools were set up during pilot testing that has been carried out on a sample of 20 residents of 2 housing schemes (10 each) with 3 independent variables that have been selected randomly.

3.3.1. Target Population

The population of the study comprised of the residents and builders of housing schemes. Data was collected from both genders.

3.3.2. Sampling Technique

In this research, the procedure of stratification was applied in which population was grouped into relatively homogeneous subgroups i.e. strata. Each stratum was developed on the basis of the housing scheme it belongs.

For present study, samples were chosen through the technique of stratified random sampling and divided the population into two major strata, the private and the public sector housing schemes, each stratum subdivided into further two stratums according to the name of housing scheme. The reason behind selecting the stratified random sampling was its effectiveness for the formulation of subcategories and its compensation characteristics. It creates equilibrium in statistical power and focuses on significant subpopulation categories.

3.3.3. Sample Size

Stratified random sampling technique was used and sample was selected by dividing the population into two groups i.e. public and private sector housing schemes. These two groups were further subdivided into two subgroups i.e. two private housing schemes and two public housing schemes. The detailed description of selected sample is mentioned below. A stratified random sample of 200 respondents was collected from four housing schemes located at Islamabad. Data was collected from both public and private housing schemes (50 for each housing scheme). The detail of selected sample is as under:

Table 3.1: Sample Size attained from the distinct group of population

S.No	Population	Sample Size
1.	Residents	200
2.	Builders	04
	Total	204

Table 3.1 illustrates the sample sizecalculatedby the technique of stratified random sampling. It is evident through this table that data was collected from 200 residents who are the owners of the apartments and 04 builders who are major constructors of selected housing schemes.

Table 3.2: List of Sampled Housing Schemes

S.No	Housing Scheme	Sector
1.	C & E Type PHAF Apartments G- 11/3	Public
2.	C & D Type PHAF Apartments I-11/3	Public
3.	High Rise Type Apartments at Khayaban- e- Kashmir	Private
4.	Grande 1 Bahria Town	Private

Table3.2 points the name of sampled housing schemes, it can be noticed through this table that for the collection of data, 2 housing schemes were selected as public and 2 were selected as private housing industry.

Table 3.3: **Demographic independent variables of Environmental Concerns for builders**

Builders	
1. Solid Waste Management	18. Seepage into Ground Water
2. OSHA	19. Water Management Authority
3. Sewage System	20. Soil Erosion
4. Ventilation System	21. Preservation of Drainage System
5. Type of Flora	22. Percolation of water
6. Noise Pollution	23. Constructed Waste
7. Noise Pollution Minimization Measures	24. Waste Disposal
8. Earthquake Proof	25. ESA in Housing Scheme
9. Manager of vegetation	26. ESA Preservation
10. Re-plantation of local flora	27. Air Pollution
11. Roads accessibility	28. Air Pollution Minimization Measures
12. Vegetation Loss	29. Streets Lights
13. Fumigation	30. EPA Construction Guidelines
14. Environmental Management Plan	31. Local Labor
15. Environmental Policy	32. Temporary Sanitation Facility
16. IEE/EIA	33. Population Compensation
17. EHS Compensation	

Table 3.4: **Demographic independent variables of Environmental Concerns for residents**

Residents	
1. Solid Waste Management	8. Fire Resistance
2. OSHA Material	9. Environmental Friendly Building
3. Sewage System Maintenance	10. Maintenance Services
4. Ventilation System	11. Surrounding Vegetation Cover
5. Noise Pollution	12. Park
6. Rain Water Harvesting	13. Environmental Management
7. Earthquake Resistance	14. Quality of life

Table.3.3 and Table.3.4 depicts the features of demographic variables which were mentioned in questionnaire through which data was collected to analyze. It can also be seen that the number of variables are more for builders than residents as builders are responsible for planning, constructing and implementing the environmental factors in a housing scheme.

3.3.4. Instruments of the Study

To get the response of questions from the sample of the population and to measure the research objectives, two indigenous research instruments were designed through standardized procedures. One instrument was designed for residents for housing schemes and the other one was designed for the builders of those housing schemes. The questionnaire designed for residents was named as "Questionnaire for Residents" consisted of three sections. One section is for demographic information; second one is based on closed ended questions for the responses of residents about environmental concerns while last section is based on open ended questions that should be filled by the respondents according to their personal opinion about environmental concerns and housing schemes. The questionnaire, developed for the builders was named as "Questionnaire for builders". It has also three sections, first one is for demographic information, second one is based on closed ended questions for builders' responses, while last section with open ended questions is to get the detailed opinion of builders about environmental factors and planning of housing schemes. Questionnaire items

coat almost all the environmental factors required for housing schemes. Two, three and five point rating scale was used to find the respondents' responses.

In order to develop the psychometric properties of research questionnaire for residents, pilot testing was carried out. Scale was managed to 19 residents of public and private sector housing schemes and one builder for public housing sector. After collection of pilot data, it was transmitted to computer, analyze through SPSS, its reliability was calculated and regression analysis was determined, some insignificant items were removed from residents' questionnaire and rest of the items were retained in the finalized scale, which was developed for the measurement of environmental concerns of public and private sector housing schemes. During collection of pilot data, it was also found out that most of the residents did not want to answer for open ended questions, hence, some of the open ended segments for transferred into closed ended questions in the residents' questionnaire. Questionnaires, designed for current research have been presented in Annex II.

Questionnaire validity was determined with the help of expert opinions, two environmentalists from the public sector housing authority i.e. Pakistan Housing Authority were asked to read and evaluate each question of two research questionnaires on the subject of its inclusion in the specific scale. Amendments and suggestions by them were integrated in the finalized scales.

3.3.5. Data Collection Method

In order to collect data, the residents of a particular housing scheme were approached by the researcher personally. The data was collected from the residents at their respective apartment/ location within the hosing scheme after giving the brief information about the research topic and they were requested to fill the questionnaire without any biasness and according to their personal agreement or disagreement for each question. While, for builders' questionnaire, respective builders were approached and after mentioning the briefs about the research topic, they were requested to fill the relevant questionnaire in accordance to their own professional practices.

3.3.6. Data Analysis

To achieve the objectives, data was analyzed statistically in order to evaluate the psychometric characteristics of questionnaires. Several statistical methods like multiple regression analysis for 5 significant environmental factors, coefficient of variance for builders' questionnaire and ANOVA was carried out with the help of SPSS 23 while MS Excel was used for plotting the

bar graphs of percentage analysis and standard deviation of individual variables mentioned in resident's questionnaire for selected 4 housing schemes.

i. Multiple Regression Model

Multiple regression model was designed through SPSS.23 for both public and private housing schemes individually that described the analysis of public and private housing schemes for five independent variables i.e. OSHA, Solid Waste Management, Earthquake Resistance, Surrounding Vegetation and Environmental Management over dependent variable i.e. Housing Scheme.

ii. ANOVA Analysis

ANOVA analysis of public and private housing schemes for five independent variables i.e. OSHA, Solid waste Management, Earthquake Resistance, Surrounding Vegetation and Environmental Management over dependent variable i.e. housing scheme was also been calculated through SPSS .23.

iii. Coefficient of Variables

Coefficient of variables, for public and private housing schemes' builders was also calculated. In order to calculate CoV, mean and standard deviation for each variable have also been calculated through SPSS.23.

After finalizing the results through SPSS.23 and MS Excel, conclusion has been drawn.

Chapter 4

RESULTS AND DISCUSSION

Present study was designed for the comparative analysis of environmental concern during construction between public and private housing industry. First objective of the study was to assess an awareness level of the environmental issues in the field of housing; second objective was to identify the environmental concerns among private and public sector by analyzing their work procedures. In order to achieve the objectives, data acquired through questionnaires was analyzed, coded and tabulated in order to get meaningful results.

4.1. Level of Execution of Environmental Factors among Housing Schemes through Residents

Variable Percentage, Regression and ANOVA analysis for the level of considering environmental factors among public and private schemes through residents are as follow:

4.1.1. Variable Analysis among Public and Private Housing Schemes through Residents

Following graphs show the percentage analysis of various variables used in the questionnaire to achieve the objective of the current study. Each variable was interpreted through percentage analysis and then standard deviation was calculated to find out the deviation of each housing scheme from the desired results. These graphs also explain the better housing scheme for individual variable.

4.1.1.1. Sewage System Maintenance

Sewage System Maintenance has effectively been implemented in High Rise Type Khayaban-e-Kashmir i.e. 96% while in Grande -1 Bahria Town, it is 68%. But when we consider public housing schemes i.e. C& D Type PHAF Apartments I-11/3 and C & E Type PHAF Apartments G-11/3, Sewage System Maintenance are 86%, which have been interpreted through the questionnaires filled by the residents of those areas.

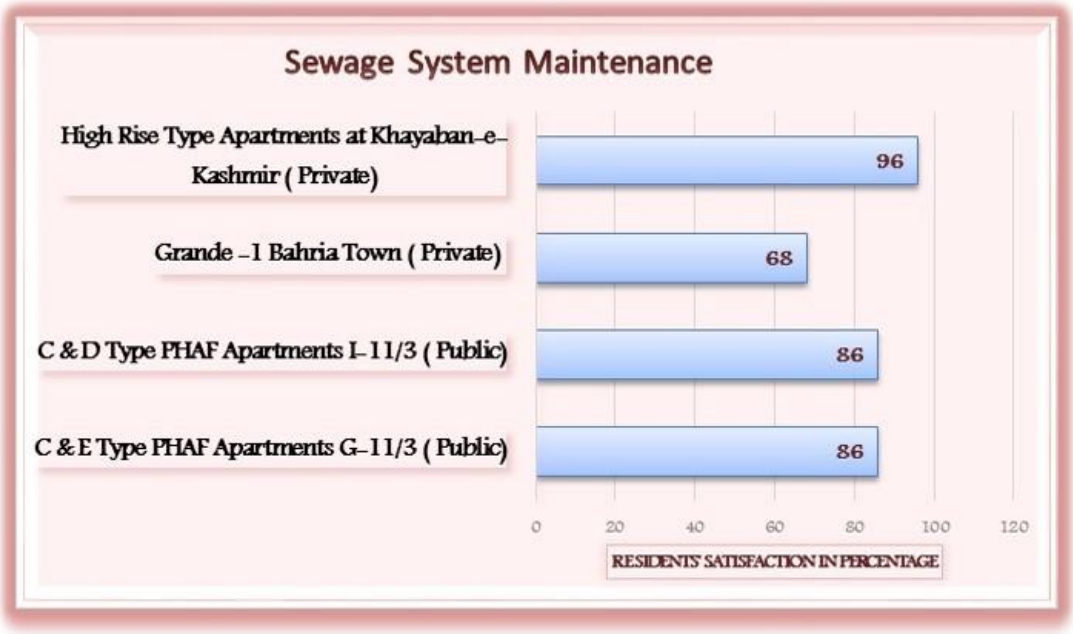

Figure 4.1: Variable Sewage System Maintenance

Figure 4.1 shows the percentage analysis and standard deviation of the variable "Sewage System Maintenance" in the selected housing industries. According to the people living there, the management is mostly done by CDA (Capital Development Authority). Hence, when considering Sewage System Maintenance, public sector has considered this factor more effectively than private.

Standard deviation error bars show the degree of precision in the consideration of variable i.e. sewage system maintenance and mentions the variability or distance of the reported value from the true (error free) value. It shows the average difference between the data points and their means. Here, highest true value is 96% which is for High Rise Apartments at Khayaban-e-Kashmir (Private), and the deviation from the true value for Grande 1 Bahria Town (Private), C& D Type PHAF Apartments I-11/3(Public) and C & E Type PHAF Apartments G-11/3(Public) housing sector are 28%, 10% , 10 % respectively.

4.1.1.2. Ventilation System

According to the interpretation of data, it has been found out that ventilation system have effectively been implemented in private sector i.e. High Rise Type Khayaban-e-Kashmir 84% and Grande -1 Bahria Town 98%. But when we consider public housing schemes i.e. C& D Type PHAF Apartments I-11/3 and C & E Type PHAF Apartments G-11/3, Ventilation system has been considered noticeably i.e. 72%, but not as effectively as in private sector.

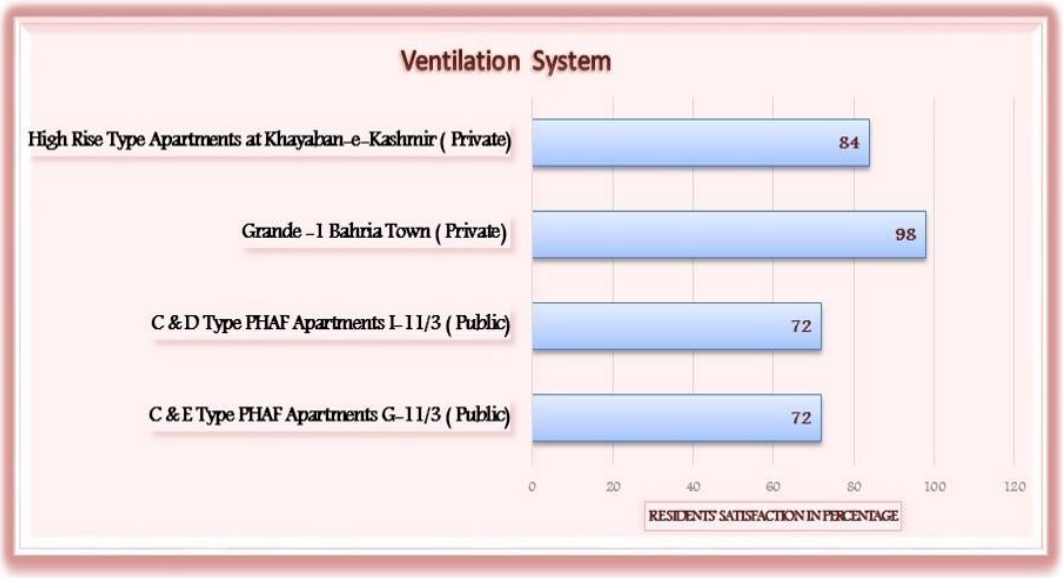

Figure 4.2: Variable Ventilation System

Figure 4.2 shows the percentage analysis and standard deviation of the variable "Ventilation System". These results have been interpreted through the questionnaires filled by the residents of those areas. Hence, when considering ventilation system, private sector has considered this factor more successfully than public.

Standard deviation error bars shows the degree of precision in the consideration of variable i.e. ventilation system and mentions the variability or distance of the reported value from the true (error free) value. Here, highest true value is 98% which is for Grande 1 Bahria Town (Private), and the deviation from the true value for High Rise Apartments at Khayaban-e-Kashmir(Private), C& D Type PHAF Apartments I-11/3(Public) and C & E Type PHAF Apartments G-11/3(Public) are 14%, 26% , 26 % respectively.

4.1.1.3. Energy Efficient Building Design

Energy Efficient Building Design factor has not noticeably been implemented in High Rise Type Khayaban-e-Kashmir i.e. 56% as well as in Grande -1 Bahria Town, it is only 48%. But when we consider public housing schemes i.e. C& D Type PHAF Apartments I-11/3 and C & E Type PHAF Apartments G-11/3, importance of this factor is considerable i.e. 56% and 54% respectively, which have been interpreted through the questionnaires filled by the residents of those areas.

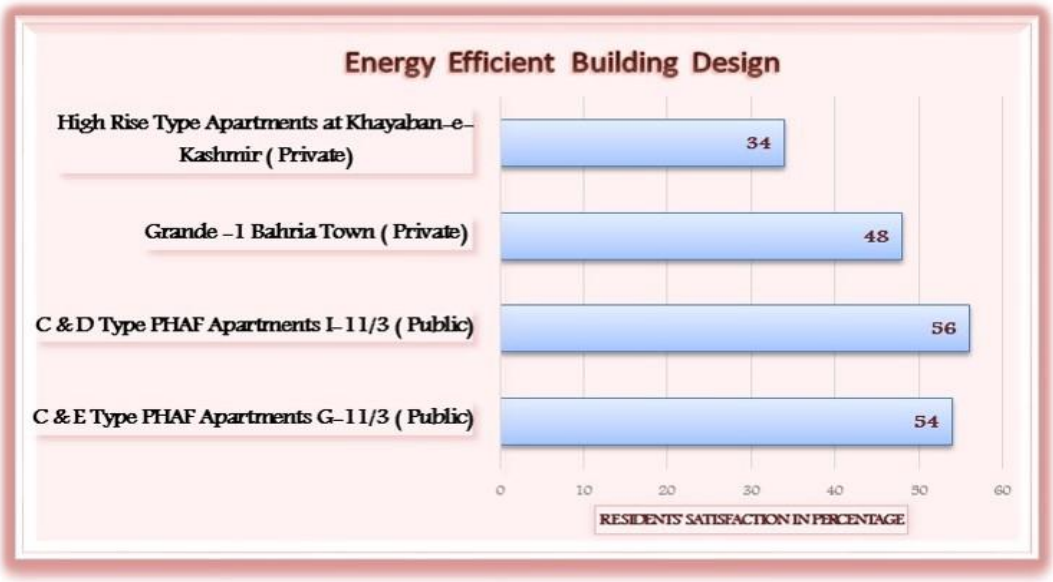

Figure 4.3: Variable Energy Efficient Building Design

Figure 4.3 shows the percentage analysis and standard deviation of the variable "Energy Efficient Building Design". Hence, according to the results when consider Energy Efficient Building Design, public sector has considered this factor more effectively than private.

Standard deviation error bars shows the degree of precision in the consideration of variable i.e. energy efficient building design and mentions the variability or distance of the reported value from the true (error free) value. Here, highest true value is 56% which is for C& D Type PHAF Apartments I-11/3(Public) and the deviation from the true value for High Rise Apartments at Khayaban-e-Kashmir(Private), Grande 1 Bahria Town (Private) and C & E Type PHAF Apartments G-11/3(Public)are 14%, 26% , 26 % respectively.

4.1.1.4. Noise Pollution

Building Design for less noise pollution variable has noticeably been implemented in High Rise Type Khayaban-e-Kashmir i.e. 64% while in Grande -1 Bahria Town, it is only 58%. But when we consider public housing schemes i.e. C& D Type PHAF Apartments I-11/3 and C & E Type PHAF Apartments G-11/3, importance of this factor is not considerable i.e. 24% and 48% respectively, which have been interpreted through the questionnaires filled by the residents of those areas.

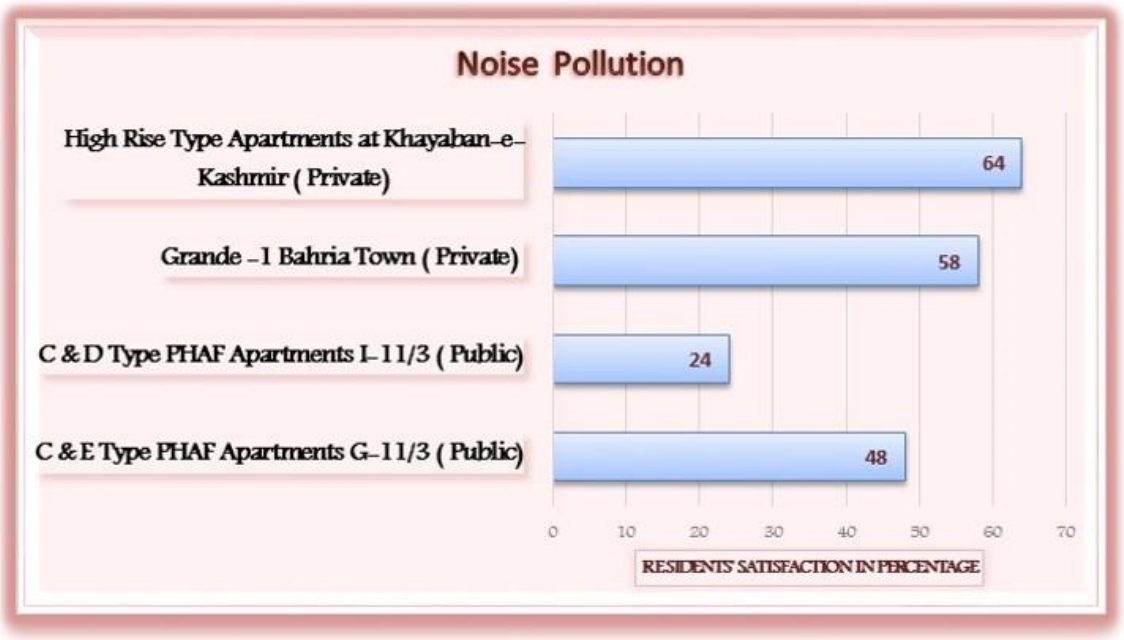

Figure 4.4: Variable Noise Pollution

Figure 4.4 shows the percentage analysis and standard deviation of the variable "Noise Pollution". Hence, for Building Design having less noise pollution, private sector has considered this factor more effectively than public.

Standard deviation error bars shows the degree of precision in the consideration of variable i.e. noise pollution and mentions the variability or distance of the reported value from the true (error free) value. Here, highest true value is 64% which is for High Rise Apartments at Khayaban-e-Kashmir(Private) and the deviation from the true value for Grande 1 Bahria Town (Private) , C& D Type PHAF Apartments I-11/3(Public)and C & E Type PHAF Apartments G-11/3(Public)are 8%, 30% , 16 % respectively.

4.1.1.5. Rainwater Harvesting

Rain Water Harvesting Methods has not noticeably been implemented in High Rise Type Khayaban-e-Kashmir i.e. 38% as well as in Grande -1 Bahria Town, it is only 40%. But when we consider public housing schemes i.e. C& D Type PHAF Apartments I-11/3 and C & E Type PHAF Apartments G-11/3, importance of this factor is less than private housing industry i.e. 26% and 38% respectively, which has been interpreted through the questionnaires filled by the residents.

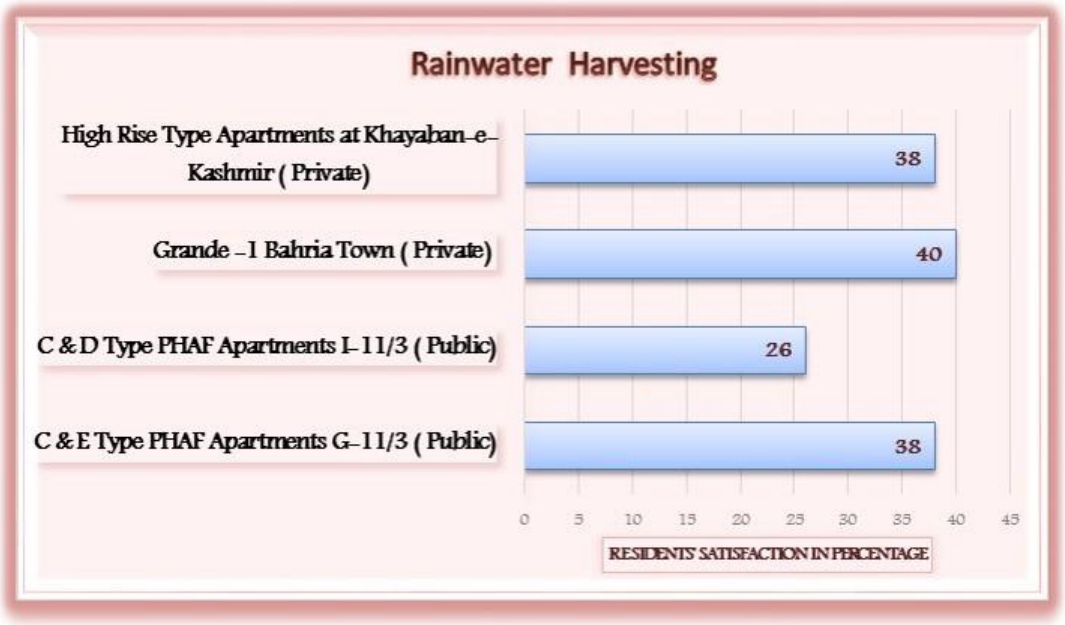

Figure 4.5: Variable Rainwater Harvesting

Figure 4.5 shows the percentage analysis and standard deviation of the variable "Rain Water Harvesting Methods. Hence, when considering rain water harvesting Methods, private sector has considered this factor more effectively than public.

Standard deviation error bars shows the degree of precision in the consideration of variable i.e. rain water harvesting and mentions the variability or distance of the reported value from the true (error free) value. Here, highest true value is 40% which is for Grande 1 Bahria Town (Private), and the deviation from the true value for High Rise Apartments at Khayaban-e-Kashmir(Private), C& D Type PHAF Apartments I-11/3(Public) and C & E Type PHAF Apartments G-11/3(Public) are 2%, 14% , 2 % respectively.

4.1.1.6. Fire Resistance

Fire Resistance Building Design has not effectively been implemented in High Rise Type Khayaban-e-Kashmir i.e. 70% as well as in Grande -1 Bahria Town, it is only 38%. But when we consider public housing schemes i.e. C& D Type PHAF Apartments I-11/3 and C & E Type PHAF Apartments G-11/3, importance of this factor is less than private housing industry; it is only 10% and 30% respectively, which have been interpreted through the questionnaires filled by the residents of those areas.

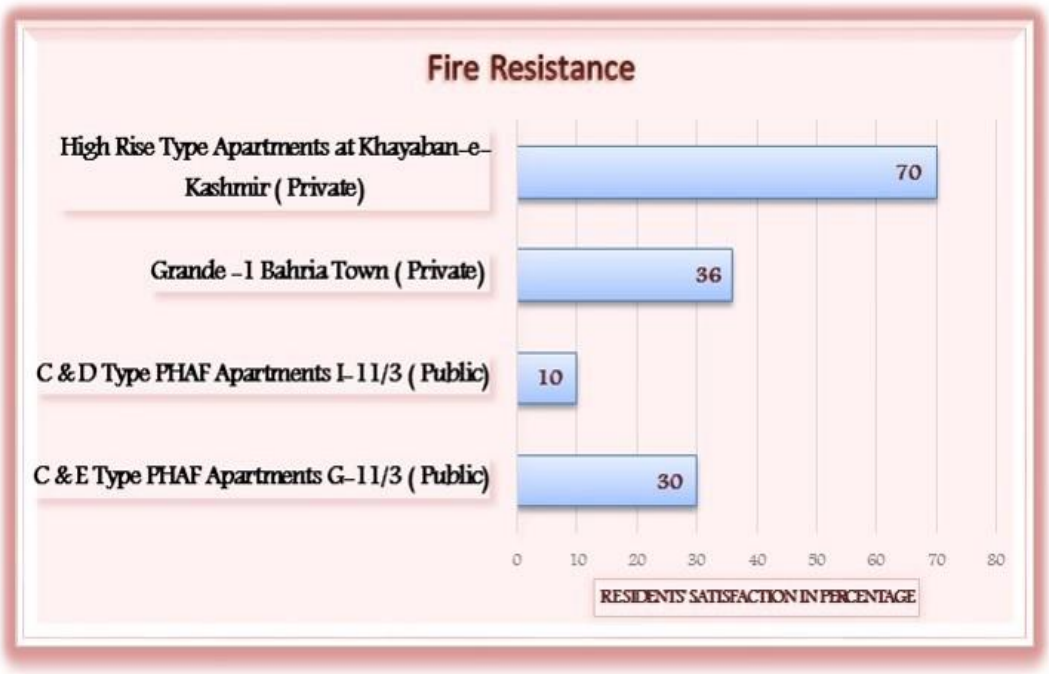

Figure 4.6: Variable Fire Resistance

Figure 4.6 shows the percentage analysis and standard deviation of the variable "Fire Resistance Building Design". Hence, when consider Rain Fire Resistance Methods, private sector has considered this factor more effectively than public.

Standard deviation error bars shows the degree of precision in the consideration of variable i.e. fire resistance and mentions the variability or distance of the reported value from the true (error free) value. It actually shows the average difference between the data points and their means. Here, highest true value is 70% which is for High Rise Apartments at Khayaban-e-Kashmir (Private), and the deviation from the true value for Grande 1 Bahria Town (Private), C& D Type PHAF Apartments I-11/3(Public) and C & E Type PHAF Apartments G-11/3(Public) housing sector is 34%, 60% , 30 % respectively.

4.1.1.7. Environmental Friendly Building Material

Environmental Friendly Building Material has almost equally been implemented in both public and private sector housing industry, with the range of 45% in High Rise Type Khayaban-e-Kashmir, 37% in Grande -1 Bahria Town within private sector. While within public housing schemes it is 40% in C& D Type PHAF Apartments I-11/3 and 39% C & E Type PHAF Apartments G-11/3 which have been interpreted through the questionnaires filled by the residents of those areas.

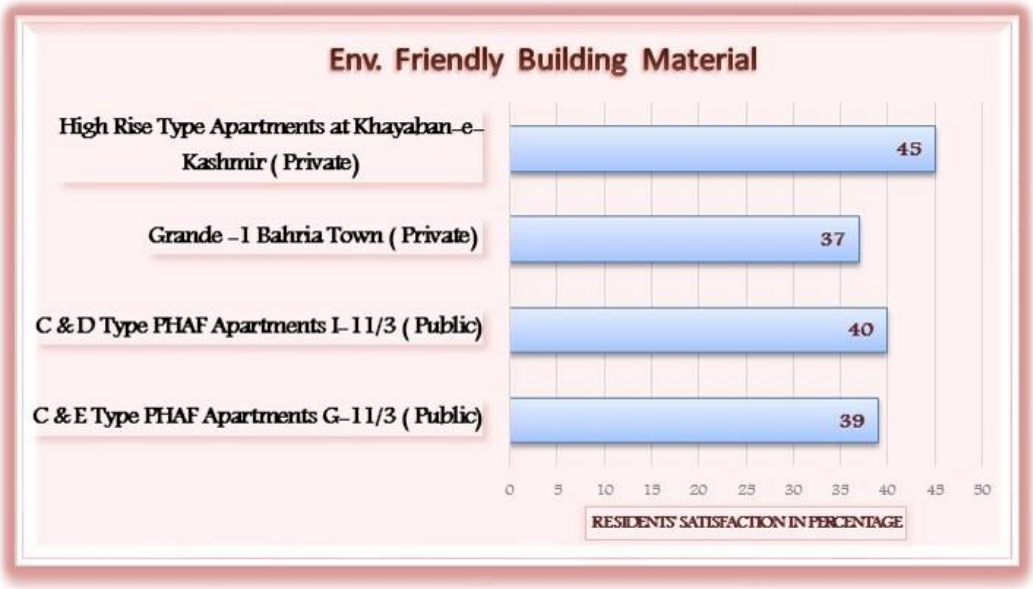

Figure 4.7: Variable Environmental Friendly Building Material

Figure 4.7 shows the percentage analysis and standard deviation of the variable "Environmental Friendly Building Material". Hence, this factor has equally been considered in both sectors.

Standard deviation error bars shows the degree of precision in the consideration of variable i.e. environmental friendly building material and mentions the variability or distance of the reported value from the true (error free) value. It actually shows the average difference between the data points and their means. Here, highest true value is 45% which is for High Rise Apartments at Khayaban-e-Kashmir (Private), and the deviation from the true value for Grande 1 Bahria Town (Private), C& D Type PHAF Apartments I-11/3(Public) and C & E Type PHAF Apartments G-11/3(Public) housing sector in accordance to the interpretation of results, are 8%, 5% , 6 % respectively.

4.1.1.8. Quality of Life

According to the interpretation of questionnaires that have been filled by the residents of the study area, it has been found out that the factor Quality of Life has very effectively been implemented in both public and private sectors with the value of 100% at High Rise Type Khayaban-e-Kashmir , 94% at Grande -1 Bahria Town. While in public housing schemes i.e. C& D Type PHAF Apartments I-11/3 and C & E Type PHAF Apartments G-11/3, importance of this factor is also very noticeable but less than private housing industry i.e. 88% and 82% respectively, that has been interpreted through the questionnaires filled by the residents.

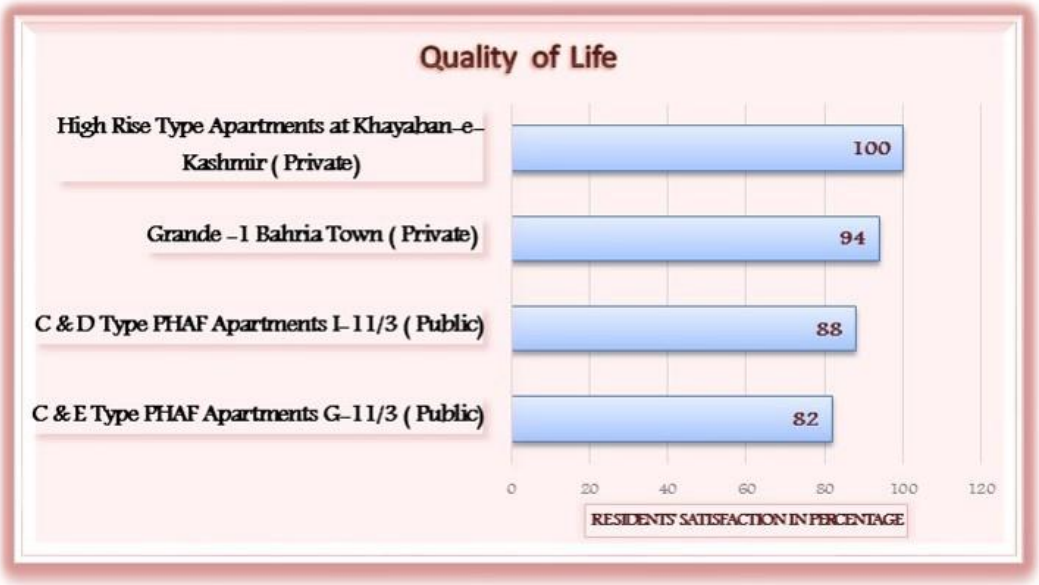

Figure 4.8: Variable Quality of Life

Figure 4.8 shows the percentage analysis and standard deviation of the variable "Quality of Life" in the selected housing industries of the current study. Hence, when consider the Quality of Life; private sector has more standard of living than public.

Standard deviation error bars shows the degree of precision in the consideration of variable i.e. quality of life and mentions the variability or distance of the reported value from the true (error free) value. It actually shows the average difference between the data points and their means. Here, highest true value is 100% which is for High Rise Apartments at Khayaban-e-Kashmir (Private), and the deviation from the true value for Grande 1 Bahria Town (Private), C& D Type PHAF Apartments I-11/3(Public) and C & E Type PHAF Apartments G-11/3(Public) housing sector in accordance to the interpretation of results, are 6%, 12% , 18 % respectively.

4.1.2. Regression Analysis of Public and Private Housing Schemes for Residents

Regression analysis of public and private housing schemes for residents is shown in Table 4.1 and 4.2.

Table 4.1: Regression Analysis of Public Housing Schemes for Residents (N= 100)

Model	Un-standardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Co-linearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1 (Constant)	.870	.254		3.421	.001					
• OSHA	.156	.092	.153	1.695	.093	.163	.172	.150	.967	1.034
• SWMS	.211	.075	.260	2.809	.006	.277	.278	.249	.922	1.084
• Earthquake Resistance	-.419	.115	-.329	-3.632	.000	-.382	-.351	-.322	.960	1.042
• Surrounding Vegetation	.168	.092	.166	1.830	.070	.222	.185	.162	.952	1.051
• Env. Management	-.061	.085	-.066	-.716	.476	.000	-.074	-.064	.919	1.088

a. Dependent Variable: Housing Scheme
b. Predictors/Independent Variables: (Constant), Env. Management, Surrounding Vegetation, OSHA , Earthquake Resistance, SWMSR

Table 4.1.shows that the regression analysis results are in negative values which mean that the expected value on the dependent variable i.e. Housing Scheme is less than 0 when all independent/predictor variables are set to 0. While significance analysis through t-test within the public housing schemes have shown that independent variables including **OSHA 0.093**, **Solid Waste Management 0.006**, **Earthquake Resistance 0.000**, and **Surrounding Vegetation Cover 0.070** have been considered while designing the public sector housing schemes but there is no environmental management practices there.

Table 4.2: Regression Analysis of Private Housing Schemes for Residents (N= 100)

Model	Un-standardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Co-linearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1 (Constant)	1.592	.900		1.769	.080					
• OSHA	.007	.139	.005	.050	.960	-.058	.005	.005	.925	1.081
• SWMS	-.248	.064	-.371	-3.858	.000	-.360	-.370	-.357	.927	1.079
• Earthquake Resistance	-.201	.098	-.195	-2.043	.044	-.206	-.206	-.189	.942	1.061
• Surrounding Vegetation	-.074	.100	-.074	-.744	.459	-.040	-.077	-.069	.864	1.158
• Env Management	.279	.278	.095	1.006	.317	.176	.103	.093	.957	1.045

a. / Dependent Variable: Housing Scheme

b. Predictors Independent Variables: (Constant), Env. Management, Surrounding Vegetation, OSHA , Earthquake Resistance, SWMS

Table 4.2.shows that the regression analysis results are in negative values which mean that the expected value on the dependent variable i.e. Housing Scheme is less than 0 when all independent/predictor variables are set to 0. While significance analysis through t-test within the private housing schemes have shown that independent variables including Solid Waste Management 0.000 and Earthquake resistance 0.044 have only been considered while designing private sector housing schemes. Surrounding vegetation and OSHA have not been considered like public housings but Solid waste management was ranked better by the residents unlike public housings. Like public housings environmental management practices was not established here too.

4.1.3. ANOVA of Public and Private Housing Schemes for Residents

ANOVA of public and private housing schemes for residents is shown in Table 4.3 and 4.4.

Table 4.3: ANOVA[a] of Public Housing Schemes for Residents (N= 100)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	6.489	5	1.298	6.591	.000[b]
	Residual	18.511	94	.197		
	Total	25.000	99			

a. Dependent Variable: Housing Scheme

c. Predictors: (Constant), Env. Management, Surrounding Vegetation, OSHA , Earthquake Resistance, SWMS

Table 4.3 represents the ANOVA analysis and mentions that the F-test for public housing schemes is 6.591 while overall significance of all independent variables on public housing schemes is 0.000. According to f-test, overall significance of the independent variables on dependent variable i.e. housing scheme is .000 that means these independent variables are very important for the development and constructions of housing schemes.

Table 4.4: ANOVA[a] of Private Housing Schemes for Residents (N= 100)

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4.833	5	.967	4.505	.001[b]
	Residual	20.167	94	.215		
	Total	25.000	99			

a. Dependent Variable: Housing Scheme

b. Predictors: (Constant), Env.Management, Surrounding Vegetation, Earthquake Resistance, SWMS,OSHA

Table no. 4.4 represents the ANOVA analysis and mentions that the F-test for private housing schemes is 4.505 while overall significance of all independent variables on public housing schemes is 0.001. According to f-test, overall significance of the independent variables on dependent variable i.e. housing scheme is .001 that means these independent variables are very important for the development and constructions of housing schemes.

4.2. Level of Environmental Awareness among the Builders and their provision of facilitation

Coefficient of Variable and Graphical representation of percentage analysis of co-efficient of variable in order to calculate the level of environmental factors awareness among public and private housing schemes' builders and the extent of providing those environmental facilities for residents are as follows:

4.2.1. Variable Analysis among Public and Private Housing Schemes through Builders

Annexure III shows the coefficient of variables for builders of public and private housing schemes, representing mean and standard deviation for each variable among housing schemes.

Table 4.5: Coefficient of Variance for Public and Private Housing Schemes for Builders (N= 04)

Housing Schemes	CoV
C & E Type PHAF Apartments G-11/3 (Public)	79
C & D Type PHAF Apartments I-11/3 (Public)	59
High Rise Type Apartments at Khayaban-e-Kashmir (Private)	89
Grande -1 Bahria Town (Private)	74

Table 4.5 shows the percentage of Coefficient of variance for builders. And Graph 4.9 shows according to builders, above mentioned environment factors have been considered to following percentages while building and developing the respective housing schemes. According to the results, private sector has considered environment noticeably as compare to the public schemes.

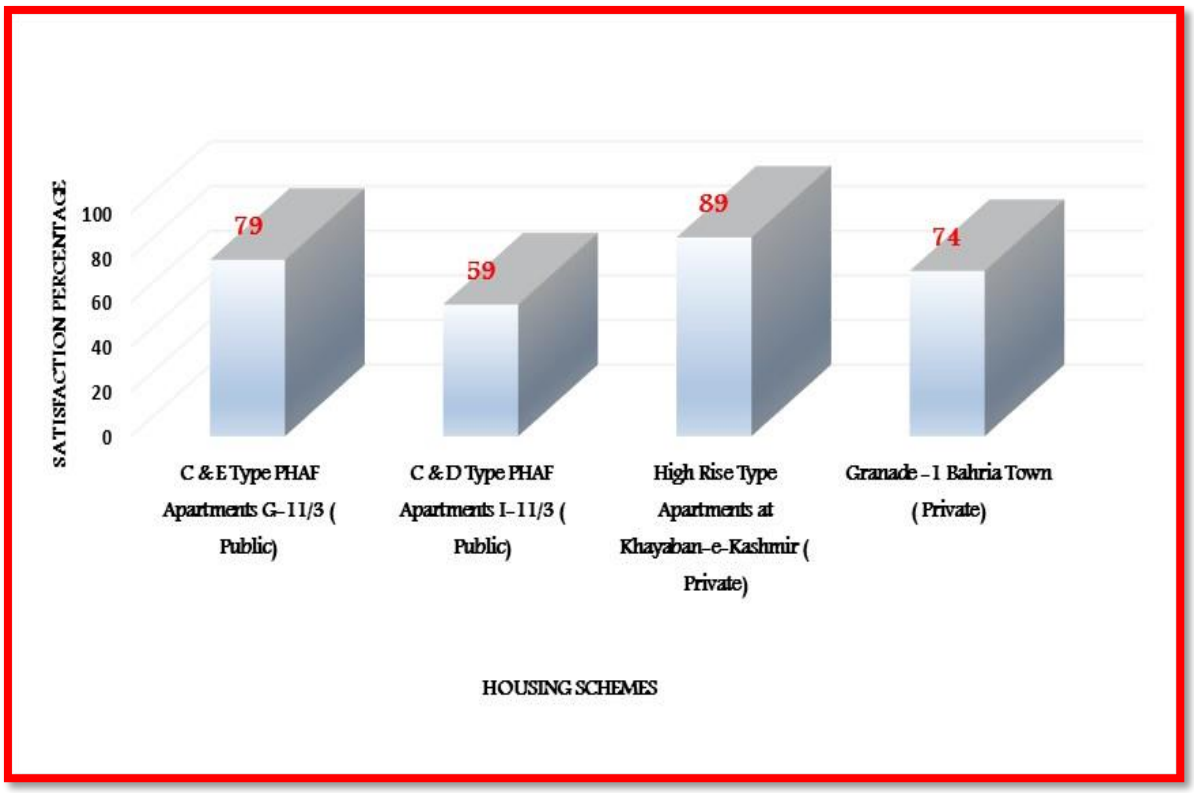

Figure 4.9: Level of Environmental Awareness among the builders and their provision of facilitation

There is a dire requirement of sustainable construction in Pakistan including these selected housing industries as houses are reponsible for production of waste materials, solid waste as

well as waste water , consumption of resources and enrgy use (UNEP). Climate change scenario, today, Pakistan is facing, may relate to housing projects as IPCC Report, 2007 metioned that emission of green house gases also come from housing. (IPCC Report, 2007). For the pupose of sustainable construction, housing sector investers, builders and dealers of private sectors have considered the environment more keenly but when we consider the cost of private sectors, it is more expensive for general pubic as compare to public sector where consideration of safety and environment is negtiable. Investors, builders and dealers of private housing sectors have considered the environment better than public schemes but it has raised the cost. Public housing sector is financially affordable but at the cost of environment. The construction cost per square feet of private housing sector is almost double of public housing sector therefore the total price of the private housing unit is not affordable for a common government employee in Islamabad. The low income group purchaser is bound to buy in public sector therefore compromising the quality of life. Environmental factors like vegetation, energy efficient building designs, rain water harvesting, solid waste management, ventilation system, earthquake resistance, fire resistance, availability of roads, recreational areas must be considered when designing a project. Residents of private housing sector are 100% satisfied with quality of life provided in private housing schemes. High maintenance charges up to Rs. 2000/month but maintenance is poor. Overall comparatively better maintenance by private housing sector because they have established their own maintenance cell which are charging from residents and taking somewhat responsibility at least better than public sector where the residents have made their own Resident's associations for maintenance which clearly shows that Public housing sector does not take the responsibility of maintenance after handing over the possession to residents. IEE and EIA- Public housing sector is implementing only by conducting the EIA/IEE but not implementing EMP. Rain water harvesting, energy efficient building design and material are new terms for residents of both schemes. Thus there is no awareness of environment in residents which is why they are least bothered with the incorporation of environmental concerns in the construction. According to the results, private sector has better management practices for solid waste and water management. However, Environmental management has not been seen in both housing sectors.

In accordance with the international standards, protection of environment, economic prosperity and social well being are the main streamline areas to be considered in Pakistan for building a housing project**.** Environmental fators mentioned as independent variables for the interpretation of results, including, vegetation, energy efficient building designs, rain water

harvestimg, solid waste management, ventilation system, earthquake resistance, fire rsistance, availability of roads, recreational areas must be considered when designing a project. When we consider intenrational guidelines for building an environmental friendly project, the most noticable factor in Pakistan , that must be considered is the maintennace and management after establishment of the project. There are authorities within study area who are responsibe for maintenance to avoid wastage to reources and management of waste material, but there should be a proper policy to have a check on it. Sustainable construction can be achieved by designing and especially implementing housing policies, strategies, programmes. This can be summaraized as green buildings to meet the intenational standards of LEED (Leadership in energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method). Environmental friendly technologies and materials have not considered in the current housing projects in accordance to international standards, hence, green buildig lead to the better approach, green and clean environmnet, specifically to face the current climate change scnerios. Pakistan Green Building Council (PGBC) as a member of World Green Building Council has been effectively following the international standards in order to establish sustainable future housing development , hence, enforcement of IEE and EIA can be seen in the current housing projects as necessary requirement in construction. Ignorance and negligence by the construction companies and low or lack of maintenance during and after the completion of construction lead towards not meeting the requirements of international standards.

When we compare the construction of considered housing schemed with national standards, specifically, CDA. By-Law including ICT Zoning Regulations 2005, Building Control Regulations 1993, ICT Municipal Bye Laws 1968, SOP for Management of Sanitation Services 2008, Islamabad Fire prevention and Life Safety regulations 2010 (CDA, By-Laws) , it has been observed through results that public sector housing industries are under the supervision of CDA, that means , Capital Development Authority is whole solely responsible for the maintenance of water and sanitation services as well for solid waste management for clean environment there. According to the results, private sector has better management practices for solid waste and water management. As private sector housing schemes are more expensive, hence, maintenance and management have been seen in private sectors. Sufficient environmental management has not been seen in both housing sectors which is alarming, especially, in climate change perspective. Sustainable construction and green building approach are actually the solution in Pakistan.

Chapter 5

CONCLUSION

Following are the conclusions made on the basis of the research:

- Construction has always a significant impact on environment in terms of consumption of resources and operation. These effects are now minimized by using environmental friendly strategies termed as “Green Building”.
- An effort has also been made in this research to develop a greater awareness of the environmental issues in the field of housing and to identify the environmental concerns among private and public sector by analyzing their work procedures.
- According to the results, private sector builders have considered environmental parameters noticeably as compare to the public schemes. While the survey of residents indicates that the parameters such as sewage system, ventilation system, noise pollution, rain water harvesting, environmental friendly building material and fire resistance have better been incorporated in private rather than public housing schemes while energy efficiency is low in private schemes and high in public schemes.
- Public housing sector is financially affordable but at the cost of environment. The construction cost per square feet of private housing sector is almost double of public housing sector therefore the total price of the private housing unit is not affordable for a common government employee in Islamabad. Difference of per square feet cost is approximately:

    - Rs. 4000/sqft in Public housing sector
    - Rs. 7500/sqft in Private housing sector

- High maintenance charges up to Rs. 2000/month and comparatively better maintenance is by private housing sector because they have established their own maintenance cell which are charging from residents and taking somewhat responsibility at least better than public sector where the residents have made their own Resident’s associations for maintenance which clearly shows that Public housing sector does not take the responsibility of maintenance after handing over the possession to residents.

- The only environmental parameter with a 100% satisfaction result is quality of life in private housing scheme.

- Sustainable construction and green building approach is the solution in Pakistan.

RECOMMENDATIONS

Following recommendations have been produced after conducting this research:

1. Builders should rethink about their potentials in a more innovative way because the environmental protection is foremost priority as a backlash to abrupt climate change occurring globally.
2. Builders should incorporate environmental issues in the construction process in all the phases including planning, design, construction, operation, maintenance, and refurbishment, upgrading and then the final destination of the materials after expiry so fusing each of these phases with environmental protection steps can tackle the problem of environmental degradation and exploitation.
3. The "green hierarchy" reduce, reuse, recycle, recover and appropriate disposal should be adopted both by builders and residents.
4. The government and local authorities should enforce the construction laws and rules such as CDA by laws. IEE and EIA and review the guidelines for improvements because as long as there is no accountability, the industrial players will only care for the economic benefits.
5. Pak-EPA should also devise or adopt the standard such as LEEDS for the evaluation of housing units and best known practices from around the world should be replicated in local construction projects.
6. The level of awareness and willingness to pay for the (HSE) Environment, Safety and Health should be increased through capacity building of individuals and companies and the developers and residents must be convinced that green building will add value to their projects and quality of life.

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ANNEX I

PHOTO GALLERY

1. Improper Sewage System

2. Ventilation System

3. No Parking

4. Unconstructed Roads

5. No Proper Sewage Management

6. No Proper Rainwater Disposal

7. Poor Construction

Figure 1: C & E Type PHAF ApartmentsG-11/3

8. Open Main Holes

9. Open Dumping

10. Drinking Water Arrangement By Residents

11. Waste Enclosures

Figure: C & E Type PHAF ApartmentsG-11/3

1. Water Management By Residents

2. Poor Maintenance

3. Old Building

4. Poor Construction

5. Vegetation

6. No Parking Place

Figure 3: C & D Type PHAF ApartmentsI-11/3

7. Poor Solid Waste Management

8. Poor Maintenance

9. Rubbish Enclosure At Site

10. Main Entrance

Figure4: C & D Type PHAF ApartmentsI-11/3

1. Main Building with Surrounding Vegetation

2. Open Area

3. Market

4. Surrounding Vegetation

Figure5: Grande 1, Bahria Town

1. High Rise Building

2. Specific Non-Parking Area

3. Poor Maintenance

Figure6: High Rise Type Apartments, Khayaban- e- Kashmir (Kashmir Heights)

ANNEX II

QUESTIONNAIRES

Questionnaire for Builders

I am MS student in NUST, carrying out final thesis on **"Comparative analysis of environmental concerns between public and private housing industry"**.

Owners/Company Information

Name: _____ **Gender:** **Male** ☐ **Female** ☐

Position in Company: _____ **Age:** _____

Qualification: _____ **Company's Name:** _____

PEC Registered: **Yes** ☐ **No** ☐ **Type of work:** _____

PEC Registration no: _____ **No. of Employees:** _____

Information about Scheme

Name of Scheme: _____ **Total Area:** _____

Approx Cost: _____ **No. of Housing Units:** _____

Land source: _____ **Type of Housing Units:** _____

Population: _____ **Khasra Number:** _____

Year of giving possession of flats/plots to the Owners: _____

1. Does your company have a written environmental health and safety policy?

Yes	No

2. Do you consider environmental and occupational safety and health issues in planning and construction of housing projects?

Yes	No

3. Did you conduct IEE/EIA?

Yes	No

4. Did you compensate existing population for the land loss?

Yes	No

5. Did the site of your constructed housing scheme consist of any ecologically sensitive area (National park/agricultural land/wetland)?

Yes	No

6. If yes, did you preserve it?

Yes	No

7. What type of flora was present in the area?

_____

8. Was vegetation was removed during construction?

Yes	No

9. How much vegetation was removed?

_____

10. What types of trees were removed?

_____

11. What is your point of view on removal of vegetation?

_____

12. Did you replant the local flora and damaged trees and aesthetic value was recovered?

Yes	No

13. Which types of trees were replanted?

_____

14. How much trees were replanted?

_____

15. Street lights have been installed?

Yes	No

16. Are major roads accessible from this scheme?

Yes	No

17. Who manages the trees and vegetation (Maali)?

Residents themselves	Authority

_____

18. What is the number of gardeners?

_____

19. Are fumigations used?

Yes	No

20. Is clean water supplied to population and name of water management authority?

Yes	No

_____

21. Who manages the solid waste and street sweeping? Mention the name of authority if present.

Residents themselves	Authority

_____

22. Sewage system is connected with the main line?

Yes	No

23. Are sanitary sewers lined to avoid seepage into ground water?

Yes	No

24. Which authority manages sewage and Nullah system?

_____

25. Environment Management Plan was prepared?

Yes	No

26. Did soil erosion occur?

Yes	No

27. Which measure was used to avoid soil erosion, pollution and siltation of water bodies?

_____

28. Did you preserve the natural drainage patterns for storm-water runoff?

Strongly Disagree	Disagree	Neutral	Agree	Strongly Disagree

29. Is the paving permeable to allow percolation of water back into soil?

Yes	No	Semi-permeable

30. How much construction waste was produced?

_____

31. How was the waste disposed off?

_____

32. Did noise pollution occur?

Yes	No

33. Which machinery produced much noise?

34. What Noise pollution minimization measures were used?

35. Did air pollution and dust problems occur at the site?

Yes	No

36. How was air pollution and dust minimized?

37. Are the flats earthquake proof?

Yes	No

38. Was the construction process conducted in compliance with EPA construction guidelines?

Yes	No

39. Local labor was used during construction?

Yes	No

40. Temporary sanitation facility was provided to workers?

Yes	No

41. Incident reporting and EHS (Environmental Health and Safety) inspections were conducted?

Frequently	Often	Never

Additional Comments/Information/Suggestions:

Questionnaire for Residents

I am MS student in NUST, carrying out final thesis on **"Comparative analysis of environmental concerns between public and private housing industry"**.

Name: _____ **Gender:** **Male** ☐ **Female** ☐

Resident of: _____ **Age:** _____

Plot Size _____ **Cost of Plot/Flat:** _____

1. Did you buy a plot or constructed house?

Plot	Constructed

2. In which year you were handed over the plot/flat?

_____

3. Are you aware of environmental issues related to housing?

Yes	No

4. Did you manage your construction waste? If yes how?

Yes	No

_____

5. Is the design of your house according to health and safety requirements?

Yes	No

6. Which authority manages the waste and sewage system?

_____

7. How will you rate the solid waste management system?

Very Bad	Bad	Satisfactory	Good	Very Good

8. Is there adequate management and maintenance of sewage system?

Yes	No

9. Are you satisfied with the ventilation system of your house?

Yes	No

10. Is the design of the building energy efficient (utilize sun light at day time or needs artificial lightening)?

Yes	No

11. Do you experience noise pollution?

Yes	No

12. Is your home water efficient (rain water harvesting)?

Yes	No

13. Is your house resistant to earthquakes?

Yes	No

14. Is the building material fire resistant?

Yes	No

15. Is the building material of your house environmental friendly?

Yes	No

16. Who provides the maintenance services? Mention the name if there is an agency.

Residents themselves	Any Agency/Authority	No one

17. Are there sufficient trees and vegetation in the surroundings?

Yes	No

18. Is there a park in your colony?

Yes	No

19. Do you have a proper car parking?

Yes	No

20. Is there a fence around your house/building?

Yes	No

21. Does your residential area have street lights?

Yes	No

22. Does the building have a generator?

Yes	No

23. There is sufficient storage space?

Yes	No

24. Who manages the environment of the town? Mention the name if there is any authority.

Residents themselves	Any Agency/Authority	No one

25. How would you rate the overall quality of your life?

Very Bad	Bad	Satisfactory	Good	Very Good

Additional Comments/ Information /Suggestions:

ANNEX III

Descriptive Statistics of public and Private Housing Schemes for Builders (N= 04)

Environmental Variables	Mean	Std. Deviation
Housing Scheme	2.5000	1.29099
Environmental Policy	1.0000	.00000
OSHA	1.0000	.00000
IEE/EIA	.7500	.50000
Population Compensation	.0000	.00000
ESA in Housing Scheme	.0000	.00000
ESA Preservation	.2500	.50000
Type of flora	1.0000	.00000
Vegetation Loss	.2500	.50000
Re-plantation of local flora	.7500	.50000
Streets Lights	1.0000	.00000
Roads accessibility	1.0000	.00000
Manager of vegetation	.5000	.57735
Fumigation	1.0000	.00000
Water Management Authority	1.0000	.00000
Solid Waste Management	1.0000	.00000
Sewage System	1.0000	.00000
Seepage into Ground Water	1.0000	.00000
Environmental Management Plan	.2500	.50000
Soil Erosion	.5000	.57735
Preservation of Drainage System	4.5000	.57735
Percolation of water	2.5000	.57735
Constructed Waste	1.0000	.00000
Waste Disposal	1.0000	.00000
Noise Pollution	1.0000	.00000
Noise Pollution Minimization Measures	.0000	.00000
Air Pollution	1.0000	.00000
Air Pollution Minimization Measures	.5000	.57735

Earthquake Proof	1.0000	.00000
EPA Construction Guidelines	.7500	.50000
Local Labor	.7500	.50000
Temporary Sanitation Facility	1.0000	.00000
EHS Inspections	1.7500	.50000