MOTIVATORS AND BARRIERS FOR GREEN BUILDING CONSTRUCTION MARKET IN TURKEY

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ABSTRACT

MOTIVATORS AND BARRIERS FOR GREEN BUILDING CONSTRUCTION MARKET IN TURKEY

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'Green Buildings' play an important role to increase the implementation of sustainable strategies in the construction industry. Although there is a process of change within Turkish building environment towards implementation of green strategies nowadays, limited research has been conducted to search the reasons that drive the market and the important barriers that block the green building movement. This thesis is intended to fill this gap in the literature and contribute to the field of knowledge regarding green building construction in Turkey. The results shall benefit both government and market practitioners for the development of green building market.

The data presented in this thesis are mainly obtained from a comprehensive questionnaire survey developed based on a deep literature search. The questionnaire is completed by professionals who have an interest on this topic or who have involvement in green building projects. In order to analyze the gathered data, a variety of statistical methods are used and the results are

evaluated in detail. In addition to questionnaire survey, six case study green building projects in Turkey are examined and so a snapshot picture of current situation of the green movement is taken. Accordingly, financial considerations, faced difficulties and lessons learned are explained. The findings shall assist in understanding the real needs for green building development in Turkish construction sector. Finally, recommendations for government and researchers are presented so as to steer the construction sector in the direction of sustainability.

Keywords: Green building, Sustainability, Turkish construction sector, Drivers, Barriers, Sustainable Design

ÖZ

TÜRKİYE'DE YEŞİL BİNA SEKTÖRUNÜN MOTİVASYON VE BARİYERLERİ

Gündoğan, Handan

Yüksek Lisans, İnşaat Mühendisliği Bölümü

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Yeşil binalar inşaat sektöründe sürdürülebilir stratejilerin uygulanmasını artırmada çok büyük rol oynamaktadır. Türkiye'de son yıllarda yeşil bina sektöründe çeşitli gelişmeler olmasına rağmen, ülkemizde bu sektörü motive eden ve engelleyen faktörler konusunda çok az sayıda çalışma yapılmıştır. Bu tezin temel amacı literatürdeki bu boşluğun doldurulması ve Türkiye'de yeşil bina konusuna katkıda bulunmaktır. Elde edilen sonuçlar devlet ve sektörde çalışanların yeşil bina sektörünü geliştirmesi için faydalı olacaktır.

Bu doğrultuda, detaylı literatür taraması sonuçları baz alınarak bir anket formu geliştirilmiş, ve bu form kullanılarak yeşil bina projeleri hakkında bilgi ve deneyim sahibi uzmanların bu konudaki görüşleri derlenmiştir. Toplanan verilerin analizi için çeşitli istatistiksel metodlar kullanılmış ve sonuçlar ayrıntılı bir şekilde değerlendirilmiştir. Ankete ek olarak, Türkiye'de bulunan altı tane

yeşil bina projesi araştırılmış ve bu sayede Türk yeşil bina sektörünün son durumu analiz edilmiştir. Buna bağlı olarak her bir projenin finansal durumları, karşılaşılan zorluklar ve öğrenilen dersler açıklanmıştır. Elde edilen sonuçlar yeşil binaların geliştirilmesi için gerçek ihtiyaçların belirlenmesine yardımcı olmuştur. Anket sonuçlarına göre, yeşil bina sektörünü geliştirmek için öneriler sunulmuştur.

Anahtar Kelimeler: Yeşil binalar, Sürdürülebilirlik, Türk inşaat sektörü, Motivasyonlar, Bariyerler, Sürdürülebilir Tasarım

Dedicated to my beloved family...

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LIST OF ABBREVIATIONS

ANOVA Analysis of Variance
BMS Building Management System
ÇEDBİK Çevre Dostu Yeşil Binalar Derneği
GB Green Building
VOC Volatile Organic Compound

CHAPTER 1

INTRODUCTION

With the world's supply of fossil fuels increasingly depleted, the price of energy rises thus every country is taking steps by establishing policy instruments to correspond the sustainable movement. All sectors like business, transportation and manufacturing have started to develop and implement sustainable strategies into their processes in order to protect the environment and to improve the quality of life for future generations. The construction industry's "cradle-to-grave" activities in the built environment have a huge contribution on global environmental impacts including the depletion of natural resources and negative effects, solid wastes, air and water pollution etc., and demand on natural resources – especially for housing and infrastructure, which are very resource-intensive. That's why construction industry has a responsibility to minimize negative environmental and social impacts and maximize positive contributions to environment and economy. It is potentially the main single-sector contributor to achieving sustainable development.

Building market is a major part of construction industry. The buildings, in which people live, work and play, have an enormous impact on the environment, including its location, construction, design, operation and demolition. The primary greenhouse gas, carbon dioxide is emitted from buildings due to natural gas, fuel oil combustion and electricity usage. Currently, many studies and reports in the literature argue the effects of building activities on environment, energy consumption, global climate change and human health. According to U.S. Energy Information Administration (EIA) data, buildings consumes almost half (42%) of all U.S. energy consumption, with 23% coming from the residential sector and 19% from the commercial arena (US EIA, 2007). In the light of these facts, sustainable building movement which works for the balance between

environmental, social and economical performance is gaining momentum in recent years. It brings a wide range of sustainable practices and techniques to minimize these negative effects of buildings on energy consumption, environment and human health.

Green building industry is very young in Turkey. Hence, the construction sector needs to have a better understanding for implementation of sustainable strategies. Interest in green building is increasing; on the other hand useful and practical knowledge of green buildings is limited. Very little research has focused on identification of motivators and barriers for the green buildings in Turkey. This thesis aims to fill this gap in green building area and to look and understand the real impact of sustainability issues in practice.

1.1. Research Objective and Questions

Growth in the number of green building projects in the world and the potential for the green building construction in Turkey has led to the need to answer the two critical questions:

1- What are the greatest barriers and motivators to green building movement in Turkish construction market?

2- What are the solutions that will facilitate the widespread adaption of sustainable buildings in Turkish built environment?

There are so many reasons to construct green buildings, but there are many factors not to. The aim of this thesis to answer the questions noted above through a questionnaire survey. Because the best way to get a better understanding of motivators and barriers and direct the sector towards a sustainable agenda can be achieved by learning from the actual practitioners in the sector. Moreover, examples of sustainable building projects in Turkey are presented regarding to financial considerations, faced difficulties and lessons learned. The results of this research shall benefit both government and market participants in order to promote green building market.

1.2. Thesis Structure

This thesis on green building movement in Turkey was organized by the following components.

Chapter 2 presents a discussion of the meaning of sustainable design, implemented green strategies, including rating systems and the movement in Turkish construction sector is presented. A review of existing studies on motivators and barriers of green building market is also included in this chapter.

Chapter 3 includes barriers and motivators to green building movement in Turkish construction market. A brief outline of the research methodology and data collection is also introduced in this chapter. The questionnaire survey data are analyzed and an overview of the critical motivators and barriers facing the industry are given.

Chapter 4 proceeds to deepen and verify challenges and barriers by examining six green building projects in Turkey. Detailed case study analyses of the costs and benefits, the overall observations and lessons learned are provided.

Chapter 5 summarizes sector's expectations, perceptions, and thoughts about the future of green industry. Solutions for the identified barriers and recommendations for both government and researchers are offered.

Chapter 6 concludes the findings of the research. Limitation of the study and future research areas are explained in order to promote the sustainable design.

CHAPTER 2

LITERATURE REVIEW

A deep literature review was conducted to explore the growing momentum of green building movement all over the world. Firstly, meaning of sustainability and green building is explained in terms of implemented sustainable strategies, integrated design process and assessment systems. Then, a brief history of green building movement in Turkey is traced. Finally, an extensive search of existing studies and research focusing on the motivators and barriers of green building movement are presented in this chapter.

2.1. Sustainability and Green Building

The term "sustainability" came into the picture since the realization of "global warming". In 1987, The World Commission on Environment and Development defined "sustainability" as "meeting the needs of the present without compromising the ability of future generations to meet their own needs." Its purpose is to create a balance between social and economic development with environmental protection, called "triple bottom line" (Figure 2.1).

This thesis considered green building construction in the context of sustainable development. A building consists of four major phases as design; construction; operation and maintenance; and demolition. As given in Figure 2.2, sustainable building means changing the process that cause pollution, non-renewable resource usage into usage of resource-efficient products and processes beneficial for environment and society during the phases of pre-building, building and post-building. The building processes should be analyzed in each of these three phases so that a better understanding of how a building's design, construction, operation and disposal can affect the larger ecosystem (Kim, 1998).

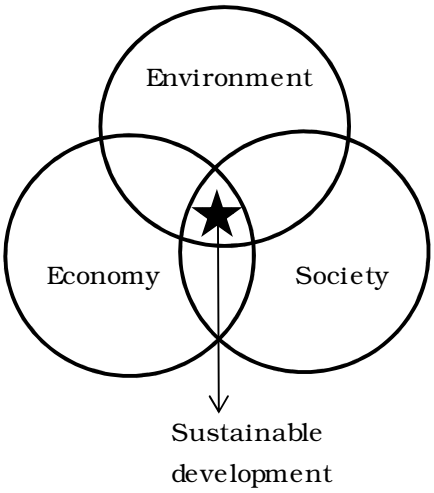

Figure 2.1. Triple bottom line of sustainable development
(Source: Parkin et al., 2003)

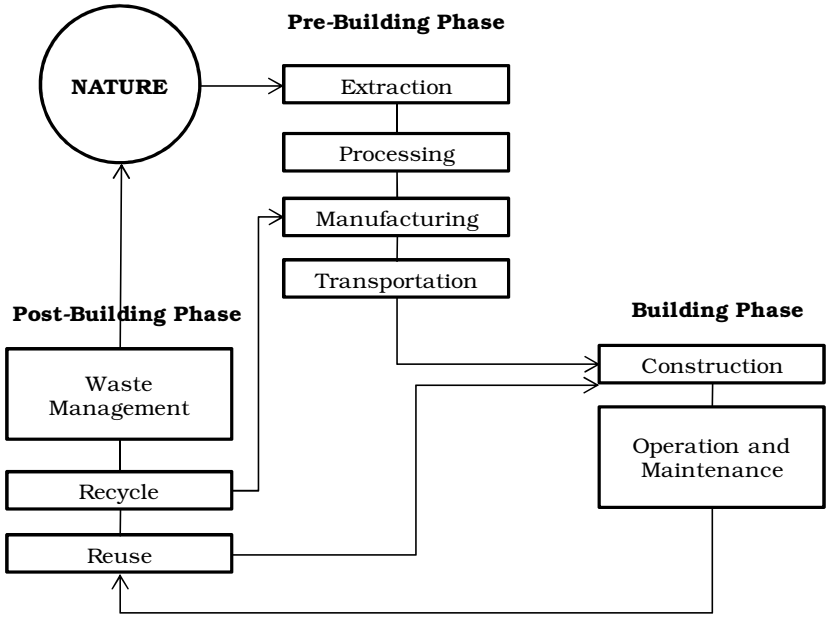

Figure 2.2. The sustainable building life cycle
(Source: Kim, 1998)

In this thesis, the definition of a green building explained in terms of its properties, purposes and implemented strategies to minimize the negative impacts of buildings on environment and human health (Table 2.1). There are also synonymous terms, such as “high-performance building”, “environmental friendly building”, “sustainable building” and “energy-efficient building”. In this thesis the terms “sustainable building” and “green building” are used identically and interchangeably.

Table 2.1. Definition of a green building

Properties	**Purpose**	**Strategies**
have less impact on environment	Saving natural resources, Low site ecology impact, Reducing greenhouse gas emissions, Slowing down climate change, Reduction of urban heat island effect,	Waste reduction, Recycling, Efficient land usage, Increased green area,
have a superior indoor environmental quality for occupants	High comfort, Well-being of occupants, Good health of occupants, Improved occupant productivity,	Healthy building material selection (low VOC - volatile organic compound) More natural light, More out view, More fresh air, High thermal comfort with controllability, Efficient lighting system,
have low financial impact	Reduction in energy and water demand Increased employee productivity, Easy risk management, Local economy support	Grey water recycling High performance mechanical systems, Management of storm water, Generation of renewable energy on-site, Selection of durable, local materials, Improved image
have a boost effect on innovation	Development of new technology, Creation of new jobs,	Integration of systems and processes, Introduction of new materials and technologies, Building management system (IT technology)

Each sustainable design is unique since it is constructed according to its own needs, different climate conditions, geographic conditions, environmental and social conditions, usage of different construction materials and so each project results in its own characteristic green strategies. To complete the green building definition, it is a must to define "integrated design process". The strategies described in the above table for green buildings should be addressed in an integrated way in order to achieve a sustainable building by focusing on the environmental, economic and social aspects of the building.

Integrated design process is an approach in the design phase to discuss and understand all subjects that may have a significant impact on sustainable performance and to deal with them at the beginning of the design process (Nills, 2009). Integrated design process creates synergies between disciplines and between technologies to achieve high levels of building performance (USGBC, 2004; Nills, 2009). For example, high performance building envelope with better windows and thicker insulation can downsize the mechanical system to reduce energy cost. In order to create these synergies and find out other opportunities integrated design team members (mechanical engineer, structural engineer, architect, etc.) should all sit down together and allow new ideas and then solve problems, at each phase of design. Each design option should be based on a full cost-benefit assessment (Nills, 2009). Furthermore, Cole (2010) emphasized that integrated design is not only a matter of bringing the design team members together at the outset of a project-setting performance targets, it is developing a shared vision for the project and improving the quality of communication and information to guide design.

According to Yudelson (2008), the key elements of integrated design process are;

1- Hiring design team members who want to participate in a new way of building design and construction,
2- Defining stretch goals for the entire team and evaluating the final results according to defined goal,
3- Getting the team to achieve zero cost,
4- "Front load" the design process with charrettes, studies and similar "thinking" time,

5- Allowing time for feedback and revisions before committing to a final design concept,
6- Involving everyone in the project,

To understand integrated design process it is necessary to know traditional design process. The optimization possibility of traditional process is limited and often causes troubles in the later stages of the process (Nills, 2004). On the other hand, as shown on Figure 2.3, integrated design provides wide range of optimization opportunity from the very beginning of the design process.

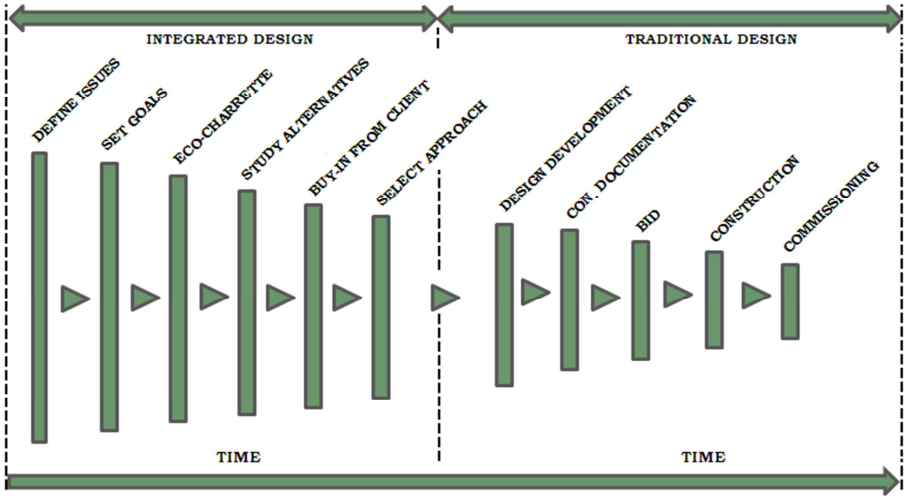

Figure 2.3. The opportunities for integrated design team diminish over time (Source: Yudelson, 2008)

Another key element of green buildings is the certification systems or rating tools to examine the performance of the building and to improve the green building process and strategies. These rating systems are refined over time in response to improvement in technology, knowledge and market advancements. Examples of rating systems including, BREEAM (Building Research Establishment's Environmental Assessment Method), developed in the United Kingdom, in 1990, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency), developed in Japan, in 2001, LEED (Leadership in Energy and Environmental Design, developed in United States, in 1998. All these rating tools provide sharing the experience of the sector and so lead to accelerate the green building movement.

2.2. Green Building Movement in Turkey

It is apparent that the growth rate of green building movement is increasing all over the world. In fact, green building or sustainable strategies have a long history since they are created due to energy crisis and environment protection movement. Hence, there is a rapid process of change in Turkish built environment and the interest in green buildings is growing rapidly.

Many concepts inside of green building term have already been considered for building projects and implemented from the view of architecture point in history. These concepts have more than 5000 year history. As an example, one of the first green building project of Turkey is "The Houses of Mardin." In a study of energy efficient design strategies in the hot dry area of Turkey, modern houses and traditional houses are compared and contrasted in terms of design criteria such as selection of area, distance between buildings, orientation, building envelope and form (Manioğlu and Yılmaz, 2006). The results of the study proved that traditional houses provide cooler indoor environment compared to the modern ones in summer. Therefore, it can be said that the history of sustainable design of Turkey has begun with the construction of the houses of Mardin.

In 1975, METU Solar House, the first green building case project, was originally designed and built as a laboratory for different research possibilities. The main purpose of the project was to examine the limits of the capability of solar energy in full scale by both active and passive gains (Demirbilek et al., 1997). After this project following projects were implemented; the Greater Ankara Municipality Solar House and Hacettepe University Solar House in 1993, TUBITAK National Observatory Guest-House and the Erciyes Active Solar House in 1996, Pamukkale University Clean Energy House in 2007 and The Diyarbakir Solar House in 2008. Most recent project, The Ayaşlı Research Center of METU Department of Electrical and Electronics Engineering was opened on March 5, 2012. It is a pioneering and prominent example of energy sensitive building as well as first building in terms of flexible membrane technology in Turkey. The building provides its own energy from the photovoltaic panels and flexible (membrane) photovoltaic system, placed on its roof that forms the south façade. These two photovoltaic systems will constantly monitor record and compare

solar energy production and electric consumption, collecting data for solar energy research.

In order to develop Turkish green building industry in terms of implication of sustainability principles, Turkish Green Building Association was established in 2007, the association currently has more than 100 supporting members. The Association organizes educational programs, develops pilot projects with government and universities and conducts lobbying activities with purpose of increasing public awareness and encouragement of building industry. Furthermore, a national environmental certificate system for buildings specific to the geographical, climatic, political, social and technological content of Turkey is being developed by this association.

In December 2008, Energy Performance Regulation in buildings is published in official gazette. The purpose of this regulation is to adjust the procedures and principles related to usage of energy and energy sources more efficiently, preventing energy squander and protecting the environment. Since Turkey is energy dependent country, government is in a need to moderate energy price relating to buildings.

2.3. Motivators and Barriers for Green Buildings

Green building movement is reshaping the construction industry and this market share is rising in the construction market (Ahn and Pearce, 2006). As Hydes and Creech (2010) pointed out that the techniques and concepts are already there, the trick is to overcome the safety of "business as usual" and dare to be innovative. A literature research was carried out to investigate the current status of research on green building projects' obstacles and catalysts.

2.3.1. Motivators

Economic Motivators

There are significant economic motivators associated with green buildings in terms of direct capital cost, operating cost, life cycle costing, employee

productivity gain and property values to building participants. Some of the published relevant studies that have attempted to quantify the financial benefits of green buildings are summarized below.

The first comprehensive study of the costs and financial benefits of green buildings, Kats et al. (2003) reported that life cycle savings provides ten times of the initial investment by making extra investment of about two percent of construction cost. As demonstrated in Table 2.2, financial benefits come from reduced energy, water, and waste; lower operations and maintenance costs: and enhanced occupant productivity and health. For instance, $100,000 initial upfront cost to incorporate green building features into a $5 million projects would provide $1 million savings over the life of the building, which is assumed as 20 years.

Table 2.2. Financial benefit results from 33 green building projects across the United States
(Source*:* Kats et al., 2003)

Benefits	**20-year NPV**
Energy Value	$5,79
Emissions Value	$1,18
Water Value	$0,51
Waste Value (construction only) - 1 year	$0,03
Commissioning O&M Value	$8,47
Productivity and Health Value	$36,89 to $55,33
Less Green Cost Premium	$4,00
Total 20-year NPV	**$48,87 to $67,31**

Another study carried out by The General Services Administration (GSA) examined 12 LEED certificated buildings across the USA in 2004. The results reveal the facts that green buildings have less operation costs and excellent energy performance.

Third study by Davis Langdon, an international cost consulting company, published a report in October 2004 and compared construction cost information of 138 buildings (libraries, laboratories etc.), 93 non-LEED (conventional) and 45

LEED seeking, across the United States. The study concluded that there was no statistically significant difference in average costs between green buildings and conventional buildings. This study is revised in 2006 and same results are obtained.

Another study which quantifies the benefits of green buildings found that manufacturing productivity increased by about 25% and energy usage decreased by about 30% on a square foot basis in the new facility, which constructed in a green way (Ries et al., 2006).

Environmentally efficient buildings have three positive effects on the capital value of the building because of improved working environment, reduced building operating cost and reduced facilities maintenance costs, depicted on Figure 2.4. Some studies which confirmed the higher value of green buildings are explained in the following paragraphs.

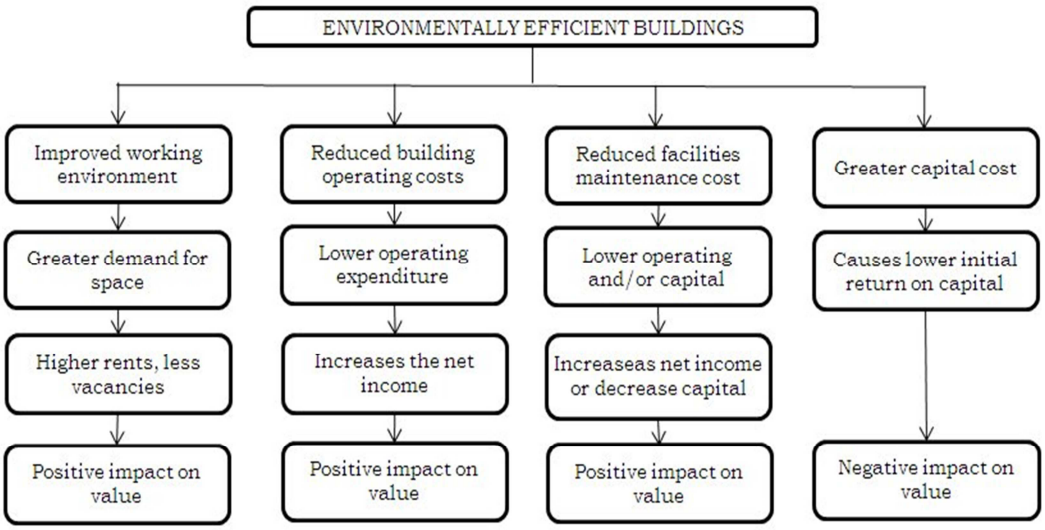

Figure 2.4. Value impact of environmentally efficient buildings
(Source: Boyd and Kimmet, 2005)

A recent work by Chegut et al. (2011) provide evidence that buildings with green characteristics have a positive impact on rental and sales transaction prices per net square meter in order of 21 and 26 percent, respectively.

Another research focusing on the relationship between energy-efficient design and the leasing/sales markets for commercial real estate revealed original results that rents are higher roughly 7 to 17%; the selling premium is found as $30 and $130/ft2 for Energy-Star labeled and LEED certified properties, respectively (Wiley et al., 2008).

Another paper by Fuerst and McAllister (2010) investigated the price effects of environmental certification on commercial real assets and found that there is price premia of 10% and 31% for 292 Energy Star and 30 LEED-Certificated buildings respectively compared to non-certificated buildings in the same metropolitan area.

Social Motivators

A growing body of knowledge and several case studies has shown the benefits of daylighting, natural ventilation and improved air quality in green buildings. All these benefits result in enhanced worker productivity and health, as well as reduced absenteeism and illness. An article occupant satisfaction with indoor environmental quality in green buildings compared green with non-green office buildings by a large indoor environmental quality survey. The results revealed that on average green building occupants were more satisfied with thermal comfort and air quality in their workplace. However, the average satisfactions in green buildings for lighting and acoustic quality were compatible to the non-green average (Abbaszadeh et al., 2006). Another research commissioned by Victoria and Kador Group (2008) reported that sustainable offices has a significant positive impact on staff productivity and satisfaction. Third study indicated that from the occupants' perspective, the best green buildings consistently outperformed the best conventional buildings in Australia (Leaman et al., 2007). On the other hand, Paul and Taylor (2007) found no evidence to believe that green buildings are more comfortable by comparing occupants' perceptions with a questionnaire between a green university building and two conventional university buildings.

However, there are still problems, questions and difficulties in this topic because of the lack of a compelling conceptual framework for measuring human outcomes and linking them to design features. Social aspects of sustainable

buildings are not fully explored because of complexity (Lützkendorf and Lorenz, 2005). The statistical analysis results of Issa et al. (2010) verified that Canadian practitioners are not sure about the productivity and health benefits of green building and do not know how to measure. These aspects are so important in terms of tenant's turnover rates and selling anticipants. Hence, they have direct and measurable effect economically (Lützkendorf and Lorenz, 2005). Fisk (2009) provided strong evidence on this issue by searching that characteristics of buildings and indoor environment have an effect the occurrence of communicable respiratory illness, allergy and asthma symptoms and employee performance. This potential health and productivity gain result in economic earnings, estimated in Table 2.3.

Table 2.3. Estimated potential productivity gains from improvements in indoor environments
(Source: Fisk, 2009)

Source of Productivity Gain	Potential Annual Health Benefits	Potential US Annual Savings or Productivity Gain (1996 $US)
Reduced respiratory illness	16 to 37 million avoided cases of common cold or influenza	$6-$14 billion
Reduced allergies and asthma	18% to 25% decrease in symptoms for 53 million allergy sufferers and 16 million asthmatics	$1-$4 billion
Reduced sick building syndrome symptoms	20% to 50% reduction in sick building syndrome health symptoms experienced frequently at work by ~15 million workers	$10-$30 billion
Improved worker performance from changes in thermal environment and lighting	Not applicable	$20-$160 billion

Environmental Motivators

Buildings have many effects on environment due to the extraction of the materials during its life, as shown in Figure 2.5. Activities start with the extraction and processing of raw materials, extending through the supply of

inputs such as energy, water and construction equipment, and terminate in demolition and the disposal of wastes.

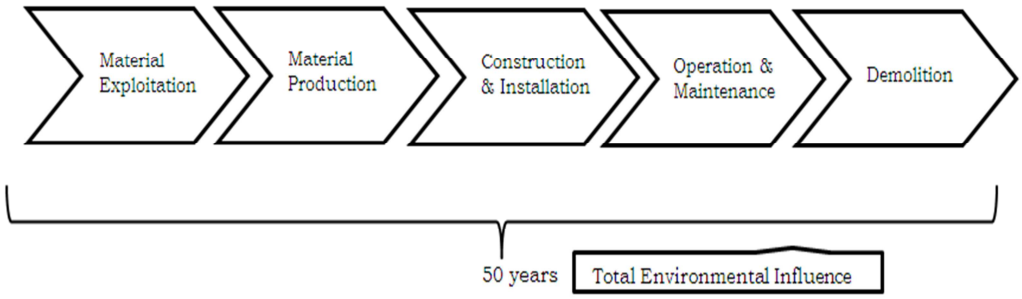

Figure 2.5. The life-cycle concerned in the study of environmental impact assessment
(Source: Zhang et al., 2004)

There is a building environmental performance analysis system-BEPAS developed based on the life cycle assessment framework to investigate the environmental impacts of the buildings in three main aspects-building facilities, building materials and location. This system obtained that the largest portion of the total environmental impacts occurs during the operation phase of a building, a huge number of pollutants will be discharged and lots of natural resources will be consumed. All these effects results in global warming, followed by the depletion of fossil energy, depletion of water and acidification (Zhang et al., 2004). Hence, construction of green buildings can reduce these negative effects and motivate the sector.

Organizational Motivators

The development of sustainable practices and strategies lead to change organization management systems, processes and culture. Lockwood (2006) stressed that green is not simply gaining more respect; it is rapidly becoming a necessity since corporations put green buildings into the mainstream over the next five to ten years. Heerwagen (2010) defined the potential links between sustainable design and organizational performance in terms of financial, business process, customer relations and human resource development by using balance scorecard framework, as shown in Table 2.4.

Organizations can integrate green strategies into their strategy plans. According to Zhang et al. (2010), meaning of green strategy is that developers can gain sustainable competitive advantage by contributing to environment protection, ecological responsiveness and social responsibility. Green buildings also shall help to the creation of environmental conscious image. This has an influence on economic aspects because it leads to employee satisfaction and well-being that translate into improved morale and productivity. In addition, green buildings provides also an effective risk management strategy for property managers by improved indoor environmental quality, higher building value, lower energy, water and waste cost, and longer building life.

Table 2.4. Potential links between green buildings and organizational performance
(Source: Heerwagen, 2010)

Financial Outcomes • Reduced resource utilization • Reduced operating/maintenance costs • Reduced risks/avoided costs • Increased overall productivity • Increased resale value of property • Reduced absenteeism	**Business process outcomes** • Process innovation • Increased work process efficiency
Stakeholders relations • Improved public image • Increased ability to sell to pro-environmental customers • Community outreach and education • Improved ability to work with community stakeholders	**Human resource development** • Improved quality of work life • Improved personal productivity • Improved well being • Reduced turnover and increased ability to attract high quality workers

Market Motivators

The current trend indicates that there is an increase in the number of green buildings all over the world. Building certification systems are being developed and implemented in a growing number of countries. This trend brings new sustainable practices and techniques. Actually, the nature and innovation in construction are very different compared to other industries since it depend critically on the physical nature of construction and social and economic conditions of a construction company. This innovation in construction sector may be achieved by the support of both manufacturers and suppliers. They may develop their knowledge, either themselves or R&D organizations and then sell to construction firms and design professionals. Another motivator to make GB more popular can be the customer demand and willingness to pay for it. At present, buyers are not willing to pay for green building although they have lower operational cost, high building and environmental performance benefits (Belloni and Hakkinen, 2011). The challenge is that construction sector should translate the benefits of sustainability into projects so that clients can appreciate and support.

2.3.2. Barriers

Economic Barriers

It is still debatable how the government can supplement the market for green building promotion. That is because the various levels of government play a pivotal role for the promotion and implementation of green building strategies in the world. Many studies try to explore the best way for the government support. Because government should expand efforts to make public facilities energy efficient, safe and healthy while minimizing their impact on the environment and providing good business value (U.S. Department of Energy, 2003).

There may be a misconception that the initial cost of green buildings is higher. That why lots of studies concentrated on the management of first cost for green buildings. In a report on the costs and benefits of green affordable housing (2005) demonstrated that there is a small green premium of 2.42% in total development cost and total development cost of case studies range from 18%

below to 9% above the costs for comparable conventional affordable housing. It indicate that lower initial cost can be achieved. Some researchers even believe that no additional cost can be accomplished in the near future. Hydes and Creech (2010) argued that both initial and operation cost of the building can be less expensive if high-technology and low technology solutions are combined in a right way. By saving even more energy, "tunnel through the cost barrier", cost comes down and the return on investment goes up, as depicted on Figure 2.5. For instance, thick enough insulation and good enough windows can eliminate the need for a furnace, which represents an investment of more capital than those efficiency measures cost (Hawken et al., 1999, 114).

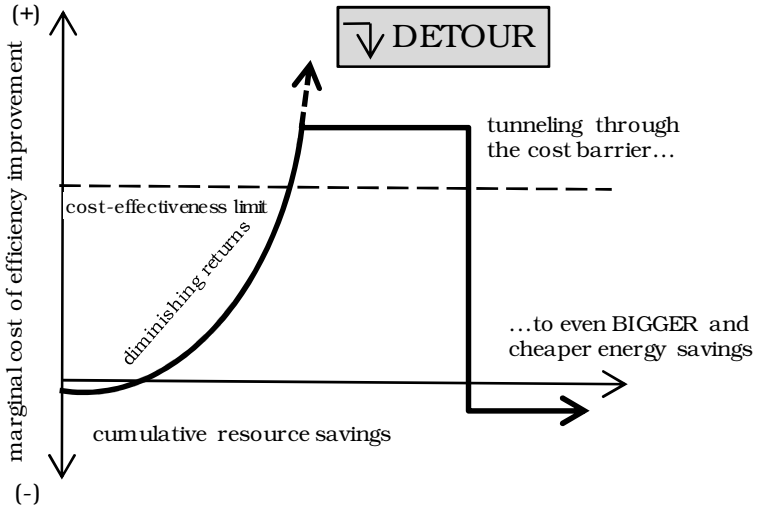

Figure 2.6. Tunnel through the cost barrier
(Source: Hawken et al., 1999)

Other key strategies to overcome "high first cost" problem can be;

1. Setting clear and measurable goals early,
2. Selecting experienced team in sustainable design and establishing a integrated team,
3. Using integrated design process, (According to Yudelson (2008), the key benefit of integrated design process is its ability to achieve higher-performance results without increasing overall building cost)
4. Looking for incentives and financial support from government or utilizes.

Educational Barriers

Life-cycle thinking is the key to the achievement of sustainable construction concept since large material and energy consumed thought the building life. The purpose of life cycle assessment or cost-benefit analysis is to count costs over a realized life of a building so that a clear decision can be made and client's long-term needs can be met by taking future factors into account. However, life-cycle costing approach is not much used because of lack of clear methodology, knowledge and absence of data currently. This can be proved by a survey carried out in Canada to assess practitioner's awareness and confidence about the research work of assessing cost premiums, long-term benefits, and health and productivity benefits of green buildings. The research results validated that practitioners continued to identify high cost premiums as the primary barrier to investing in green practices and the majority of them were uncertain about the size and impact of productivity and health benefits, and about how best to measure them (Issa et al., 2010). This is because most of the parameters that respond to quality, performance and environment effect remain subjective, difficult to measure and thus difficult to award. To achieve the evaluation of these parameters all together, there should balanced standards and specifications including environmental and social policies. Lützkendorf and Lorenz (2005) formed a set of possibility sustainability key performance indicators in terms of object characteristics, environmental performance, economic performance and social performance, presented on Table 3.12. By the help of these indicators the achievement of required performance with minimum environmental impact shall be checked. Another educational barrier can be the need of more established documents and education programs to make lasting change for such a rapidly growing industry in the direction of sustainability.

Table 2.5. Possible sustainability key performance indicators
(Source: Lützkendorf and Lorenz, 2005)

Criteria	Indicators for the assessment of existing buildings
Object characteristics/object performance	
Technical performance	Realized heat insulation class Realized sound insulation class Realized fire safety class Realized load carrying capacity Ease of conducting maintenance, servicing and recycling activities
Functional performance	Functionality and serviceability Adaptability and responsiveness Suitability for remaining service life Accessibility
Environmental performance	
Energy use	Primary energy demand during occupation (measured)
Rawmaterial depletion	Use of fossil fuels
Land use	Current degree of sealing of the lot Current land use per unit (e.g. number of workstations)
Impacts on the environment	GWP100 (CO2-equivalent) ODP AP (SO2-equivalent) EP Photo-oxidant formation potential
Waste production	Waste production during occupation and use Total waste accumulation (by categories)
Impacts on soil and ground water of lot	Impacts on soil and ground water of lot
Economic performance	
Life cycle costs	Costs for refurbishment and modification Effectivemaintenance and operating costs Effective/projected disposal costs
Development of income, value and/or worth	Income stream/current market value/current calculation of worth
Social performance	
Health of occupants/users	Appearance of Sick Building Syndromes/BRI Appearance of black mould
Comfort and well-being of occupants/users	Occupant/user satisfaction
Safety of occupants/users	Number of building related accidents
Indoor air quality	Olfactory freshness Concentration of selected substances (TVOC) Concentration of radon
Comfort and well-being of neighbours	Disturbance through building/use and occupation of building
Cultural value	Existing monumental protection

Market Barriers

Currently, Turkish construction industry seems unaware of potential benefits in order to reshape the market and client demand. That's why the choice of the winning bid is simple in principle: the most economically advantageous or short construction time offer. Award criteria other than price and time should take into account quality, performance and environmental effect assessment including sustainability factors.

Other market barriers can be unavailability of technology and green materials. Two important decisions for the procurement of building materials and equipment are what to buy and from whom to buy it. For sustainable materials, made from recycled or agricultural waste, do not have any toxic or other emissions that contribute to building occupants health, it is necessary to know quantified environmental life-cycle product information. In a study of breaking down the barriers: challenges and solutions to code approval of green building, it is asked to code officials the reasons for denial of green product, material, system, or design application. The results showed that there are building code barriers to the approval of green building alternatives. Technical barrier is supporting information for alternatives accompany plans and non-technical one is a conflict with the intent of the code (Eisenberg et. al., 2002). Besides, there can be resistance to use of new technologies, because they need process of changes, difficult to apply, operate and integrate to the building, including possible risks and unforeseen costs. Since the construction sector has a complex supply chain; the various players have different interests and understanding on issues. This hinders the implementation of sustainability requirements. Here, importance of integrated design team is emphasized because it allows the interaction among the parties involved.

Organizational Barriers

Currently, Turkish construction companies, both consultants and contractors, have little knowledge and experience on this issue. This causes in schedule delays and high initial cost of the projects and hinders the growth of green building market. This problem brings the question that what should be done to create, develop, apply and diffuse knowledge among practitioners in order to

encourage and change the management systems of construction companies. Organizations should develop their knowledge on sustainability and be reluctant to finance and take risks in a highly competitive and uncertain environment since environmental issues influence business and business influence environmental protection and quality (Schaltegger and Synnestvedt, 2002).

2.3.3 Previous Studies from Different Countries

Many existing studies have addressed the most important motivators as *lower operational cost* and *higher building value* to accelerate the green building movement (Pitt et al., 2007; Turner, 2008; Chan et al., 2009; Zhang et al., 2010; Azizi, et al., 2011). On the other hand, other studies agreed that green buildings are perceived as having high first cost for both design and construction than traditional buildings as a barrier (Landman, 1999; Wilson and Tagaza, 2004; Williams and Dair, 2006; Turner, 2008; Chan et al., 2009).

The most frequent barrier cited in the literature is due to lack of understanding related to costs and benefits linked to green buildings (Williams and Dair, 2006; Pitt et al., 2007; Wood, 2007; Turner, 2008; Chan et al., 2009; Winston, 2010; Belloni and Hakkinen, 2011). Building industry should have accurate understanding of the meaning green and how a sustainable building is achieved among all stakeholders. Bartlett and Howard (2000) stressed that "Construction professionals need to be informed of the whole life cost and environmental impact of buildings so that they can encourage key stakeholders to make more sustainable choices.

Compared to conventional buildings, the second obstacle to green building market identified from previous studies is the complexity of issues (Moore, 1994; Williams and Dair, 2006; Wood, 2007; Turner, 2008; Chan et al., 2009; Belloni and Hakkinen, 2011). Research and development are critical points for demonstrating and communicating the value and economic viability of green buildings (Cole, 2010).

In a research on the barriers that blocks the adoption of sustainable actions, Moore (1994) cite government barriers as; inappropriate structure of government

(vertical), weak linkages among the policies of civic and senior levels of government and weak communication linkages between government and its constituents. In the same vein, more recent studies by Wood (2007), Chan et al. (2009) and Zhang et al. (2010) provide evidence that there is not enough government support to accelerate green building movement in terms of policy implementation and incentives. However, even though lack of government support is shown as obstacle to development of green buildings, other studies (Wilson and Tagaza, 2004; Williams and Dair, 2006; Pitt et al., 2007; Chan et al., 2009; Azizi et al., 2011) regarded government regulations, standards and policies as an effective way in promoting green buildings. The summary of the previous studies is given in Table 2.6.

Table 2.6. Existing studies about motivators and barriers of green buildings

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Moore, J. L.(1994)		x Lack of understanding about the subject, x Perceived lack of empowerment, x Competing issues, x Inadequate funds, x Fear of losing constituent support, x Limitation of jurisdiction, x Differences in perception, x Inappropriate structure of government (vertical), x Weak linkages among the policies of civic and senior levels of government, x Weak communication linkages between government and its constituents,	To understand the barriers that prevent individuals and society from adopting sustainable actions	Interviews

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Landman, M. (1999)		x Lack of interest in or demand from clients(owners/developers) x Lack of training and education x The failure of service fee structures to account for the recovery of long-term savings x Higher cost (both real and perceived)	To discuss the concept, benefits, and history of sustainable buildings	Interviews Questionnaire survey

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Wilson, J.L., Tagaza, E. (2004)	✓ Reinforcing the green brand of an organization ✓ Satisfying Government ESD(ecological sustainable design) standards for the building leased and occupied by government ✓ Improving staff health and staff satisfaction and productivity levels though superior indoor environmental quality ✓ Avoiding building obsolescence by embodying ESD principles in the building design	x Higher initial capital cost x Short term payback financial modeling x Perceived lack of tenant demand x Different contact forms of project delivery x Longer design time using integrated design teams x Introduction of greener and recycled materials x Changed site practices and behaviors x Protracted planning process x Longer approval process for new technologies and recycled materials	To define the drivers and barriers of green buildings in Australia	Investigating case studies

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Williams, K., Dair, C. (2006)		x Lack of consideration of sustainability measures x Real and perceived costs x Inadequate expertise and power	To determine barriers for achieving sustainability in England	Examining five case studies of residential and mixed-use schemes in England
Wood, J.(2007)		x Confusion related to the costs and benefits linked to green building x The risks and fears associated with using new technology or new processes x The lack of consistency within the movement and so, the assortment of definitions and approaches to green building x The lack of knowledge, education and training particularly among building practitioners x The policy and incentive-based deficiencies	To answer the question: Why don't more people live in green houses?	An in-depth literature review Internet research Media analysis Interview

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Richardson, G. R.A., Lynes, J.K. (2007)		x A lack of internal leadership amongst stakeholders with decision –making power x A lack of quantifiable sustainability targets x An operational structure that does not reward building design with lower energy costs x Lack of communication between professional designers, facilities management and faculty.	To explore the barriers and motivations to the construction of green buildings at the University of Waterloo	Semi-structured in-depth interview Documenting and analyzing the UW building process

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Pitt, M., Tucker, M., Riley, M., Longden, J.(2007)	✓ Client awareness ✓ Building regulations ✓ Client demand ✓ Financial incentives ✓ Investment ✓ Labeling /measurement ✓ Planning policy ✓ Taxes / levies	x Affordability x Building regulations x Lack of client awareness x Lack of business case understanding x Lack of client demand x Lack of proven alternative technologies x Lack of one labeling/measurement standard x Planning policy	To understand what factors best promote or prevent sustainable construction practices and establish the consistency of how sustainability is measured.	Literature review Questionnaire survey

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Ambec, S., Lanoie, P. (2008)	✓ Better access to certain markets ✓ Differentiating products ✓ Selling pollution-control technologies ✓ Easy risk management and relations with external stakeholders ✓ Reduction of expenditures on raw material, energy, or services ✓ Lower cost of financial capital ✓ Young, well-educated worker attraction		To review empirical evidence of improvement in both environmental and economic performance	Studying and analyzing the existing studies

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Turner Construction, 2008	✓ Health and well-being of occupants ✓ Building value ✓ Asking rents ✓ Return on investment ✓ Occupancy rates ✓ Worker productivity	x Cost and documentation for LEED certification x Higher construction cost x Payback too long x Lack of awareness of benefits x Difficulty quantifying benefits x Short-term budget horizon	To understand the views of executives involved with commercial real estate about green buildings	Questionnaire survey
Chan, E.H.W., Qian, Q.K., Lam P.T.I. (2009)	✓ Lower operation cost ✓ Higher building value ✓ Lower lifetime cost ✓ Rising energy cost ✓ Government regulation/building code ✓ Lower life-cycle cost	x Perceived higher upfront cost x Lack of education x Lack of awareness x No fiscal incentives from government	To explore the business elements, the favorable factors and the obstacles that affect market participants considering green building investment.	Questionnaire survey

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Zhang, X., Shen, L., Wu, Y. (2010)	✓ Green brand reputation gain ✓ Lower construction and operation cost ✓ Gain favorable land prices ✓ More channels available for financing	x Higher costs for green appliance design and energy-saving material x Higher cost in relation to customer's demand x Insufficient policy implementation efforts	To examine the benefits and barriers in applying green strategies in the process of housing development and facilities management.	Examining case studies Questionnaire survey

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Winston, N. (2010)		x Lack of a shared vision of sustainable housing, x Inadequate building regulations and non-compliance with existing regulations x Limited knowledge and expertise in green building methods x Negative perceptions of higher density housing x Poor quality designs x Negative attitudes to social mix x An emphasis on demolition x A failure to recognize the need for social regeneration x Limited resources	To outline the key characteristics sustainable housing, including environmental, economic and social dimensions	Interviews

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Belloni, K., Hakkinen, T. (2011)	✓ Development of the awareness of clients about the benefits ✓ The development and adoption of methods for sustainable building requirement management ✓ The mobilization of sustainable building tools ✓ The development of designers' competence and team working, ✓ The development of new concepts and services	x Steering mechanisms x Economics x Lack of client understanding x Process (procurement and tendering, timing, cooperation and networking) x Underpinning knowledge (knowledge and common language, the availability of methods and tools, innovation)	To address the question: What are the actual barriers and drivers for sustainable building?	A literature review Interviews Case studies

Table 2.6. Existing studies about motivators and barriers of green building market (continued)

Researchers	MOTIVATORS	BARRIERS	Objective	Research Method
Azizi, N.S.M., Fassman, E., Wilkinson, S., (2011)	✓ The implementation of new government policies ✓ Higher profit in return and more economical to operate ✓ The increase in the level of awareness due to multiple researches on performance of green buildings	x Financial risk x Regulatory risk x Standard of care/legal risk x Inexperience consultants and contractors x Availability of green materials x Performance of the green buildings	To help the decision makers to better understanding on the significant risks that must be considered deeply to increase the construction of green buildings.	Reviewing research studies on the risk involved in green building implementation

CHAPTER 3

RESEARCH METHODOLOGY

As the primary aim of the thesis is to answer the question what is accelerating and blocking the green building movement in Turkish construction sector. Surveys and interviews are used to obtain the perceptions of the professionals within the industry. This chapter will focus on the issues associated with thesis research methodology, how data is obtained and analyzed.

3.1. Research Methodology

The research data used in this thesis is collected from a questionnaire survey conducted though professionals who have experience about Turkish green building market. The survey was conducted between September 2011 and December 2011. After data collection, six face-to-face interviews with green building project managers were carried out to reveal the experienced motivators and barriers by examining the green building projects in Turkey.

3.1.1. Questionnaire Development

The questionnaire survey was based on the comprehensive review. The review was conducted to find out the barriers and motivators which have been addressed in various previous studies. Finally, all identified motivators are categorized as economic, social, environmental, market and organizational and all observed barriers are grouped as economic, awareness/educational, market and organizational.

3.1.2. Questionnaire Format

The questionnaire comprised three parts. The first part of the questionnaire was related to questions about the respondents' background. The second part was prepared to understand respondents' perceptions on the motivators and barriers for Turkish green building market. The likert scale is used to show respondents' opinion. The scale included the responses, "Strongly agree", "Agree", "Neutral", "Disagree", and "Strongly Disagree". Final part of the questionnaire was composed of two open-ended questions where the respondents can write their own ideas. The questionnaire is presented in Appendix A.

3.2. Data Collection and Analysis

The questionnaire survey in this study was conducted among Turkish professionals who have experience in green building area. First of all, professionals who are LEED Accredited Professional and BREEAM Assessors in Turkey are found from the Green Building Certification Institute and GreenBookLive websites, respectively. Then, an e-mail for participating the survey was sent to them with an explanation of the research. In addition, questionnaire was distributed among the members of Turkish Green Building Association. To increase the sample size, it is requested from professionals to distribute the questionnaire between their business partners and specialist who have a strong interest or involvement in Turkish Green Building Market. As a result, 64 effectively completed questionnaires were returned.

In this thesis student's t-distribution, a statistical hypothesis test is used to decide whether respondents agree, neutral or disagree to statements. Further, analysis of variance (ANOVA) and unequal variance t-test are used to identify respondents' perceptions according to their professions and experience. The respondents surveyed represents a broad spectrum of different professions including 29% architects, followed by 25% mechanical engineers, 23% civil engineers, 5% electrical engineers, 5% urban and regional planners, 3% environmental and chemical engineers and 7% from other professions, such as industrial, geological and meteorology engineers and editor, as shown in Figure 3.1.

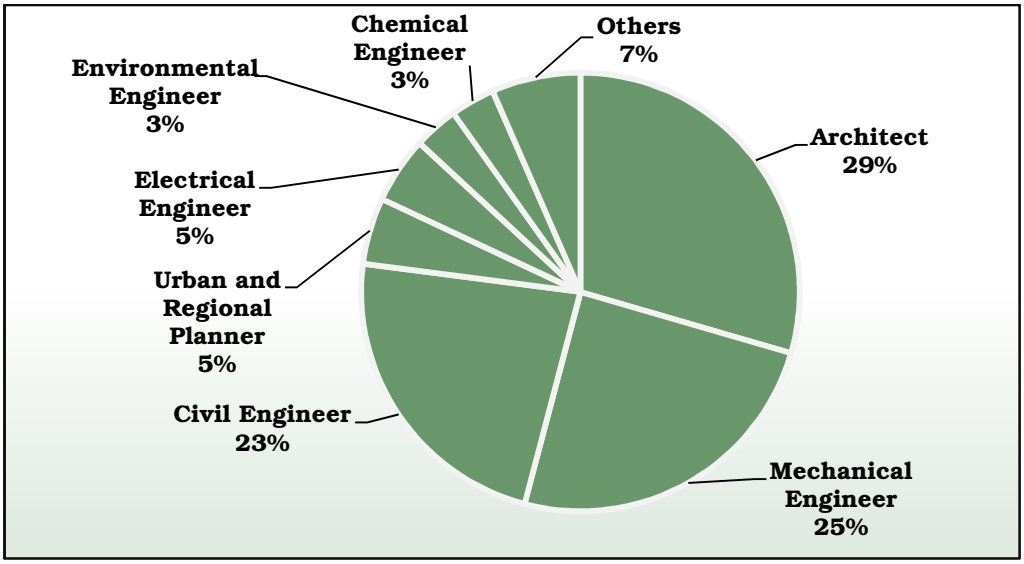

Figure 3.1. Professions of the respondents

The responses highlighted that "working with consultants", "internet research", "attending conferences", "sharing knowledge with my colleagues", "and taking courses about green buildings", "reading trade publications" are almost equal common ways to gain green building knowledge, as presented in Figure 3.2. However, "master degree" represents only two percent.

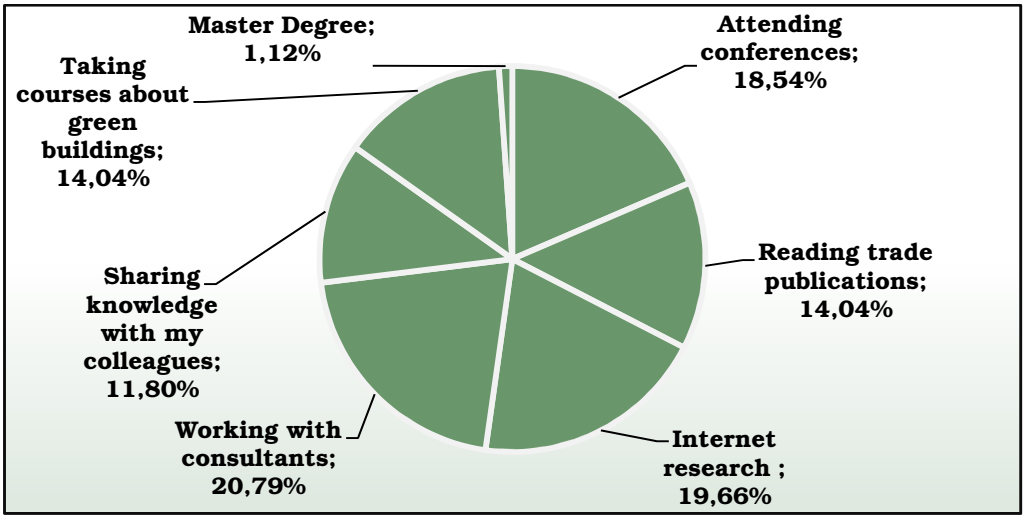

Figure 3.2. Ways of gaining green building knowledge

3.2.1. Student's t distribution

This test is a statistical hypothesis testing about the mean of a small sample taken from a normally distributed population, μ. According to Ott (1988), properties of Student's t distribution;

1. The t distribution, like that of z, is symmetrical about 0.
2. The t distribution is more variable than the z distribution.
3. The degrees of freedom refers to the number of independent observations in a set of data. And equal to;

$$df = n - 1 \quad (1)$$

A t-distribution with n-1 degrees of freedom is specified as;

$$t = \frac{\bar{y} - \mu}{s/\sqrt{n}} \quad (2)$$

Where n is the sample size, μ is the population mean, $\bar{y}$is the sample mean, s is the sample standard deviation calculated from the following formula;

$$s = \frac{1}{n-1}\left[\sum_i y_i^2 - \frac{(\sum_i y_i)^2}{n}\right] \quad (3)$$

In this thesis, the null and alternative hypothesis for green building catalyzes and obstacles are;

H_0: μ = 0 (respondents ideas about the statements are "neutral")

H_a: μ ≠ 0 (respondents ideas about the statements are different from "neutral")

The significance level of t-test was defined as α= 0.001. In this study, since sixty four respondents returned to the questionnaire, the sample size of the survey (n) is equal to sixty four, and so degree of freedom (df) is sixty three. From t-table, the critical value on sixty three degrees of freedom is 3.228. The null hypothesis is rejected when the calculated absolute t-value exceeds the critical t-value.

3.2.2. Analysis of Variance

The inferential method to compare several means is called the analysis of variance, ANOVA. The assumptions for the test are as follows:

- For each group, the population distribution of the response variable Y is normal
- The standard deviation of the population distribution is the same for each group. Denote common value by σ.
- The samples from the populations are independent random samples.

Let *t* denote the number of groups to compare. The means of the response variable for the corresponding populations are μ_1, μ_2,...,μ_t. The analysis of variance (ANOVA) is an F test of

H_0: $\mu_1 = \mu_2 = \ldots = \mu_t$ (i.e., the *t* population means are equal)

H_a: At least one of the *t* population means differs from the rest.

If H_0 is false, perhaps all the population means differ, perhaps some differ, or perhaps merely one mean differs from the others. The test analyzes whether the differences observed among the sample means could have reasonably occurred by chance, if H_0 were true.

After completing the F tests, the result of a study are then summarized in an analysis of variance table, shown on Table 3.1.

Table 3.1. An example of an AOV table for a completely randomized design

Source	Sum of squares	Degrees of freedom	Mean square	F test
Between samples	SSB	t-1	s_b^2	s_b^2 / s_w^2
Within samples	SSW	n-t	s_w^2	
Totals	TSS	n-1		

where,

TSS = Total sum of squares
SSW = Within-sample sum of squares
SSB = Sum of squares between samples
s_b^2= Mean square between samples
s_w^2= Mean square within samples

The null hypothesis of equality of the t population means is rejected if

$$F = \frac{s_b^2}{s_w^2} \quad (4)$$

Exceeds the tabulated value of F for α, df_1 = t-1, and df_2= n-t.

In this study, since sixty four respondents returned to the questionnaire, the sample size of the survey (n) is equal to sixty four.

Firstly, three groups (t), i.e., architects, engineers and others are compared to see the difference of comments between them. Furthermore, analysis is repeated according to respondents' experience, i.e. number of completed projects, 1-3 projects, 4-6 projects and more than 6 projects.

The critical value of F = s_b^2/ s_w^2 is 4.98, which is obtained from percentage points of the F distribution for α = 0.001, df_1 = 2, and df_2 = 61.The calculated F value does not exceed this value; hence the null hypothesis cannot be rejected with 99 percent confidence interval.

3.2.3 Unequal Variance t-test

In order to compare the means of two nonpaired groups the unequal variance t test, also called the Welch t test is used. It assumes that both groups of data are sampled from Gaussian populations, but does not assume those two populations have the same standard deviation. In this thesis, two-sample t-test is used to test which group thinks differently:

H_0: $\mu_1 - \mu_2 = D_0$

H_a: 1. $\mu_1 - \mu_2 > D_0$

2. $\mu_1 - \mu_2 < D_0$

3. $\mu_1 - \mu_2 \neq D_0$

$$t' = \frac{\bar{y}_1 - \bar{y}_2 - D_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{5}$$

For a specified value of α, the results are verified by:

1. reject H_0 if $t' > t_\alpha$
2. reject H_0 if $t' > -t_\alpha$
3. reject H_0 if $|t'| > -t_\alpha$

Where

$$df = \frac{(n_1-1)(n_2-1)}{(n_2-1)c^2+(1-c)^2(n_1-1)} \tag{6}$$

$$\text{where} \quad c = \frac{s_1^2/n_1}{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}} \tag{7}$$

3.3. Survey Findings

3.3.1. Motivators

In this study, motivators of sustainable development are defined on a framework of benefits and catalysts: economic, social, environmental, organizational and market.

Economic Motivators

Figure 3.3 shows a list of economic motivators with the order of calculated t-value and Table 3.3 demonstrates the agreement percentages of respondents on economic motivators. *Lower annual energy cost, lower annual water cost* and *increased profitability of company with improved productivity* were identified as main economic drivers for green building development and construction. These three main identified economic motivators have been also supported by literature as Zhang et al. (2010) pointed out that the green elements provide the reduction of operation and maintenance cost. Further, Paumgartten (2003) examined the financial benefits of green buildings, such as reduced energy consumption, increased occupant productivity further as an integrated building whole and indicated that buildings constructed to LEED standards can save more than 250 percent of its up-front cost over the course of its 40-year useable life cycle.

Besides, since the direct and indirect cost of employees is more than the cost of energy or construction, even small change in productivity and health convert into enormous financial benefits (Kats et al., 2003). Moreover, Fisk and Seppanen (2007) provide evidence that improved indoor environmental quality can improve work performance and health. Cost-benefit analyses results indicated that improved indoor temperature control and increased ventilation rates are highly cost-effective with benefit-cost ratios as high as 80 and annual economic benefits as high as $700 per person. Hence, in today's world "enhanced employee productivity" is perceived as the main motivator for especially green office buildings.

Table 3.2. Agreement of respondents on economic motivators to green building movement

Economic Motivators (%)	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**	**A12**	**A13**
Strongly disagree	34	1.6	3	3.3	4	6	6.5	1.5	1.5	1.5	4.8	17.5	35
Disagree	42	3.4	0	0	13	16	1.5	0	9.5	4.5	7.2	45	43
Neutral	14	16	0	1.6	36	16	13	9.5	18	17	24	27	17
Agree	6.5	55	29	30	25	46	44	46	55	45	40	11	1.6
Strongly agree	3.5	24	68	65	22	16	35	43	16	32	24	0	3.4

In order of importance, other highlighted economic motivators are *greater return on investment, higher building value, lower environmental and emission cost, lower cost of dealing with complaints, longer economic life, lower maintenance and repair cost* and *lower waste disposal cost.* Respondents think that green features increase the value of building as Cole (2010) wrote: "Innovative design must be valued and rewarded". This higher value attracts the building investors.

On the contrary, as it is expected, respondents disagree the statement that *less construction time and cost, lower initial cost, government and utility incentives* are the economic motivators behind the Turkish green building market. Generally, cost associated with green buildings may vary according to building type, climatic and site conditions to achieve different levels of "green". In fact, there is very little study which has proved that green buildings cost less than conventional buildings. Some studies explained in the literature review chapter indicated that green buildings increase the initial capital cost. Except, Langdon (2004) noted that "many projects can achieve sustainable design within their budget or with a very small supplemental funding". Yudelson (2008) stated that positive public relations may provide monetary benefits such as gaining government approvals or mitigating citizen opposition to projects for private developers. On the contrary, as respondents' thoughts, Kats et al. (2003) claimed that integration of sustainable building practices into projects lead to increased architectural and engineering design time, and modeling cost.

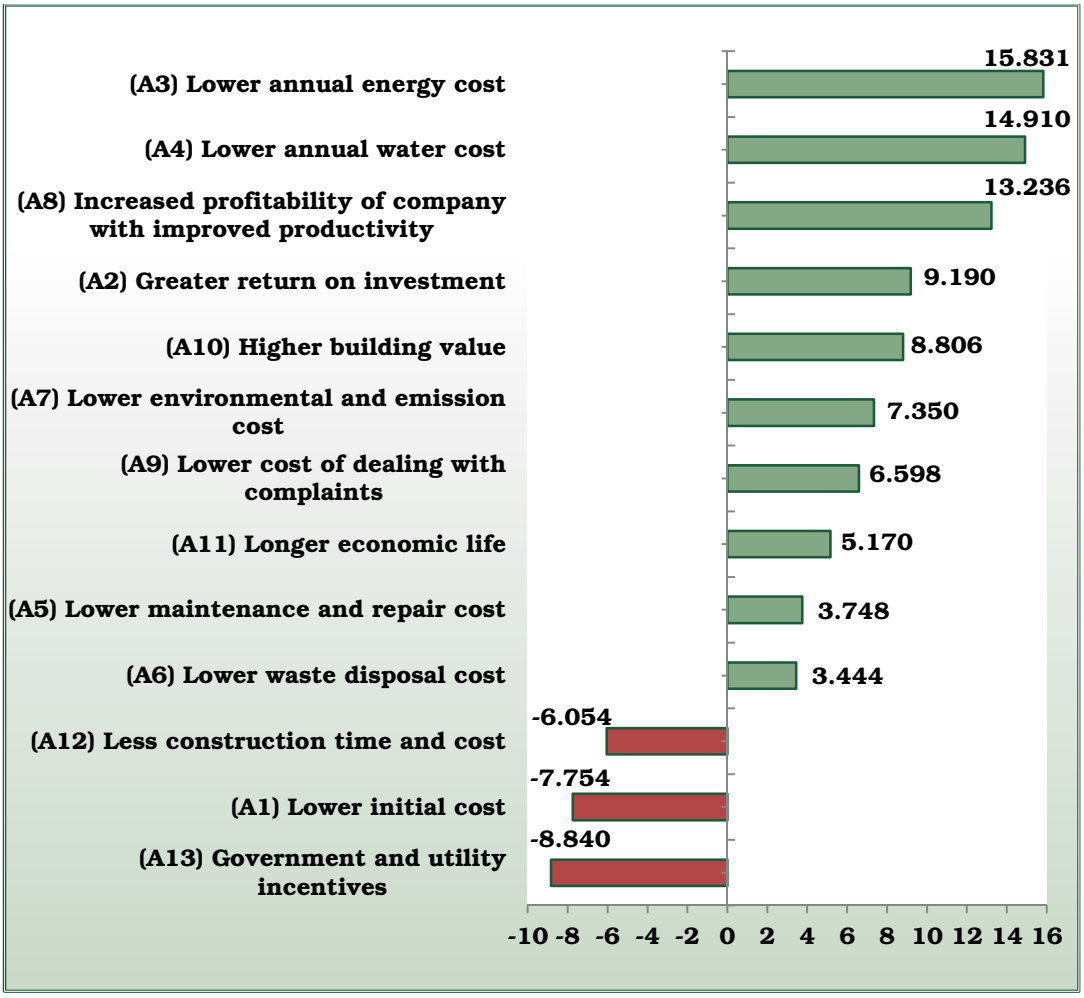

Figure 3.3. t-values of economic motivators

Social Motivators

Currently, Sick Building Syndrome (SBC) and Building Related Illness (BRI) have become more common in the workplaces. This results in sickness absenteeism and increased liability claims of the employees. Thus, a key element of green buildings is "healthy and productivity of workers".

The calculated t-value results of social motivators presented graphically on Figure 3.4. As shown on Table 3.4, over 90% of respondents agreed that *improved quality of life, well-being of occupants and better occupant health* are the most important drivers to promote green building design and construction.

Higher building safety is also evaluated as social motivator with a lower t-value, 5.029. Previous studies also have addressed the importance of social benefits of GB. The comprehensive study of the costs and financial benefits of green buildings, mentioned earlier, showed that productivity and health have the biggest financial benefit as 70 percent while reduced operation and maintenance, water, energy, emissions is 16%, 1%, 11% and 2%, respectively (Kats et al., 2003). Also, in Turner's study (2008) "Health and well-being of occupants" is defined as the greatest benefit for green buildings compared to traditional buildings.

Table 3.3. Agreement of respondents on social motivators to green building movement

Social Motivators (%)	B1	B2	B3	B4
Strongly disagree	0	0	0	0
Disagree	1.6	4.8	12.7	0
Neutral	1.6	1.6	33.3	3.2
Agree	54.7	57.1	36.5	49.2
Strongly agree	42.2	36.5	17.5	47.6

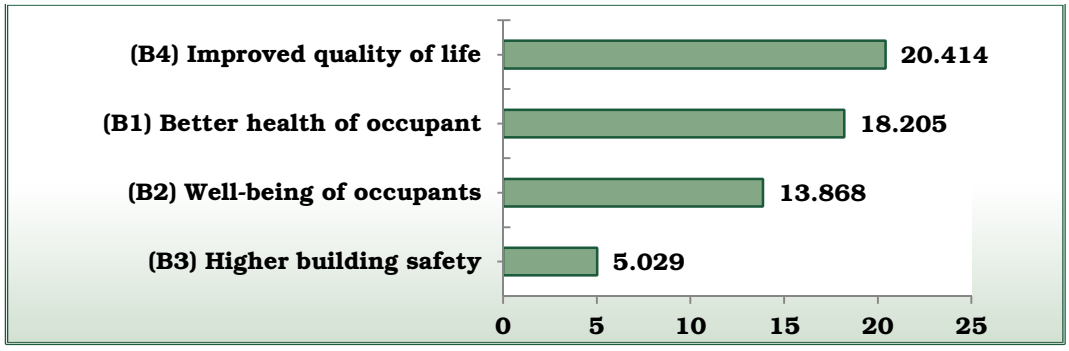

Figure 3.4. t-values of social motivators

Environmental Motivators

Figure 3.6 demonstrates a list of environmental motivators with the order of calculated t-value and also agreement percentages of respondents are tabularized in Table 3.6. A clear majority of respondents see environmental

motivators i.e., reducing *negative impacts of buildings on environment, decreased use of natural resources, control of the climate change and increased water and air quality* as foremost catalyzes to the promotion of sustainable design development.

Table 3.4. Agreement of respondents on environmental motivators to green building movement

Environmental Motivators (%)	**C1**	**C2**	**C3**	**C4**
Strongly disagree	3.2	1.6	3.1	1.6
Disagree	0	3.1	1.6	1.6
Neutral	3.2	4.7	9.4	9.4
Agree	31.7	50	50	43.8
Strongly agree	61.9	40.6	35.9	43.8

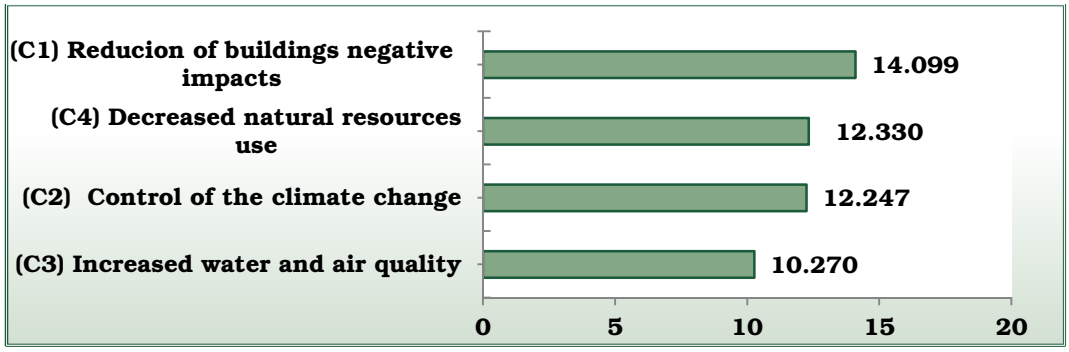

Figure 3.5. t-values of environmental motivators

Organizational Motivators

Figure 3.7 shows a list of organizational motivators with the order of calculated t-value and Table 3.8 demonstrates the agreement percentages of respondents on organizational motivators. *Improved image, easy advertising* and *development of new products and services* are seen as the most crucial organizational motivators for making green buildings attractive.

This finding support the early finding of the research by Turner et al. (2008) which reported "community image" as the most important benefit of green facilities by gaining about 90% rating from executives at organizations involved with green K12 facilities, green college and university facilities.

Table 3.5. Agreement of respondents on organizational motivators to green building movement

Organizational Motivators (%)	D1	D2	D3	D4	D5	D6	D7	D8	D9
Strongly disagree	3.1	3.2	1.6	3.1	1.6	1.6	1.6	1.6	1.6
Disagree	1.6	3.2	0	14.1	9.4	13.1	0	0	3.2
Neutral	0	12.7	3.1	32.8	12.5	39.3	1.6	4.8	4.8
Agree	39	50.8	34.4	31.3	46.9	32.8	47.6	33.3	46
Strongly agree	56.3	30.2	60.9	18.8	29.7	13.1	49.2	60.3	44.4

Most of the respondents agreed the idea that green buildings *demonstrate corporate social responsibility.* Nowadays, more and more companies generate a sense of social responsibility because of the worsening environmental problems (Chan et al., 2009). Corporate social responsibility (CSR) shows company's environmental, social and economic performance of company. In other words, it measures company's progress towards sustainability and seen as an important element for organization culture, image and competitiveness. In addition, up to 90% of respondents believe that green buildings make easy to *enter new market* and sell green building know-how. By the help of the improved image, new housing market entrance will be easy and also the relationships with government, local communities and consumers (Zhang et al., 2010).

It is a good sign to find out that many respondents agree the statement that green building strategies are *an integrated of corporate strategic planning and risk assessment*. It demonstrates that organizations start to change their management systems to promote sustainable design. On the other hand, Myers (2004) proved that although the construction industry has its own sustainable agenda, a few companies have changed their business paradigm.

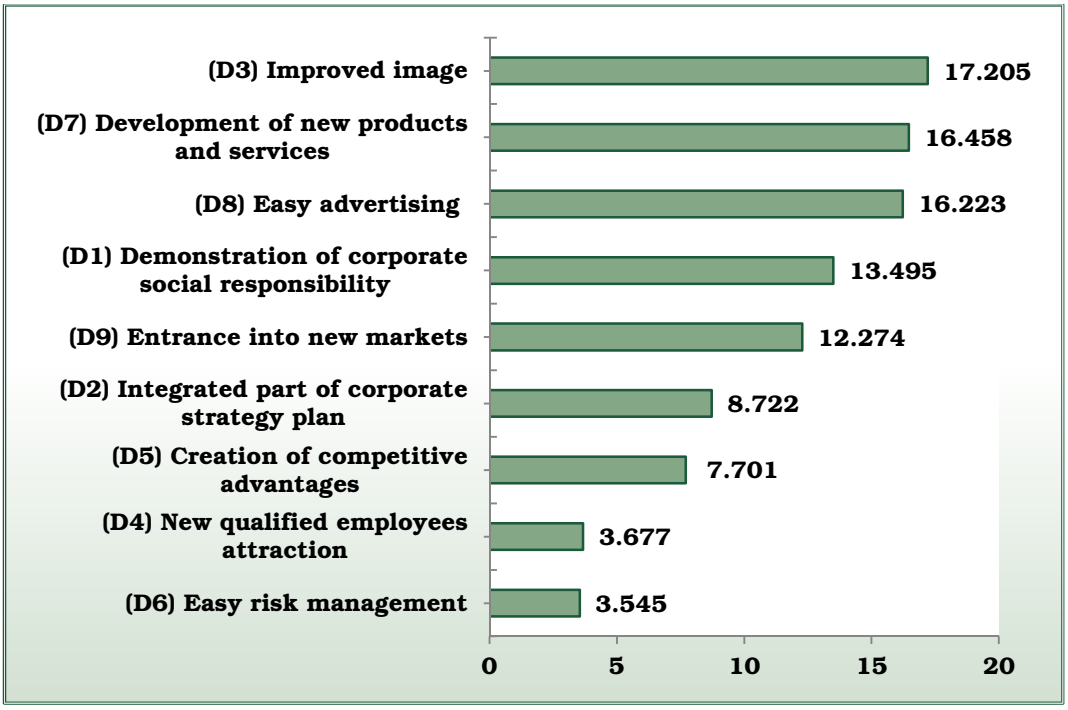

Figure 3.6. t-values of organizational motivators

Creation of competitive advantages, attracting new qualified employees and *easy risk management* are deemed the least effective organizational motivators in green building design and construction. Green buildings tend to be easier to sell and rent compared to similar projects in the same city as tenants increasingly understand their benefits (Yudelson, 2008). These motivators supported by other studies as well. Zhang et al. (2010) stated that green image provides high-income buyers attraction with higher sales price. Enhanced image by green building design allows the company to attract and retain high caliber staff. Also, Yudelson (2008) stated that green buildings protect against future lawsuits though verification of measures installed to protect indoor air quality, beyond meeting the minimum code requirements. Better environmental performance may make the relations between the firm and its external stakeholders (e.g., government, ecological groups, media, communities) easier and reduce the risk associated with these relations (Ambec and Lanoie, 2008).

Market Motivators

Currently, there is a growing attention to the green building market. As set out in the literature review, also 95% of respondents agree that popularity of rating systems are raising. In Turkey, currently, the number of LEED certified green buildings is seventeen, and the number of registered projects is thirty according to USGBC website. Totally, there are forty seven green building projects seeking LEED certification by now, but there are also green building projects not seeking LEED certification. Besides, more owners want to achieve a level of certification to quantify the sustainable features of the building.

The calculated t-value results of market motivators are presented graphically on Figure 3.8. Respondents consider *innovation in the construction sector, increased media attention* and *main subject of conferences* as the first three significant market drivers that makes green buildings more popular, as demonstrated also in Table 3.9. These factors could lead to innovation and help drive the green building market forward. In other words, better environmental performance through greener products or services can allow companies to use a differentiation strategy so as to exploit niches in environmentally conscious market segments (Ambec and Lanoie, 2008).

Table 3.6. Agreement of respondents on market motivators to green building movement

Market Motivators (%)	**E1**	**E2**	**E3**	**E4**	**E5**	**E6**
Strongly disagree	0	0	0	0	1.6	1.6
Disagree	0	0	0	3.2	12.7	0
Neutral	3.2	4.7	6.3	30.6	12.7	3.1
Agree	46	48.4	42.9	41.9	49.2	50
Strongly agree	50.8	46.9	50.8	24.2	23.8	45.3

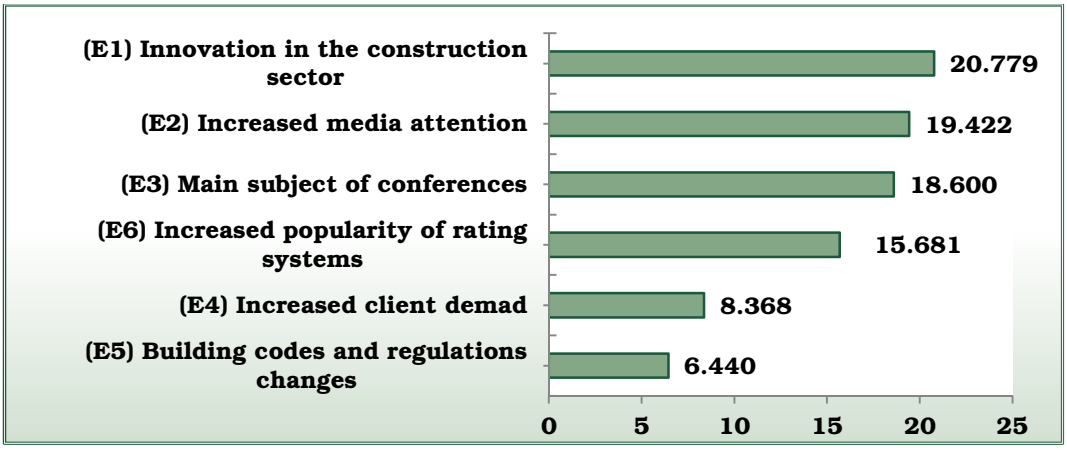

Figure 3.7. t-values of market motivators

Increased client demand and *building codes and regulations changes* are also regarded as fifth and sixth factors that motivate the green building market. Sometimes, building stakeholders are unable to implement green objectives because they are not allowed by the policies and regulations. Yet, this is not valid for Turkey.

3.3.2 Barriers

Although the benefits of green buildings and worsening environmental conditions are known by the construction sector, there are still barriers to adoption of green building technologies and systems. In this thesis, the obstacles of green building market are explored in terms of economic, educational/awareness, organizational and market to help find ways and solutions to promote green building movement.

Economic Barriers

The overall result in Figure 3.9 and Table 3.10 show that almost 90% of the respondents put *lack of government support* as the first economic barrier to the widespread adoption of sustainable design strategies, and *high technology and material cost* as the second barrier.

Table 3.7. Agreement of respondents on economic barriers to green building movement

Economic Barriers (%)	A1	A2	A3	A4	A5	A6	A7	A8
Strongly disagree	11.1	9.4	4.7	14.1	1.6	3.2	3.2	9.7
Disagree	54	25	4.7	48.4	9.4	14.3	1.6	43.5
Neutral	20.6	18.8	17.2	15.6	9.4	23.8	4.8	29
Agree	9.5	40.6	62.5	17.2	70.3	47.6	36.5	16.1
Strongly agree	4.8	6.3	10.9	4.7	9.4	11.1	54.0	1.6

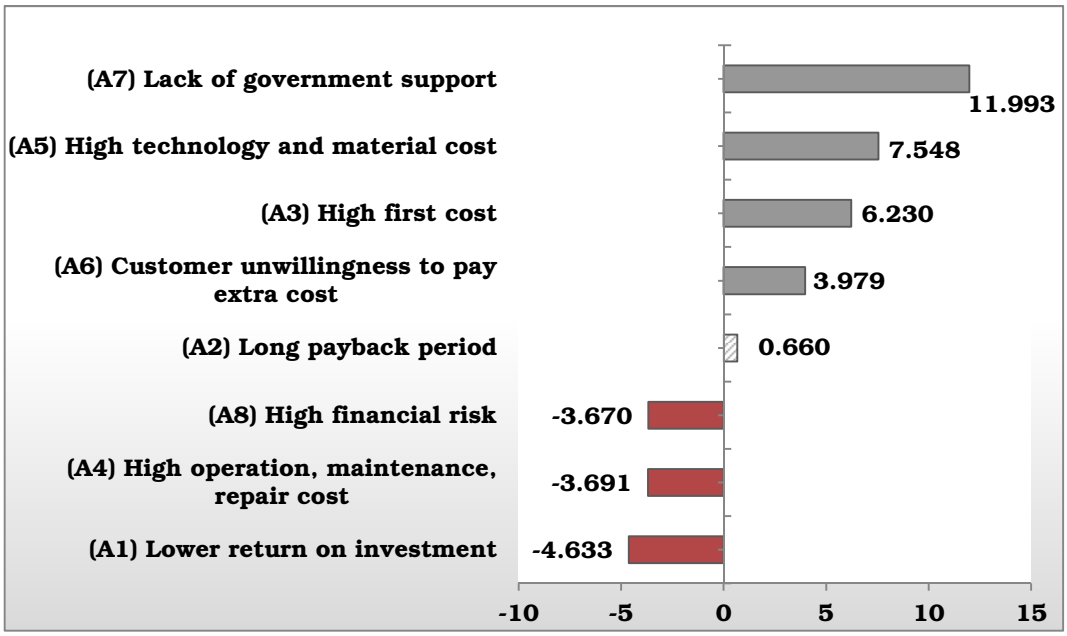

Figure 3.8. t-values of economic barriers

It is not surprising to find *high first cost*, a common perception, and *customer unwillingness to pay extra cost* as third and final economic obstacles, respectively. The findings result of the survey supports findings of previous studies. People who worked in the field and involved in a green building project still believe that green buildings have high cost premium (Issa et al., 2010; Ahn and Pearce, 2007; Turner, 2008). According to Kats et al. (2003) green building cost premium calculation is difficult since today's green buildings are showcase projects thus they can have expensive non-green features. However, Qualk and

McCown (2009) concluded that that any additional cost for greening are recouped in about one to two years and leave traditional construction cost behind in the following years with exponential savings. In response to a question result asking respondents the additional/ premium cost of green building compared to conventional building in Turkey showed 1% to 6% with a 32.69% agreement among the respondents in Figure 3.9. Besides, the majority of respondents consider the payback period of green building cost as 6-11 years.

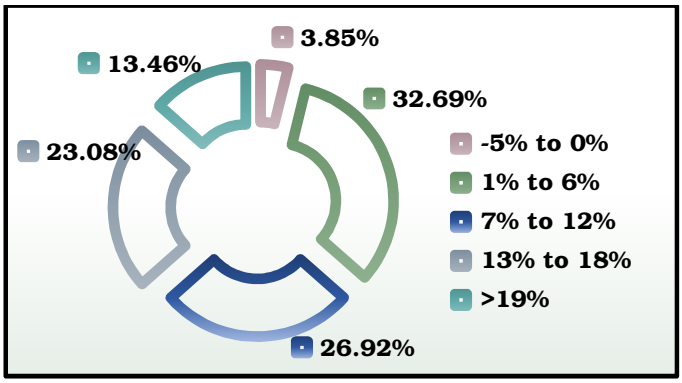

Figure 3.9. Cost premium of green building compared to conventional building

The majority of respondents do not think *high financial risk, high operation, maintenance and repair cost* and *lower return on investment* as a barrier for green building movement.

Since the observed value of t, 0.660 is not greater than 3.228 and does not fall in the rejection region, the respondents are neutral on the question that the length payback period of the initial cost green buildings is too long. Besides, most of the respondent agreed on the idea that green buildings total lifecycle costs can be lower than traditional buildings long-term cost over 20 years' time period with a t-value of 5.6.

Education/Awareness Barriers

The overall results in Figure 3.9 and Table 3.11 indicate that about 60% of respondents reported that *shortage of experienced professionals* and *inadequate cost-benefit studies* are the biggest education/awareness deterrents to green

building movement. Decisions should be made a more realistic life cycle cost-benefit analysis during the construction of sustainable design. Because the design process is an iteration of generating ideas, predicting their performance and then assessing it, in order to determine what the next step should be (Papamichael, 2000). However, there is not many published study that proved the financial benefits of green buildings empirically (Kats et al., 2003). Most of the previous studies focused on the initial construction cost instead of life-cycle costing, discussed in literature review chapter. Because design and construction costs are *hard* because they occur in the present, on the other hand energy savings, water savings and productivity gain are *soft* because they occur in the future (Yudelson, 2008). If the key benefit of green buildings, effect on productivity, is definitely proven, then there would be certainly a dramatic increase in demand for green buildings.

Table 3.8. Agreement of respondents on education/awareness barriers to green building movement

Educational Barriers (%)	B1	B2	B3	B4	B5	B6	B7	B8	B9
Strongly disagree	4.7	6.3	6.3	4.7	0	6.3	10.9	6.3	1.6
Disagree	23.4	23.4	31.7	35.9	25	22.2	25	41.3	20.3
Neutral	15.6	9.4	19	14.1	12.5	9.5	14.1	31.7	18.8
Agree	45.3	46.9	31.7	35.9	53.1	50.8	34.4	19	56.3
Strongly Agree	10.9	14.1	11.1	9.4	9.4	11.1	15.6	1.6	3.1

Since the observed value of t, 2.656 is not greater than 3.228 and does not fall in the rejection region, the respondents are neutral on the question that there are not *sufficient consultant and education program* about green building concept.

Calculated value of t, 2.648 ≤ 3.228 verifies that the respondents are neutral on the question that it is difficult to measure and to make identification, evaluation and verification of green buildings performance and so there is *not reliable performance & saving data of green buildings*. Requirement of building performance data identification is another important factor. Green building data

results should be obtained and gathered according to specified location/climate, building type/size, and intended use (Meister, 2005). Currently, performance data on green buildings –both technical and economic- are often incomplete and unstructured. Besides, the flow of information is constrained within the respective disciplines and feedback from operation to design is limited (Cole, 2010).

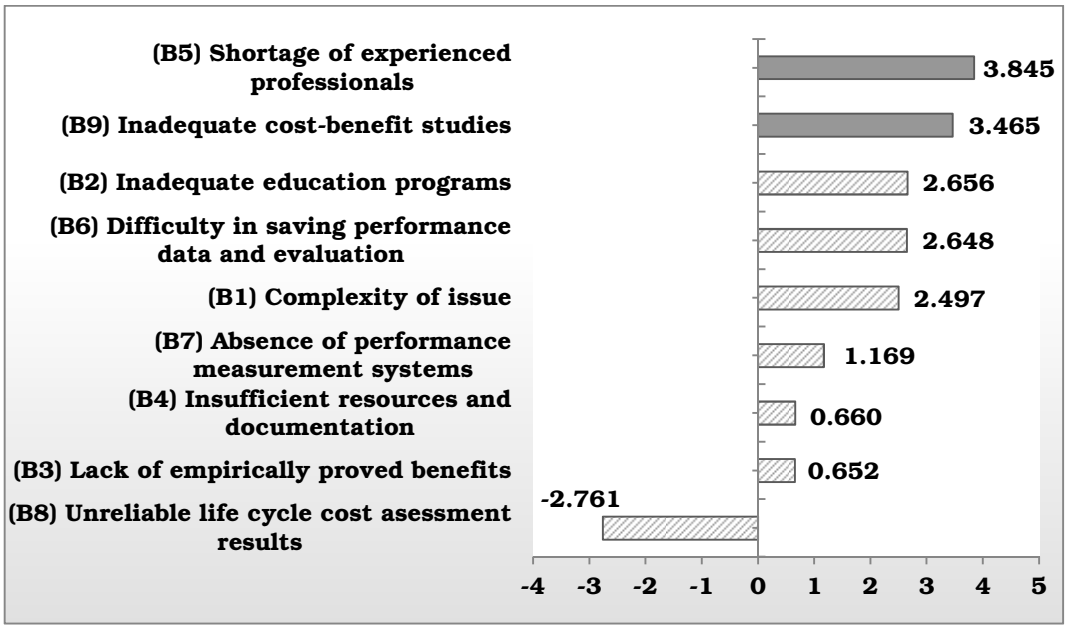

Figure 3.10. t-values of education / awareness barriers

Since the observed value of t, 2.497 and 0.660 are not greater than 3.228, the respondents are neutral for *the complexity of issue* and *insufficient resources and documentations* as a barrier to green movement, respectively.

Considering calculated value of t, 1.169 is not greater than 3.228 and the respondents are neutral on the question that there is not a *robust tracking and performance measurement system* to evaluate environmental and financial performance data of green buildings. Papamichael (2000) also supported this argument by saying that performance assessment tools are available, but they are hard and time-consuming to use and also underline that complex tools usually in the form of computer-based simulations which can vary significantly with respect to their modeling capabilities and prediction accuracy are required

for green performance prediction and assessment. Moreover, Belloni and Hakkinen (2011) pointed out that life cycle assessment tools, energy consumption estimation methods and service-life prediction methods entail significant amount of extra work.

Since the estimated value of t, 0.652 is not greater than 3.228 and does not fall in the rejection region, the respondents are neutral on the question that researchers do *not prove empirically the benefits of green building*s and so there is not accurate information to easily convince decision makers. As noted before, there is inadequate information on building characteristics and related performance and this lead to difficulties in empirical demonstration of the financial benefits of sustainable buildings (Lützkendorf and Lorenz, 2005). Life-cycle cost analysis helps for understanding economic benefits of improved environmental performance during building operation phase. With this in mind, according to Kats et. al. (2003) making a comparison between a green and conventional design options for the same building is essential to obtain a meaningful cost assessment result of a green building.

When calculated t-value is considered, -2.761 ≤ 3.228 demonstrated that respondents are neutral on *the guarantee of life cycle cost assessment results for green building projects.* In a report on the life cycle assessment of green buildings, explained above, Kats et al. (2003) supported this argument by noting that calculation of true life cycle impacts and costs of green buildings is still evolving and not implemented yet.

Market Barriers

Figure 3.10 shows a list of market barriers with the order of calculated t-value. The clear majority of respondents believe *wrong contracting and tendering process* is the main obstacle that hinders the development and construction of green building projects in Turkey as present on Table 3.13. Today's contracting and tendering process in the construction sector have lots of drawbacks, focusing on low cost and less time and ignorance of performance, that affect the green building movement negatively. Building contractors compete intensely on cost reduction instead of technology improvement (Chan et al., 2009). Whereas, green buildings needs more time for design and construction due to additional integrated technologies and solutions. Hence, this situation prevents the

involvement of the private sector in building industry while only large developers which have superior financial resources could remain active in the sector.

Deficiencies in regulations and standards and *absence of insurance policies are* considered as effective market barriers by respondents followed by *difficulty in finding green materials, barriers to system and product innovation, insufficient number of investors,* absence *of Turkish Certification system* and l*ack of consensus in the sector.* Since green buildings provide many benefits such as less water and energy usage, as well as healthier for occupants, a variety of risks reduced automatically thus this should be reflected to insurance premiums. However, in Turkey there is not such an insurance policy specific to sustainable buildings.

Table 3.9. Agreement of respondents on market barriers to green building movement

Market Barriers (%)	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**
Strongly disagree	1.6	1.6	0	0	1.6	12.5	3.1	11.1	1.6	1.6	6.3	1.6
Disagree	37.5	12.5	4.8	9.5	12.9	43.8	17.2	12.7	6.5	17.5	34.9	4.8
Neutral	21.9	21.9	7.9	7.9	22.6	12.5	4.7	0	48.4	34.9	30.2	33.3
Agree	31.3	59.4	47.6	52.4	45.2	25	51.6	27	35.5	36.5	27	46
Strongly Agree	7.8	4.7	39.7	30.2	17.7	6.3	23.4	49.2	8.1	9.5	1.6	14.3

Since the estimated value of t, 2.961 is not greater than 3.228, the respondents are neutral on the question that companies in construction sector *do not support each other* in order to improve green building movement. It is important that experienced companies should share their experiences learned from good practices.

Computed t-value, 0.482 and -1.444 are not greater than 3.228, the respondents are neutral on *fear of change* and *disagreement between parties* as a barrier, respectively. Most of the respondents answer the question that who is an effective participant in making decision to build green as building owner and

investor. Since the estimated value of t, -2.143 is not greater than 3.228 and does not fall in the rejection region, the respondents are neutral on the question that there is *no available technology* for green buildings in construction market.

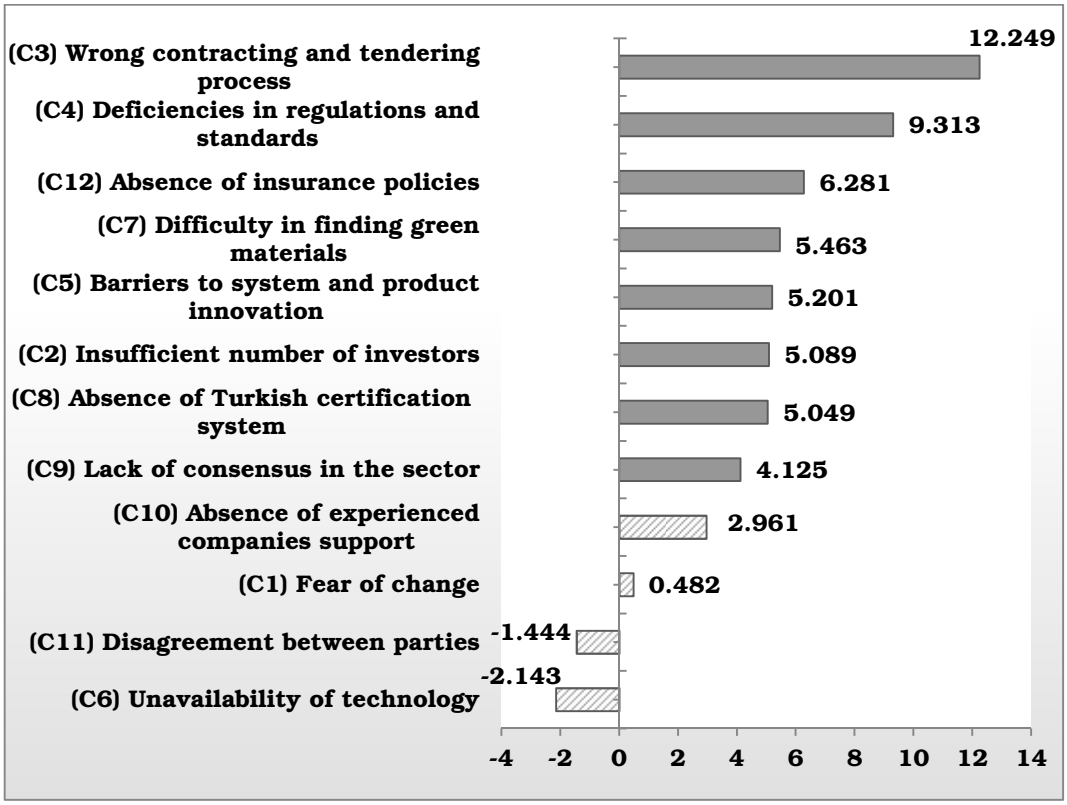

Figure 3.11. t-values of market barriers

Organizational Barriers

As given in Figure 3.11 and in Table 3.13, i*nadequate experience of construction companies* is seen as the biggest organizational barrier to the successful promotion of green building market. Experience and knowledge of green building strategies and energy or water modeling programs impact significantly the success of the project. Because the team can spend lots of time and resource for researching appropriate technologies or materials. As the team gain experience in time, this problem shall be solved and time spend can be shorten. Most importantly, green buildings will become less expensive in time as experience is gained (Kats et al., 2003). Other organizational barriers are *unavailability of management systems* and *wrong financial methods usage* in order of

significance. This indicates that construction companies do not try to change their management systems in order to implement sustainability principles. Uncertainties and risks about the new sustainable technologies and materials may lead to decision not to go green. Also, Turner (2008) stated that most institutions either do not care about the long-term costs or else give importance in their planning. Different accounting methods, such as life cycle cost, capital cost might cause the confusion between traditional building and green building. Another reason can be problems in the communication between separate actors and firms but as well as management and communication-related issues within organizations (Belloni and Hakkinen, 2011). Since the estimated value of t, 3.122 and 0.559 are not greater than 3.228 the respondents are neutral on *not being upper managers priority* and *improper financial conditions of construction companies* as a barrier, respectively.

Table 3.10. Agreement of respondents on organizational barriers to green building movement

Organizational Barriers (%)	D1	D2	D3	D4	D5
Strongly disagree	4.7	3.1	7.9	6.5	3.2
Disagree	17.2	14.1	28.6	12.9	15.9
Neutral	23.4	12.5	17.5	17.7	3.2
Agree	40.6	54.7	39.7	50	58.7
Strongly Agree	14.1	15.6	6.3	12.9	19

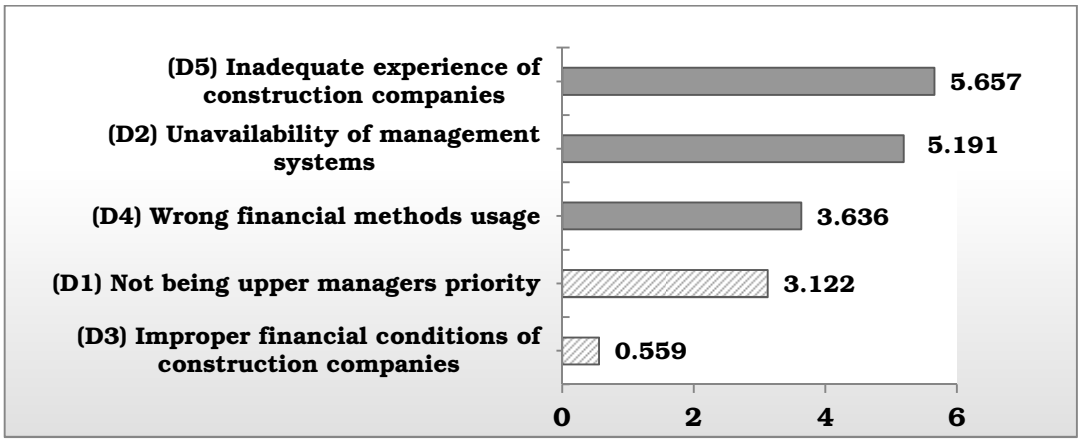

Figure 3.12. t-values of organizational barriers

3.3.3. Agreement within the groups according to professions of the respondents

An analysis of variance (ANOVA) analysis was performed to identify the difference in agreement of respondents according to their professions, i.e., architects, engineers and others for all identified motivators and barriers. The test result showed a significant difference only for educational/awareness barriers, complexity of issue (B1) and inadequate education programs (B2), having F-Value of 6.595 and 5.052, respectively.

Since from ANOVA test result in Table 3.15, the computed F value for educational /awareness barrier, the complexity of issue is 6.595 is and greater than the F critical value of 4.98 with a significance level of 0.001, the null hypothesis is rejected and it is concluded that there is a significant difference between professions' perceptions.

Table 3.11. AOV table for education/awareness barrier- *the complexity of issue*

SOURCE	Sum of squares	Degrees of freedom	Mean square	F test
Between samples	13.589	2	6.794	**6.595**
Within samples	62.849	61	1.030	
Totals	76.438	63		

Then, t-tests are performed to identify the professions with different perceptions. Since t (test statistic) = 3.79 > t (critical value) = 3.32, there is a significant difference in the perception of the complexity of issue barrier between architects and engineers, as shown in Table 3.16. On the contrary, there is no significant difference in the perception of the complexity of issue barrier between architects and others since t (test statistic) > t (critical value), as demonstrated in Table 3.17. Also, there is no significant difference in the perception of the complexity of issue barrier between engineers and others since t (test statistic) is greater than t (critical value), as shown in Table 3.18.

Table 3.12. t-test results for education/awareness barrier- *the complexity of issue* between architects and engineers

t-Test: Two-Sample Assuming Unequal Variances		
	Architects	*Engineers*
Mean	1	-0,026315789
Variance	0,823529412	1,053342817
Observations	18	38
df	38	
t Stat	**3,78636518**	
P(T<=t) one-tail	0,000264662	
t Critical one-tail	**3,319029655**	

Table 3.13. t-test results for education/awareness barrier- *the complexity of issue* between architects and others

t-Test: Two-Sample Assuming Unequal Variances		
	Architects	*Others*
Mean	1	0,625
Variance	0,8235294	1,410714286
Observations	18	8
df	11	
t Stat	**0,7957302**	
P(T<=t) one-tail	0,221511	
t Critical one-tail	**4,024701**	

Table 3.14. t-test results for education/awareness barrier- *the complexity of issue* between engineers and others

t-Test: Two-Sample Assuming Unequal Variances		
	Engineers	*Others*
Mean	-0,0263158	0,625
Variance	1,0533428	1,410714286
Observations	38	8
df	9	
t Stat	**-1,4418295**	
P(T<=t) one-tail	0,0916138	
t Critical one-tail	**4,2968057**	

Since from ANOVA test result in Table 3.19, the computed F value for educational /awareness barrier, inadequate education program is 5.052 is and greater than the F critical value of 4.98 with a significance level of 0.001, the null hypothesis is rejected and it is concluded that there is a significant difference between professions perceptions.

Table 3.15. AOV table for education/awareness barrier– *Inadequate education programs*

SOURCE	Sum of squares	Degrees of freedom	Mean square	F test
Between samples	12.395	2	6.198	**5.052**
Within samples	74.839	61	1.227	
Totals	87.234	63		

Then, t-tests are performed to identify the professions with different perceptions. Since t (test statistic) > t (critical value), there is a significant difference in the perception of the complexity of issue barrier between architects and engineers, as shown in Table 3.20. However, there is no significant difference in the perception of the complexity of issue barrier between architects and others since t (test statistic) > t (critical value), as demonstrated in Table 3.21. In addition, there is no significant difference in the perception of the complexity of issue barrier between architects and others since t (test statistic) is greater than t (critical value), as shown in Table 3.22.

Table 3.16. t-test results for education/awareness barrier- *Inadequate education programs* between architects and engineers

t-Test: Two-Sample Assuming Unequal Variances		
	Architects	*Engineers*
Mean	1,055555556	0,052631579
Variance	0,879084967	1,348506401
Observations	18	38
df	41	
t Stat	**3,453740263**	
P(T<=t) one-tail	0,000648832	
t Critical one-tail	**3,301272889**	

Table 3.17. t-test results for education/awareness barrier- *Inadequate education programs* between architects and others

t-Test: Two-Sample Assuming Unequal Variances		
	Architects	*Others*
Mean	1,0555556	0,5
Variance	0,879085	1,428571429
Observations	18	8
df	11	
t Stat	**1,1649927**	
P(T<=t) one-tail	0,1343321	
t Critical one-tail	**4,024701**	

Table 3.18. t-test results for education/awareness barrier- *Inadequate education programs* between engineers and others

t-Test: Two-Sample Assuming Unequal Variances		
	Engineers	*Others*
Mean	0,0526316	0,5
Variance	1,3485064	1,428571429
Observations	38	8
df	10	
t Stat	**-0,9669392**	
P(T<=t) one-tail	0,1781887	
t Critical one-tail	**4,1437005**	

These differences in perceptions on the complexity of issue and inadequate education programs between architects and engineers may arise from the difference of university educational programs of engineering and architectural faculties. An architect in the survey commented on this issue by saying that "In spite of my interest about this topic, my real idea is: sustainability or green building topics are not new". On the contrary, it is a new approach for many engineers.

3.3.4. Agreement within the groups according to experience of the respondents

An analysis of variance (ANOVA) analysis was run to identify the difference in agreement of respondents according to their experience, i.e., number of completed projects, 1-3 projects, 4-6 projects and more than 6 projects From ANOVA test results, computed F-values not exceed 4.95, the null hypothesis for all identified motivators and barriers are accepted and it illustrates that there is a good consensus of the arguments between these groups.

CHAPTER 4

GREEN BUILDINGS IN TURKEY

The following chapter highlights the six case study green building projects in Turkey studied and to explore the of the green buildings and also to investigate lessons learned from each project's perspective. These green projects were built in three different cities in various regions of the country. They were constructed recently and they include commercial offices, industrial buildings and laboratories.

4.1. Interviews

The data of case studies were compiled based on the interviews. Then obtained data is used to validate the motivators and barriers obtained from the questionnaire study. For this aim, several questions were asked in interviews:

1. What was the driving force behind green building project decision?
2. What were the barriers experienced and the main methods to overcome?
3. Did you apply integrated design process on your green building project?
4. How much was the green project cost and how much it would have cost to build traditionally?
5. What are financial, environmental and social considerations of the project?
6. What were the main lessons learned from green strategy implementation?

The selected practitioners were chosen based on green project experience and their position in the building process. The interview discussions for each case project lasted around three hours and the interviews conducted in September, 2011. Detailed interview questionnaire is presented in Appendix B.

4.2. Case Studies

Six case studies that implemented various green strategies to reduce the negative impacts of building activities on environment and human health were conducted for further understanding the questionnaire results. Each case study project write-up is broken up into organized sections. First, an overview of the project and the company is provided. This is followed by detailed information about building performance data, implemented innovative technologies and lessons learned.

4.2.1. Eser Green Building

The seven stories, 6,971m^2 interior area and 1,741m^2 total site area, Eser Green Building serves as office space for approximately 200 employees. The building is located in Ankara, capital of Turkey, completed in 2010. The construction company do not has a sustainable group, but has lots of activities such as publishing educational materials on intranet or website, hosting green/sustainable building conference, meetings, publishing articles or reports and developing guidelines and resource to make contribution on green building movement.

Green goals were established at design development stage of the project. The building generates power by on-site renewable energy sources, wind turbine, photovoltaic (PV) panels and ground source heat pump technology which extracts heat from the earth in winter and transfer heat to the earth in summer through 5 of each 120 deep drilling wells located at the front garden of the building. Smart lighting control systems is used to adjust daylight levels and turn on and off depending on office rooms occupancy, automatically.

A 45 kWh electricity and 90 kWh heat capacity of cogeneration system which uses natural gas to produce electricity was used. This system supplies the building's power need, while waste heat from the system is used to heat the building's water in winter and to support the heat demand of absorption unit in summer (tri-generation). Also, there are thermal energy storage tanks to store excess heat from cogeneration unit and ground source heat pump system. Ice

storage system produces and stores ice by taking advantage of lower electricity price during night times. During summer days, this system helps to meet cooling load of the building and reduces the burden on the local electric distribution system during periods of high electricity demand. Storm water collection system, waterless urinals, graywater recycling system and low-flow water fixtures reduce the water use by about 51.41 percent. This office building achieved LEED Platinum certification by gaining 90 points out of 110.

Comparison of green versus traditional building

Total construction and design cost of the project, including green features was 15,689,334 TL and 252,130 TL, respectively. The total construction cost of a project with conventional features was estimated to be 14,409,740 TL. So, all used green materials and systems brought an added cost of 1,279,594 TL or approximately more than 8.16% of total construction cost. Initial cost increase was due to the added investment in energy efficiency measures and renewable energy systems. From a life-cycle perspective, these systems add long-term value to the project. For the two year period from Oct 2010 to Feb 2012 total electricity produced from PV panels integrated into building façade is 6,605 kWh and this generated power is used directly for lighting in the building. The PV system would have paid off the cost of purchase within fifteen years.

Operation savings data taken from energy modeling analysis that was submitted for LEED certification is displayed in Table 4.1. This computer analysis indicated that the building uses approximately 47.5% less electricity and 38.7% more natural gas due to cogeneration system per year if it had been simply built to the ASHRAE 90.1 energy standard referenced in the LEED version. The estimated earnings for the building are about 54,578.41 TL annually, 7.83 TL per square meter.

Table 4.1. Operation savings according to Eser Green Building energy modeling

Annual usages during operation	Baseline building	Green building	Operation saving (%)	Economical earnings (TL)
Electricity (kWh)	546,649	286,743	47.5	64,375.56
Natural gas (kWh)	495,483	687,149	-38.7	-11,404.88
Water (kGal)	204	99.12	51.41	1,607.73
Total				54,578.41

Innovative Technologies

Eser Green Building is an important model of sustainable technologies. The most important innovation is the mechanical system of the building, a hybrid composition of several systems to achieve minimum exergy destruction and life cycle cost goals along with the highest efficiency (Cakmanus et al., 2010). Many of the green features mentioned above can be considered innovative.

To help reduce the interior temperature of top floor and cooling load during summer as well as to minimize the urban heat-island effect, a green reflective roof coating was applied over the roof. Bike racks were placed near the building to encourage the employees to use alternative transportation.

Lessons Learned

The main driver for designing Eser Green Building was to construct 100 percent energy natural building and to create more healthy and comfortable work environment.

The project was very successful in achieving its sustainable goals because everyone involved in integrated design team was very excited about the LEED process. There were two difficulties during the project. First one is finding green materials with low environmental impact, recyclable and low VOC content. Secondly, as described above, the mechanical system of the building is a hybrid composition of several systems. Because of that, there are problems with operation and maintenance of these systems. Several strategies have still identified not only solving the faced problems but also improving building

performance by monitoring its performance through building management system. In addition, it is planned to develop a web-enable display system that shows data gathered from all systems, including the ground-source heat pump system, solar panels, cogeneration for further research and education purposes.

The necessity is that since lots of systems were installed in this building, a detailed life cycle cost-benefit assessment of each system should have been estimated and evaluated based on building real performance data.

A booklet about the green building project was published to educate the community about the environmental and financial benefits of sustainable buildings. The building is also leading the way in use of laboratory and exhibits the sustainable strategies employed to visitors from public, communities or universities.

Indoor Environmental Quality Survey

Before the construction of green building a questionnaire survey was carried out to observe the occupant (employee) satisfaction and find out their demands since creation of good indoor environmental quality was a major challenge. Productivity could be improved by 4 to 10% by promoting the office environmental conditions (Croome-Clements and Baizhan, 2000). Then, to ensure high indoor environmental quality, all finishes and paints with low or zero volatile organic compound (VOC) were used and an HVAC system that provides a high number of air changes per hour and carbon monoxide monitors were installed. More daylighting is provided by operable windows and solar light tube system. Occupants have the ability to control their indoor environment conditions and allow natural ventilation.

To monitor the social benefits of a green building discussed earlier in the literature review chapter an indoor environmental quality satisfaction survey were prepared by using a report of building cost and performance metrics: data collection protocol survey (Fowler et al., 2005). Since self-rated productivity and other-reported IEQ values can be obtained by data surveys of building occupants.

The survey was carried out in December 2011. Survey questions asked building occupants to rate their degree of satisfaction about work environmental features in six categories: thermal comfort, air quality, lighting quality, natural dayligting, outview, noise and overall building environment quality on a scale from "strongly agree" to "strongly disagree". In the survey, effects on health, job satisfaction, work productivity and company image compare to their old office buildings are included. The survey questionnaire is presented in Appendix C. Totally ninety-two employees (sixty four male, twenty-eight female) attended the survey.

Building occupants are mostly satisfied with lighting quality of the building, followed by thermal comfort, natural daylighting and overall indoor environmental quality, as shown on Figure 4.1. Although, more than 90% of occupants have direct views outside, since the observed value of t, -0.845 is not greater than 3.195, the respondents are neutral on the question that "I am contented with outside view of my work area and interaction with the external environment".

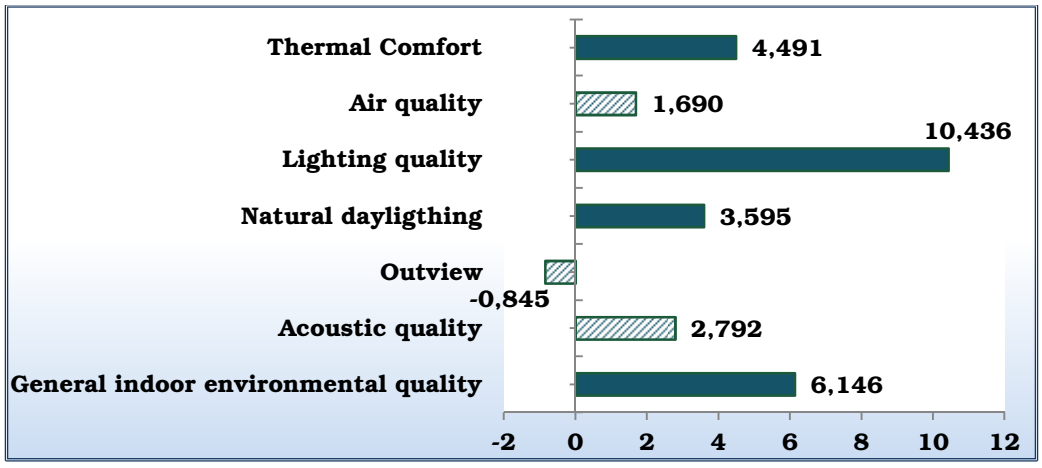

Figure 4.1. t- values of indoor environmental quality satisfaction

Computed t-value, 2,792 ≤ 3.195 verifies that the respondents are neutral on the question that "I am satisfied with the acoustic quality in my work area". This noise problem was generally related to the configuration of the open office. In addition, since the observed value of t, 1,690 is not greater than 3.195, the respondents are neutral on the question that "I am satisfied with the air quality of my work area in general".

The occupants were also asked whether starting to work in a "Green Office Building" affects their productivity or not when compared with their old offices (non-green). Most of the occupants considered that their personal productivity and team work productivity increased in this building. Besides, as demonstrated on Figure 4.2, they thought that ability to control indoor environmental factors affect their productivity positively.

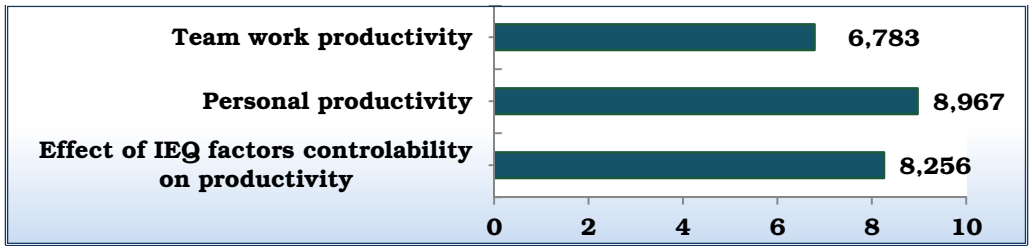

Figure 4.2. t-values of indoor environmental quality effect on productivity

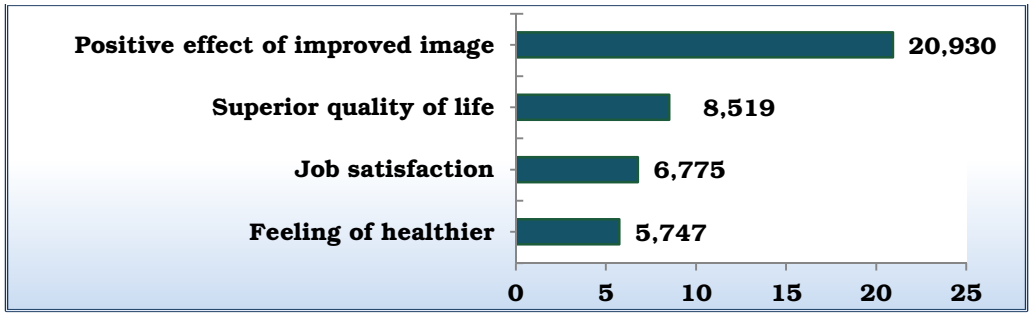

Figure 4.3. t-values of indoor environmental quality positive effects

The respondents feel that working in a "Green Office Building" increased their job satisfaction level when compared with their old offices (non-green, as depicted on Figure 4.3. Occupants feel healthier in the building compared to their old offices, also they agreed the idea that their life quality improved with the help of green building. In addition, responses to company public image question indicate that their company has a great image to public and other firms by the help of the green building.

4.2.2. YKS- Logistic Center & Product Development Center

Second case study project is YKS Logistic Center and Product Development Center is used for product development, completed in 2010. This industrial building is located in Gebze, Kocaeli with 30 occupants in 2400 m^2 interior area. Expected life of the building is 100 years. The chemical company has sustainable group with three people and has many activities such as publishing educational materials on intranet or website, sponsoring of green building research, and publishing articles or reports to make contribution on green building movement.

Green goals were established at design development stage of the project. The building was awarded with LEED Platinum certificate by covering all of the green building basics including, rainwater collection system (collected from 2500 m^2 area and on the roof, then stored in 2000m^3 water pools), drought-tolerant and native plantings, high efficiency glazing, and solar thermal-hot water system. The carbon emission of the building is 122.021 kg_e CO_2 per year.

Lessons Learned

The push behind the going green was the company strategy that all buildings should achieve LEED Gold certificate level. Project team faced with problems about the project options acceptance. Each design option lead to discussions between the parties involved. The problem was solved with the help of the consulting company.

The mistake according to the respondent is that initially high VOC content floor materials are used, and then they are changed with materials which have low VOC content. This resulted in additional time and increased the initial cost. Therefore, most important learned lesson is that sustainable materials should be defined at very early design stage of the project.

The major reason for the increase in initial capital cost compared to conventional buildings is the windows which are not produced in Turkey thus, brought from Belgium. The second reason was the high cost of green materials with low VOC values because they are more expensive than standard materials.

The two biggest success of the project is collection of all rainwater on building area and meeting the hot water need for heating the building from solar collectors.

Innovative Technologies

Solar collectors provide all necessary hot water for heating the building. Neopor material is used for the isolation of the building.

4.2.3. Turkish Engine Center

Third case study project is Turkish Engine Center is used for Maintenance and repair of the airplane's engines, completed in 2010. This industrial building is located in Sabiha Gökçen Airport / İSTANBUL with 23,600 m^2 interior area and 100,000 m^2 total site area. The building has about 300 occupants daily. Expected life of the building is 30 years.

Turkish airlines do not have a sustainable group, but has lots of activities such as publishing educational materials on intranet or website, posting signs or posters about sustainability, and publishing articles or reports to make contribution on green building movement.

Green goals established at project conceptualization stage of the project. The building awarded with LEED Gold certificate by covering all of the green building basics including, solar light tube system, reflective roof coating, light color covering on park areas, rainwater collection system (collected rainwater is purified and stored in 500m^3 tanks.) and increased rate of fresh air, outside view and daylighting.

Financial evaluation of green systems and materials are made separately. Life cycle costing assessment of integrated green systems is not calculated in detail. A Feedback Mechanism or Automation System for evaluating the benefits of implemented green strategies and measuring the real performance is installed to provide necessary data.

Comparison of green versus traditional building

Total construction and design cost of the project, including green features was 1,250 TL/m² and 32 TL/m², respectively. The total design and construction costs of a project with conventional features were estimated to be 27 TL/m² and 1,100 TL/m², respectively. The total cost of greening this development was 155 TL/m² or approximately more than 12% of total construction cost. This additional capital expenditure was due to increase in costs of mechanical and electrical works.

Operation savings data taken from energy modeling analysis that was submitted for LEED certification is presented in Table 4.2. Water savings data are not provided. This computer analysis indicated that the building uses approximately 15.1% less electricity and 67.6% less natural gas per year if it had been simply built to the ASHRAE 90.1 energy standard referenced in the LEED version. The estimated earnings for the building are about 274,555.4 TL annually, 11.6 TL per square meter. A building automation system for evaluating the benefits of buildings and measuring results was developed and saving-economic plan is presented to upper managers every year.

Table 4.2. Operation savings according to Turkish Engine Center energy modeling

Annual operation cost category	Baseline building	Green building	Operation savings	Economical earnings (TL)
Electricity (kWh)	3,887,300	3,300,700	15,1%	146,720.4
Natural gas (kWh)	3,300,701	1,068,788	67,6%	127,835
Total				274,555.4

Innovative Technologies

Solar tube skylights with parabolic lenses were used to track the sun's movement and provide large amounts of daylight to airplane's engine repair area. This daylighting feature reduces the power demand and provides a consistent level of daylighting by decreasing the number of lambs.

Lessons Learned

The most important difficulty was that the construction company has not any knowledge about green construction strategies and so lots of problems came out during applications of LEED certification requirements such as waste management, erosion control, etc. The problem solved by tracing the general contractor constantly and warning the construction company to fulfill the contract requirements (Meeting LEED certification requirements was a condition in contract).

The success of the project is that during design stage, the building occupant comfort and quality of life were increased appreciably compared to old offices by selecting green building features and these features applied in an economic way. On the other hand, the mistake of the project according to the respondent is that "bioswale" method was considered at the beginning of the project in order to collect the rainwater from the field, but impropriety for the project field was realized very lately and given up during construction phase of the project. Besides, if rainwater tank had been chosen bigger capacity, it would have been a big water saving source.

The most important lesson is that the decisions should be made at early design stage and be evaluated very carefully and these decisions should be applied by all project participants in a very discipline way.

4.2.4. Levent Office Building

Forth case study project is Levent Office Building is completed in 2010, September. This office building is located in Levent, İstanbul with 17,000 m^2 interior area and 2,700 m^2 total site area.

Green goals established at schematic design stage of the project. The building awarded with LEED Gold certificate by covering all of the green building basics including, rainwater collection system and low flow water fixtures reduced the water use by about 50 percent. High efficiency HVAC system and planting on the building facades to decrease cooling energy, the most important innovative

strategy of the project. As a result, energy consumption of the building decreased by about 35 percent. Besides, 100% fresh air supply system, by the help of the inner gardens higher motivation and improved comfort for occupants are provided.

The cost of green office building was not compared with a conventional one, but according to respondent forecast green measures increased the initial cost about 20-25 percent due to high standard applications.

Lessons Learned

There were difficulties to research and find green materials and their information, such as recyclability and VOC content. In order to overcome this difficulty alternative materials are searched. Another difficulty arose from building exterior design due to planting strategy. It is solved by making design with both building façade and landscape firms. The most important lesson is that all disciples should work together and take necessary precautions at the design phase of the project.

4.2.5. ADH2 Transformer Distribution Factory

Another case study project is ADH2 Transformer Distribution Factory is used for production, completed in 2010. This industrial building is located in TOSB Çayırova / KOCAELİ with 37,000 m^2 interior area and 70,000 m^2 total site area. Expected life of the building is 50 years. The company does not have a sustainable group, but develops training green programs for employees.

Green goals established at pre-design stage of the project. The building awarded with LEED Gold certificate by covering all of the green building basics including, increased isolation, high efficiency lighting and controls, high efficiency HVAC system, rainwater collection system.

Total construction and design cost of the project, including green features was 42 Million TL and 1,200,000 TL, respectively. The cost of the green building was not compared with a conventional one, but according to respondent forecast

green measures increased in the initial cost about two percent due to additional mechanical and electrical works (armatures and systems). On the other hand, these installed mechanical and electrical technologies will create long-term value and energy cost savings in the future.

Operation savings data taken from energy modeling analysis that was submitted for LEED certification is tabularized in Table 4.3. This computer analysis indicated that the building uses approximately 26.1% less electricity and 19.9% more natural gas per year if it had been simply built to the ASHRAE 90.1 energy standard referenced in the LEED version. Data for water savings are not available. The estimated earnings for the building are about 270,850.55 TL annually, 7.32 TL per square meter. Additionally, in order to evaluating the benefits of buildings and measuring results BMS has been improved (for watching, reporting and action).

Table 4.3. Operation savings according to ADH2 Transformer Distribution Factory energy modeling

Annual operation cost category	Baseline building	Green building	Operation savings	Economical earnings (TL)
Electricity (kWh)	3,683,927	2,722,422	26.1 %	240,491.63
Natural gas (kWh)	1,100,943	1,320,031	-19.9 %	-12,548.48
Total				227,943.15

Lessons Learned

Project completed successfully. Duration of the project completion would be reduced. The biggest success according to respondent is the achievement of LEED Gold certificate level. If certification level had been LEED Silver, respondent would have been sad about it. The most important lesson learned by respondent is the installation of rainwater collection system and selection of plants (native, water-resistant).

4.2.6. Sabancı University Nanotechnology Research and Application Center (SUNUM)

Sabancı University Nanotechnology Research and Application Center is a laboratory of Sabancı University, completed in 2011. The laboratory has about 120 occupants in 7,368 m^2 interior area and 9,932 m^2 total site area. Expected life of the building is 50 years.

Green goals established at project conceptualization stage of the project. The building awarded with LEED Gold certificate by covering all of the green building basics including, double glass windows with low emissivity coatings and filled with argon gas in the cavities, high amount of daylighting, storm water collection system for irrigation, water-efficient fixtures, no water urinals, adaptable plants with less water need, low VOC emitting construction chemicals and bicycle parking area. The carbon emission of the building is reduced by 193.715 kg_e CO_2 /year and become 511.567 kg_e CO_2 per year. Total construction cost of the building is 25 million TL. Since the building is new constructed, the building performance data is not available.

Innovative Technologies

The architectural concept of warp-around front façade of the building is inspired from "biological cell membrane" and from hexagonal carbon structure (C-60, fullerenes). Specially designed pre-tensioned, heat-insulating, metal and glass doped modular pre-cast concrete elements without any support of columns are used as a load-bearing wall with integrated windows, first time in Turkey.

Lessons Learned

The difficulty was that demand and expectations of building occupants have changed frequently. Also, there were difficulties to reach good and robust information for technical projects. To overcome the faced problems consultant firms and meetings were helped. The biggest success is getting maximum benefit from sun light, application of daylighting strategy. The most important lesson of this project is that project participants realized the importance of human health and comfort in green buildings.

4.3. Discussion of Results

From interviews, information about the economical, social (health and productivity) and environmental costs and benefits of six case studies of recently developed projects in Turkey were gathered. All case study projects maximized employment of recycled, recyclable materials and the use of renewable energy and minimized energy and water usage. The research has revealed a number of key barriers and practical problems that hinder the green building movement.

Firstly, total development cost for the green building projects in this thesis ranged from 2% to 12 % above the costs of comparable conventional buildings. These increases in cost are largely due to increased electrical and mechanical works (both design and construction). Generally, green strategies such as geothermal heat pump, photovoltaic panels are the reason of higher initial costs. Interviewees do not have any knowledge about cost effectiveness of applied sustainable strategies in detail. According to questionnaire respondents, green buildings have higher up-front cost; on the other hand, they think that green buildings have a higher building value and lower operating cost. Then, this higher value and longer term benefits may allow the building stakeholders to recoup any additional cost of greening.

Secondly, the case projects in this thesis are recently constructed, so they do not have any operating history data. That's why; three projects provided partial LEED Energy modeling data. From a life-cycle net present value perspective, three case projects indicate that energy and utility costs are lower than their baseline building according to energy modeling program results. These decreased operating expenditures may pay for the initial investment in greening the project. Also, the value of improved comfort, indoor air quality and health for building occupants have a big contribution economically, but were not quantified in this thesis. Because, health and productivity benefits are not well documented among six projects. Only case study Eser Green Building supported and verified how the indoor environment conditions can provide increased productivity and higher satisfaction level from occupants' perspectives. This is especially related to lighting quality and thermal comfort.

“Commissioning” is an important aspect for achieving energy efficiency in the buildings. Commissioning means testing the performance of building systems so that the design intents and occupant needs met. Regular monitoring of building energy systems result in a better understanding of the building operation and energy efficiency. Each case project leaves no doubt that a rigorous operational and maintenance program for sustainable buildings throughout their lifetimes is an important requirement in Turkey.

Integrated design process was applied in all case projects successfully. Several members of the integrated design team had little experience in the field of sustainable development. It took time to educate contractors who does not have experience in sustainable building strategies. Hence, they have needed an extensive education about green design and construction process.

There is no government support or incentive for sustainable development for all case project funding.
It is also apparent that the most cited barrier identified in the questionnaire is the problems over the unavailability, price and supply of green materials, products or systems. As was expected, of the five case studies faced this difficulty, and generally they solved this by the help of their consultancies or they had to use alternative materials. Most of the suppliers do not have any knowledge about green attributes of their materials such as recyclability and VOC content. They should have adequate proof and information to claim that their materials are more durable, recyclable and low embodied energy through life cycle. Demand for these products may be stimulated so that suppliers of built environment have to change their manufacturing methods.

CHAPTER 5

RECOMMENDATIONS FOR THE IMPROVEMENT OF TURKISH GREEN BUILDING MARKET

This chapter attempts to draw a picture of the current barriers in Turkey green building market and suggest some solutions to solve or some strategies to overcome faced problems. Then, the current state of green building market and expectations on the future of green buildings are presented. The final section of the thesis presents limitation of the study and a number of suggestions for further research.

5.1. Solutions for Barriers

When asked about the key strategies to make green buildings advantages bigger during both interviews and in the questionnaire survey, respondents listed a number of solutions and strategies that improve the green building movement. The most commonly cited strategies are as follows:

- Proper planning, planning is more important than being green.

- Life-cycle assessment of green buildings should be made in order to convince the investors and government. Examining green technology, materials and alternatives by analyzing obtained data.

- By examining the financial implications of sustainable design in detail, making green buildings more flexible. During design of the project, choosing feasible options from economic point of view as much as possible.

- Production of construction materials in Turkey, using imported materials for being used sustainable material is contrary to the sustainability logic. Besides, imported materials increase the cost and so affect negatively.

- Easy access of technical information for material manufacturers should be provided.

- Green buildings should be designed in an integrated way, basic design properties of the building should be defined by considering environmental conditions, sun, building direction and orientation.

- The cost of green building varies according to design strategies. If the aim is saving the energy, the initial investment cost is higher for Turkish market conditions. However, since the unit price of energy is too expensive, payback period can be short. For material selection, the initial cost is high and there is not payback but, it has a huge contribution on building occupant health. In addition, these systems should be monitored by building management system. Here, money seems as a continuous expenditure. The life cycle assessment of green buildings should be calculated by taking the design strategies into account. To impress and convince customers by economical evidences, energy-efficiency strategy can play a key role.

- Government should impose some basic mandatory requirements and standards. Public awareness should be increased. Everybody should have knowledge about building resource reduction.

- Developers, general contractor, sellers, buyers and building occupants should be educated and informed. Especially, energy and sustainable benefits of green buildings should be explained.

- Only electro-mechanic systems do not make the building “green”. Green architecture design elements should be improved.

- Chambers of professional should allocate resources and give speeches about this kind of important topic.

- The public should be informed about the topics below in detail:
  - Can be heated without natural gas or fuel oil
  - Not being affected by the increase cost of energy
  - High performance and comfort with a little green technics
  - Constructability of zero-energy buildings
  - Explaining what the zero carbon means

- The real needs of the building should be defined. Then, attention should be paid for application of the needs. Integrating the green building concept at the beginning of the project. Early green decision results in low initial cost of the project. Choosing suitable strategies according to project conditions, finding little but effective solutions.
- In the first few years, it may not be financially advantageous, but, if the state (govt) gives support (through, for example, requiring lower energy consumption, etc.) it could be. At first, construction would occur according to the law (meaning, if the state put limits that encourage green construction) and then later, the market would get bigger, the demand of the market (i.e., supply of materials) would be met, and then green construction would be routine.

- Improvement of volunteer certification and related real estate evaluation system, announcing the life-cycle cost analysis results, investigating the green building occupants of health and happiness indexes and publishing the results.

- Constructing big and important projects in a green way can form basis.

- Government policies should be structured in a supportive manner for green building construction. Making green buildings more favorable in the long and short-term by tax regulations.

- Energy efficiency, high indoor environmental quality. At the same time, offering a good and lovely atmosphere for building occupants is so important.

- Incentive programs, investor awareness, long-term programs, development of local technology.

- Instead of foreign certification systems, a national building evaluation (certification) system should be created according to Turkey local and regional climatic, geographical and environmental conditions. Because certification tools provide valuable information and guidance for the public on green building subject all over the world. In addition, production of ecological materials in Turkey will play an important role in increasing the number of green building projects.

- Firstly, local material production and variety should be increased so that the cost of green materials reduces. In order to increase the number of green building projects in Turkish construction sector, "green cost" should become compatible to traditional system costs.

- Green strategy should be included in company policy and should become a part of quality standards.

- Project firms should develop original and unique projects instead of monotone and same projects. It should be made progress about uniqueness of each project. Here, design firms' approach is so important because they should create green building projects and suggest to owners and investors as an alternative.

- Integrated design process is the solution (respect and love between disciplines).

- As much as possible natural and easy solutions should be found for the design of green building projects. Because extreme usage of high-technologies will cause troubles during building operation. In other words, "green building" should not be a technological. Instead, more rational, simple and natural solutions should be emphasized so that initial cost shall be minimized.

- Individuals and institutions should embrace the principles of green life so that green building subject will be insistent and consistent. Beside from education programs, media is playing an important role. It should discuss

the subjects like introducing new building materials and their benefits to increase public awareness.

Respondents offered quite a variety of suggestions to the open ended question of what can be done to accelerate green building movement in Turkish construction sector. The following sections present respondents' recommendations and suggestions.

5.1.1. Recommendations for Government

Respondents were asked to rank people or skill sets in wider industry in order to manage and implement green building projects according to importance. Government ranked as the most important factor for helping the improvement of green building market. Here are the written comments about government support:

- Government can be pioneer:
  - All governmental buildings should be obligated to have a definite level of green certificate or green feature.
  - Regulations about energy, recycling etc. can be made flexible.
  - Tax reduction policies can be implemented for buildings which achieved a high standard level.

- Increase in the number of voluntary councils like ÇEDBİK (Çevre Dostu Yeşil Binalar Derneği) will become very beneficial to the sector. In addition, to make the coordination about this topic, institutions should be established.

- Government should develop reference projects and publish their benefits to increase the awareness. What's more a guideline should be created to make implementation of green strategies easy.

- Government or an institution which has a power on the construction sector should be a pioneer. This can be a nongovernmental organization or an institute established by a university. Certainly, it would be the result of institutional work. Success probability of non-governmental organization is

low due to limited financial opportunities. A governmental corporation (ministerial, or university) independent from private sector can be an ideal solution.

- Green buildings have a 15-20 year history in Europe. Although Turkey is very behind applying the green strategies, due to quick process of change Turkey will reach other countries' experience and knowledge in a very short time. In this area, the most important task belongs to government and municipality. The number of green buildings is growing exponentially as a new construction sector every day. Increase of interest in this topic will lead to the expansion of suppliers.

1. *Government may give support to this movement by financial incentive mechanisms.*

- Compliance in the US and Europe is currently more widespread because the requirements came from top down (i.e., government). In my opinion, the government played a big role in this scenario, and the markets and building sector were required to comply. Of course, the situation here is a bit different, and unfortunately, sometimes the state (i.e., building inspectors) is not responsible enough. For this reason, social and professional groups or labor unions need to take a bigger role.

- First of all, necessary motivation should be created by providing tax advantages. This situation will decrease whole energy cost of the country significantly in the future. Green building movement will gain importance in countries which import the energy like Turkey.

- Moderating energy and water prices as well as increasing the building value for green buildings shall create a more profitable option than traditional buildings.

- Creating innovative funding mechanisms that recognize the long-term value of green projects by government may shorten the duration of building green.

- No sector can improve without financial motivators. Government incentives such as tax reduction or abatement should be established and put into practice immediately. Taxation (local credits) and financial instruments- more long term and low interest rate credit opportunities- would help. In addition, incentives for green buildings, such as value added tax and special consumption tax exemptions, reduction of property tax, discount of energy price may be effective to support the movement.

- In Turkish construction sector, the biggest motivator can be provided by financial incentives. In this sense, regulations and laws should provide financial advantages. For example, if a green building is constructed, the property value can be increased; unit price of resources such as energy, water can be reduced.
- Both government and private sector should have green strategies in their plans. Not only government but also private sector should think their own financial utilities all together. For example, property tax advantages can be provided. Financial institutions can provide more feasible credits compared to market conditions for green building investors.

- In the short term, to increase the number of green building projects in construction sector. Incentive schemes and tax reduction policies can be provided for construction companies, building investors, building user or manufacturers in the sector.

- Investors do not prefer green buildings because of high initial capital cost. To decrease the initial cost, local manufacturer should become strong, incentive programs should be prepared, existing buildings should be renovated. First of all, local manufacturers should be encouraged by government incentives. When looked at green buildings in Turkey, it can be seen that more than 80% of building materials are imported from other countries. By government support and green building certification systems construction firms and manufacturers will tend to sustainable design.

2. *Mandatory regulations may be effective.*

- First of all, application of green strategies should be made mandatory. For example, if the defined minimum standard criteria are not fulfilled reconstruction allowance of the project would not be given.

- Higher mandatory standards for energy efficiency building codes and adoption of minimum green standards should be instituted.

- Government definitely should impose and implement mandatory regulations, environmental policies and legislation to support the green building market.

- Government should apply energy efficient strategies and green building strategy for existing and new buildings, respectively. States should provide advantages for green areas. (ex. reconstruction, operation, permission)
- Building environmental performance regulations should be created. Just like building energy performance regulations a set of mandatory applications, except energy, will provide the evolvement of green buildings to the basement. In addition to this, again "Nish" projects will continue to take international certificates which go beyond the regulations like LEED, BREEAM.

5.1.2. Recommendations for Professionals

Research and development is a critical in order to prove the benefit of green buildings. Therefore, an institute for sustainable development research should be established in order to create unified center for R&D and data collection on sustainable design and development for universities, government and the private sector.

1. *The level of awareness should be raised.*

- Public awareness about sustainable design needs to be raised at market as a consequence of active work of non-profit organizations. Featuring the

positive effects of green buildings (both economically and socially) shall stimulate public demand and this will ensure the green sector improvement.

- From my point of view, in order to increase structures which protect the nature such as green buildings and to live with nature friendly, firstly society awareness needs to be increased. Raised community awareness will shift construction sector to this direction anyway.

- Demand should be increased by more advertisement program on visual and printed media. The most important thing is to explain the meaning of green building correctly. These days, if you ask the meaning of green building to somebody, I am sure he/she cannot answer.

- The awareness of the public should be increased. For this to happen, organizing awareness and education programs, using visual and printed media, providing fiscal government and international institutions incentives and subventions or grants will be adequate.
- Constructed green buildings should be placed in the media. Both financial benefits and long-term effects on environmental pollution should be promulgated. Also, relations between private and public institutions should be built.

2. *Education programs should be created.*

- Subjects should be explained to shareholders and project teams. Especially, education is a must for design firms. Necessary education should be given at architecture faculties. Also, it would help to add this topic into youth's educational curriculum. (i.e., start early) so that suitable and sophisticated professionals can be raised.

- The more number and more easy access of education programs should be provided to inform the public to stimulate tender demand.

- Certainly, developers who design and improve green building should be trained by this vision. That is why; lessons about green or sustainable

design should be included in the academic programs of Engineering and architecture faculties.

- The importance of green building should be emphasized at architectural/engineering faculties and more education programs/seminars should be arranged to raise the awareness of public and to stimulate demand.

3. *More research and development is essential.*

- Design and operation data of pilot projects should be measured and evaluated. Then, they should be published to convince investors by the scientists and researchers. Because, getting performance data of green buildings, reduction of energy consumption and decreasing costs will encourage the investors about this subject. Besides, with the help of correct information, energy and sustainable buildings should be constructed instead of certificated buildings.

- Universities should make research and development on this topic.

- Cost analysis of green building projects should be made in a correct, objective and unbiased manner. The content of green building consulting and engineering services should be researched very well. It is not an individual service that everybody can give. Unfortunately, just like other subjects green building topic is regarded as simple and everybody can do it. This is a comprehensive job and requires lots of experiences and different specialties. If green team is selected according to this earnest, substantial and spiritual load of green buildings will minimize.

- First of all, green building real performance data should be recorded and evaluated for the long-term life cycle assessment. According to obtained results during real needs for new green building projects shall be learned and appropriate choices can be made. Both by making the feasibility analysis of green buildings and by making right choices accordingly during design and construction phase would increase the number of green buildings.

- Especially, architects and engineers have a big responsibility, and lots of work to do. When pluses and minuses of green buildings are evaluated and explained to investors in detail, the process of change become faster. In addition, the critical point of green building strategies application is that professionals should both study about green buildings and monitor the green technologies professionally.

- The life cycle assessment and financial benefits of green buildings needed to be clarified for construction companies in the sector. For this to happen, a stable economic regime is necessary. Unfortunately, our country economy system is not convenient to this situation. Construction companies always need to make risk assessment about green building subject. Since implementation and production are more expensive and not guaranteed the profit, every firm would not take the risk.

5.2. Future of Green Buildings

Green buildings are the construction of future without doubt. One respondent commented on the current situation of green building construction in Turkey by writing “Although it is not enough, there is an effort to build green”.

When asked to the respondents “Which buildings should be green” question, they think that education is first one, health care is the second one and the least importance is private houses.

Since finding out future expectations will bridge the gap between market practitioners, researchers and government, the question of how will green building impact the construction industry in the future is asked to respondents and the comment analysis of the open-ended answers are tabularized on Table 5.1.

Table 5.1. Looking to the future

Effects of Green Buildings	Number of times mentioned
The future way of building construction	
Without doubt it will affect the sector positively. Green building vision will be common with increased environmental susceptibility in a very short time. It will be an emerging trend. There will be a significant increase in the number of green buildings. The demand will increase.	27
Become "norm"	
There will be no distinction as green. Strategies interpreted as green building in todays' building sector will become "norm" and implemented to all building in the future.	6
Innovation in the construction sector	
It will be a study that every company has to know and perform. Construction firms will make a transition to green buildings. Construction companies will rearrange their decision-making process, project creation and implementation process according to green building criteria. This movement will cause an improvement in the area of building technology and materials.	16
Increase in standards	
They will increase the quality and performance of the buildings. The standard of existing buildings will improve.	6
Need of specialist	
Qualified and accredited firms and professional need will emerge. The need of experts in different areas will arise.	5
Marketing strategy	
"Green Buildings" are a prestige or advertisement material for construction sector. Green buildings will be defined as prestige projects. Green buildings will be criteria to prefer.	5
Temporary trend	
I do not expect that green building concept has a permanent effect in Turkish construction sector.	1

The future way of building construction…

Most of the respondents think that the number of green buildings will climb up with government leadership and sensitive private sector and organizations as a result of the high energy cost and environmental pollution. According to one respondent, green buildings are the future of architecture due to their real meaning and properties. Importance of green buildings will increase, especially for office and commerce buildings. One respondent feels that green buildings will be construction sector itself. In time, all costs of green building systems will be reasonable and take the place of available system and applications.

Another respondent wrote that in the future, construction sector would have to change all the buildings "green". This may be due to law and regulations or everybody will construct their buildings green by observing each other. Because the ones not build green would not be in the market.

Become "NORM"…

Many respondents feel that in the future, there will be not a "green" concept, because it will become standard. In this respect, progression of the sector is a condition and inevitable to this direction. Nowadays, green buildings can seem and evaluated as high performance or luxury, however in the future they will be a standard of building sector. The willingness of increasing the comfort will not be luxury; instead it would be a standard since it is a must for sustainable life.

Innovation in the sector…

A respondent foresees that information technology and data processing will integrate more into building process. More natural architectural solutions will be found and then more unique projects according to climate and geographic conditions will be developed. Lots of routine and memorized projects will be broken. Electrical and mechanical installments will be smart systems.

According to another respondent, new, different and more efficient systems will be used, and the sector will expand (widen). Influences from outside (of Turkey,

i.e., foreign architects and construction materials firms) have already begun to appear, and I hope that will continue.

It will absolutely change the way of building material usage and project design processes. Just like risks encountered during the development of all new ideas is same for green buildings, too. In time, financial, social and environmental benefits of green buildings will be proved and understood. So, this will change the perspective of construction sector in the area of project design, budget, material selection and preference.

In my opinion, construction sector shall be forced to construct green buildings in terms of sustainability. I think green buildings will become widespread in most of the countries in the world. In the future agenda, from the point of construction sector, different approaches to green buildings are inevitable. It will lead to the creation of a different specialty area in the sector.

Construction companies will gain more experience and knowledge about this area in the direction of investors' demand. It can be said that green building and energy efficiency topics are factors that shape the design, construction and usage phases of construction projects.

All construction investors and firms will rearrange their decision-making process, project creation process and implementation according to green building criteria. Material suppliers are obligated to produce suitable materials to green standards and meet the market needs.

Since green sector has accelerated all over the world, it will be the same for Turkey. (green building construction and investment) As a result of this, while more experienced investors, developers and construction companies (contractors) will gain importance, inexperienced and conservative (close to innovative technologies) actors will be eliminated.

Green buildings shall provide new technology follow-up and its implementation, usage. Green materials will cause not only the development of construction firms but also the improvement of production sale firms. By providing the more demand and usage of recyclable, low VOC content and low CO_2 emission

materials, green buildings will lead to increase in manufacture of these materials in Turkey.

Increasing standards…

Most of the respondents believe that increasing interest of investors and so increased demand will lead to both reduction of initial cost of green construction and increase in quality of built environment. Nongovernmental organizations or quality assurance and quality management mechanisms will come up to control whether green certification system is used in a right way or not.

Need for specialists…

One respondent noted that it cannot be possible to convince the investors unless cost-benefit analysis is calculated explicitly and transparently. For this to happen there is a requirement for specialist. If this happens, the number of green buildings will increase and construction sector can approach this topic in a positive manner. Otherwise construction of traditional buildings will continue.

Marketing strategy…

Europe has started to design "0" energy buildings. In our country, green building knowledge is very low. Firms who accelerate this transition will come into prominence. In the future green building concept will become an important part of the marketing strategy. So, the interest of investors and demand will increase.

Temporary trend…

One respondent commented on this issue saying that thinking that green buildings will be common in the future cannot be true. While saying that green buildings become widespread, I mean, of course the number of green buildings can increase one by one, but it is not possible to see the real benefits on environment without gaining popularity between residential or existing buildings.

CHAPTER 6

CONCLUSION

Turkish Green Building Industry is very new; it has a history of two years. It is small now but is expected to grow. Many building owners are demanding green building strategies for new structures nowadays. The findings of the thesis have attempted to draw out the potential linkages between respondent's considerations and real world green building projects to achieve green building construction.

Innovation in the construction sector as a market motivator and improved quality of life as a social motivator was identified as the top two motivators in the questionnaire. Occupant health and well-being, improved productivity benefits of GB is realized by the respondents. They feel that they are preferable and alternative for these reasons. By referring to Eser Green Building this study confirmed these motivators that self- rated worker productivity and satisfaction and quality of life are higher in green buildings. It means that green buildings enhance employee productivity and create a positive image for the organization. Other major motivators include: increased media attention, main subject of conferences, better health of occupants, improved image, development of new products and services, easy advertising work, lower annual energy cost and increased popularity of rating systems. It is surprising to find lower energy cost as ninth motivator since energy is so expensive in Turkey.

The result of this thesis shows that from the viewpoint of survey respondents, the construction sector avoid green buildings due to three main reasons;

1. Building contracting and tendering process focus on low cost and less time rather than performance of the building.

2. Government incentives are not enough to encourage green building movement.
3. Regulations do not insist on a higher standard of building design and construction.

Other most critical barriers to the achievement of sustainable practices are high technology and material cost, absence of insurance policies, high first cost, inadequate experience of construction companies, difficulty in finding green materials and barriers to system and product innovation in order of importance.

Barriers to the growth of green building market are generally due to the relative youth of the industry, the nature of construction sector and unavailability of management systems. Many of these barriers can be removed through education, government support and research in green buildings. There are complaints of insufficient government support such as fiscal incentives, tax abatements and policy instrument. It is clear from respondents' comments that they would like Turkish government set mandatory regulations, policies and legislation for green buildings or incentives and introduce energy-efficiency regulation and code changes so that market demand can be created. Another role of government can be funding professional's education and research programs for green buildings and working on building certification procedure. Moreover, buildings which use environmentally-harmful products like fossil fuels should pay tax; on the other hand, green buildings should be awarded. The long-term cost saving of demonstrative projects can be publicized by government so that a competitive environment shall be created.

Besides, respondents called for more cost-benefit studies on this topic to overcome initial cost problems and perceptions. More data and information needed to support the arguments of sustainable design on first cost; annual energy and other operating costs; occupant health, productivity, and well-being; environmental impacts; and other social and business impacts. Researchers should develop and refine methods of analyzing the true cost of green buildings over its entire life cycle. Increasing the knowledge of financial earnings from productivity will greatly help the development of sustainable design. As the benefits of green buildings are realized by building stakeholders, the number of green buildings will increase. Insurance companies, banks and tenants should

understand the benefits and value of green buildings so that a shift in the market demand can be created. Another most common idea among the respondents is that if owners and public are aware of potential savings from a life cycle perspective, they will demand environmentally responsible buildings. Here, since any added costs for the project effect primarily the clients; educational programs and financial incentives must be aimed directly at potential clients, in other words, the general public.

The problems with conventional buildings are known, the benefits of green buildings have been identified. 63 out of 64 respondents foresee that green buildings are the future way of future construction. More examples of green buildings, sustainable goals should be set and guidelines can be created in the future.

6.1. Limitation of the Study

This thesis has fulfilled its initial purposes and objectives and has displayed an in-depth analysis of the motivators and barriers towards green building design and construction. However, the thesis has some limitations. First of all, there are not enough number of completed green buildings with comprehensive data to compare with the green operating cost and the capital and operating costs of conventional building projects. Much of the operating data of today's green buildings was not available because they were constructed recently. In this study, all operation savings data were taken from energy modeling analysis report. However it is still debatable how valid or accurate the energy models for calculating energy savings. Besides, a large data set of green building projects from different locations and climate conditions should be collected so that broad conclusions can be made without any curiosity. Conducting questionnaires or interviews with a greater number of market actors beyond sixty-four participants for this thesis would also allow for a more comprehensive and in-depth analysis.

6.2. Further Research

More research is needed for understanding and improving the green building movement in Turkey in the following areas. First and foremost, actual post-occupancy performance of the buildings should be done so that actual operating data of green building can be compared to the other buildings (green or

conventional). Building performance measurement and analysis is critical to quantify a buildings 'environmental impacts and energy efficiency' over its life cycle and persuade and encourage policy makers and other stakeholders in the sector by providing understandable and actionable feedback.

Secondly, comprehensive and definitive studies are required that focus on single green strategy to prove the effects and benefits of these specific green building strategies. Financial benefits and risks (both long-term and short-term) analysis for each strategy can be made provided that these strategies must have a strong and sound statistical basis. Also additional research and development in the process and materials is needed.

Thirdly, employment of integrated design approach can be investigated and the low initial cost of green building should be proved.

It can be further researched that governments have been introducing different policies and regulations to improve the sustainable development in the world-wide thus these government incentives can be investigated. Not only buildings but also other infrastructure can be examined and researched to define what can be done to promote sustainability movement in construction sector.

Finally, greater public awareness of benefits of green buildings has a huge importance. It is hoped that people start to about green building in public employ sustainable strategies in their own homes. To make this happen, a survey can be carried out to understand their knowledge and demand. This also helps defining the needs and target for residential buildings.

To summarize, this study provides valuable information for government to create more sustainable cities as well as organizations and construction companies to improve their competitiveness in the market. Identified motivators in promotion of green building can be integrated into organization strategies.

Anyway, change is in the air, in near future, all buildings will be constructed in a green way!

REFERENCES

Abbaszadeh, S., Zagreus, L., Lehrer, D., Huizenga, C. (2006) "Occupant satisfaction with indoor environmental quality in green buildings", Proceedings of Healthy Buildings 2006, Vol. III, 365-370, Lisbon, Portugal, June.

Ahn, Y. H., Pearce, A.R. (2007). "Green construction: contractor experiences, expectations, and perceptions", in: Journal of Green Building, Volume 2, Number 3.106-122.

Altensis (2010) "Eser Holding Headquaters Building Energy Modeling Analysis".

Altensis (2011) "Turkish Engine Center Building Energy Modeling Analysis".

Ambec, S., Lanoie, P. (2008) "Does it pay to be green? A systematic overview", Academy of management perspectives, 45-62.

Azizi, N.S.M., Fassman, E., Wilkinson, S., (2011) "Risks associated in implementation of green buildings." Department of civil environmental engineering, The university of Auckland.

Bartlett E., Howard, N. (2000) "Informing the decision makers on the cost and value of green building", in: Building Research and Information, 28:5, 315-324.

Belloni, K., Hakkinen, T. (2011) "Barriers and drivers for sustainable building", in: Building Research and Information, 39(3), 239-255.

Boyd, T., Kimmet, P. (2005) "The triple bottom line approach to property performance evaluation", PRRES Conference 2005, Cairns, Australia, School of Construction Management and Property, Queensland University of Technology.

Chan, E.H.W., Qian, Q.K., Lam P.T.I. (2009) "The market for green building in developed Asian cities-the perspectives of building designers, in: Energy Policy, 37(2009), 3061-3070.

Chegut, A., Eichholtz, P., Kok, N. (2011). "The value of green buildings new evidence from the United Kingdom", Maastricht University, July 2011.

Cole, R. J. (2010) "Editorial: cost and value in building green", in: Building Research and Information, 28:5, 304-309.

Croome-Clements, D., Baizhan, L. (2000) "Productivity and indoor environment", Proceedings of Healthy Buildings 2000, Vol. 1, 629-634.

Çakmanus, İ., Kunar, A., Toprak, G., Gulbeden, A. (2010) "A case study in Ankara for sustainable office buildings", *10. Rehva World Congress Sustainable Energy Use in Buildings,* 9-12 May, Antalya, Türkiye. Available from: http://www.cakmanus.com.tr/doc/a-case-study-in-ankara-for-sustainable-office-buildings.pdf, retrieved 12 March, 2012.

Davis Langdon (2004). Costing green: a comprehensive cost database and budgeting methodology. And revised in 2007: Cost of green revisited: Reexamining the feasibility and cost impact of sustainable design in the light of increase market adoption. 13.11.2011. Available from: http://www.usgbc.org/Docs/Resources/Cost_of_Green_Full.pdf, retrieved 13 September, 2011.

Demirbilek, F.N., Yalçıner, U.G., Ecevit, A., Özgümüş, M. (1997) "METU Solar House", Solahart Proceedings, SOLAR' 97, Sustainable Energy 35th Annual Conference, 1-5 Aust, NewZel. Sol. Energy, Canberra, Australia, December 1997. Available from: http://www.metu.edu.tr/ayasli-research-center, retrieved 5 March, 2012.

Edwards, B. (2006) "Benefits of green offices in the UK: Analysis from examples built in the 1990s", Sustainable Development, 2006, no 14,190-204.

Eisenberg, D., Done R., Ishida, L. (2002) "Breaking down the barriers: Challenges and solutions to code approval of green building", Development center for appropriate technology, Tucson, AZ.

Fisk, W. J. (2000) "Health and productivity gains from better indoor environments and their relationship with building energy efficiency", Annual Review of Energy and the Environment 25(1), 537-566. Available from: https://www.usgbc.org/Docs/Resources/Fisk(LBNL)HealthandProductivityEE2000.pdf, retrieved 5 March, 2012.

Fisk, W., Seppanen O. (2007) "Providing better indoor environmental quality brings economic benefits", Proceedings of Clima 2007 Well Being Indoors, 10-14 June 2007, Paper A01, Published by FINVAC, Helsinki.

Fowler, K.M., Solana, A.E., Spees, K. (2005) "Building cost and performance metrics: data collection protocol revision 1.1", Pacific Northwest National Laboratory.

Fowler, K.M., Rauch, E.M. (2008) "Assessing green building performance: a post occupancy evaluation of 12 GSA buildings", Pacific Northwest National Laboratory, Richland, Washington 99352.
Fuerst, F., McAllister, P. (2010) "Green noise or green value? Measuring the price effects of environmental certification in commercial buildings", Real Estate Economics, 39, 1, 46-69.

Hawken, P., Lovins A., Lovins, L.H. (1999) "Natural capitalism: creating the next industrial revolution". Boston: Little, Brown and Co. Available from: http://www.natcap.org, retrieved 25 February, 2012.

Hawken, P., Lovins A., Lovins, L.H. (1999) "Natural capitalism: creating the next industrial revolution". Boston: Little, Brown and Co. Available from: http://www.natcap.org, retrieved 25 February, 2012.

Heerwagen, J. (2001) "Do green buildings enhance the wellbeing of workers?" Available from: http://www.edcmag.com/articles/do-green-buildings-enhance-the-well-being-of-workers, retrieved 01 March, 2012.

Heerwagen, J. (2010) "Green buildings, organizational success and occupant productivity", in: Building Research and Information, 28:5-6, 353-367.

Hydes, K. R., Creech, L. (2010) "Reducing mechanical equipment cost: the economics of green design", in: Building Research and Information, 28:5-6, 403-407.

Issa, M. H., Rankin J.H., Christian A.J. (2010) "Canadian practitioners' perception of research work investigating the cost premiums, long-term costs and health and productivity benefits of green buildings", in: Building and Environment, 45 (2010), 1698-1711.

Kats, G., Alevantis, L., Berman, A., Mills, E., Perlman J. (2003) "The costs and financial benefits of green buildings", A report to California's sustainable building task force. Washington, DC: Capital E.

Kim, J. (1998) “Sustainable Architecture Module: Introduction to Sustainable Design.” Available from: http://www.umich.edu/~nppcpub/resources/compendia/ARCHpdfs/ARCHdesIntro.pdf, retrieved 23 January, 2012.

Landman, M. (1999) “Breaking though the barriers to sustainable building: ınsights from building professionals on government initiatives to promote environmentally sound practices.” Master of art in urban and environmental policy and planning, Tufts University, USA.

Larsson, N., (2004) Integrated Design process, Available from: http://www.iisbe.org/down/gbc2005/Other_presentations/IDP_overview.pdf, retrieved 25 February, 2012.

Larsson, N. (2009, September). Integrated design process: theory, history, demonstrations. The international initiative for a sustainable built environment.

Leaman, A., Thomas, L., Vandenberg, M. (2007) “‘Green’ buildings: what Australian building users are saying”, EcoLibrium, Vol. 6, 22-30.

Lockwood, C. (2006) “Building the green way”, Harvard Business Review, June 2006.

Lützkendorf, T., Lorenz, D. (2005). “Sustainable property investment: valuing sustainable buildings through property performance assessment”, in: Building Research and Information, 33:3, 212-234.

Manioğlu G., Yılmaz, Z. (2006) “Energy efficient design strategies in the hot dry area of Turkey”, in “Building and Environment”, 43(2008), 1301-1309.

Meister, E. (2005) Using hard cost data on resource consumption to measure green building performance. Master of science in building construction, University of Florida, Florida.

Moore, J. L. (1994) “What’s stopping sustainability?” Master of arts in the Faculty of graduate studies, The University of British Columbia.

Myers, D. (2005) “A review of construction companies’ attitudes to sustainability”, in: Construction Management and Economics, 23:8, 781-785.

New Ecology, The Green CDCs Initiative (2005) "The costs and benefits of green affordable housing". Available from: http://www.housingtrustonline.org/download/GreenAffordableHousing.pdf, retrieved 13 September, 2011.

Ott, L. (1988). "An introduction to statistical methods and data analysis". Boston: PWS-KENT Publishing Company.

Oxford instate of sustainable development, school of the build environment, Oxford brookes university, UK.

Papamichael, K. (2000) "Green building performance prediction/assessment", in: Building Research and Information, 28:5, 394-402.

Parkin, S., Sommer, F., Uren, S. (2003) "Sustainable development: understanding the concept and practical challenge", Proceedings of the institution of civil engineers, Engineering sustainability 156, 19-26.

Paul, W. L., Taylor, P. A. (2007) "A comparison of occupant and satisfaction between a green building and a conventional building", in: Building and Environment, 43 (2008), 1858-1870.

Paumgartten P. (2003) "The business case for high-performance green buildings: Sustainability and its financial impact", in: Journal of Facilities Management, Vol. 2, No.1, 26-34.

Pitt, M., Tucker, M., Riley, M., Longden, J. (2007) "Towards sustainable construction: promotion and best practices", in Construction Innovation, Vol. 9, No.2, 201-224.

Qualk, J.D., McCown, P. (2009) "Busting the myth that green costs more green", in: Strategic planning for energy and the environment, 28:5-4, 36-48.

Richardson, G.R.A., Lynes, J.K. (2007) Institutional motivations and barriers to the construction of green buildings on campus, in: International journal of sustainability in higher education, Vol 8., no.3, 339-354.

Ries R., Bilec M. M., Gokhan N. M., Needy K. L. (2006). "The economic benefits of green buildings: a comprehensive case study", in: The engineering economics, 51:259-295.

Schaltegger, S. and Synnestvedt, T. (2002) "The link between 'green' and economic success: environmental management as the crucial trigger between environmental and economic performance", in: Journal of Environmental Management, 65(2002), 339-346.

Turkish Green Building Association's website: www.cedbik.org, retrieved 15 January, 2012.

Turner Construction Company (2008) "Green building market barometer", November 2008.

U.S. Department of Energy, Energy Efficiency and Renewable Energy, Federal Energy Management Program (2003) "The Business Case for Sustainable Design in Federal Facilities." August 2003. Available from: http://www1.eere.energy.gov/femp/pdfs/bcsddoc.pdf, retrieved 01 March, 2012.

USGBC (2004, March). An introduction to the U.S. Green Building Council and the LEED Green Building Rating System. Available from: http://www.developmentexcellence.com/presentations/SEE_Week04/m_kaweckii.pdf, retrieved 23 January, 2012.

United States Energy Information Administration (EIA). (2012, March). Buildings Energy Data Book: 1.1 Buildings Sector Energy Consumption. Available from: http://buildingsdatabook.eren.doe.gov/docs/xls_pdf/1.1.3.pdf, retrieved, 20 April, 2012.

Victoria and the Kador Group (2008) "Employee productivity in a sustainable building", Melbourne, Australia: Sustainability Victoria.

Wiley, J. A., Benefield, J. D., Johnson, K.H. (2008). "Green design and the market for commercial office space", in: Journal of Real Estate Research, 41:228-243.

Williams, K., Dair, C. (2006) "What is stopping sustainable building in England? Barriers experienced by stakeholders in delivering sustainable developments", Oxford Institute of Sustainable Development, School of the Built Environment, Oxford Brookes University, UK.

Wilson, J.L., Tagaza, E. (2004) "Green buildings in Australia: drivers and barriers", The university of Melbourne, Business outlook and evaluation.

Winston, N. (2010) “Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas”, University College Dublin, Ireland, in: Willey online library, 319-330 (2010).

Wood, J. (2007) The green house: barriers and breakthroughs in residential green building. Master of art in urban and environmental policy and planning, Tufts University, USA.

Yudelson, J. (2008). Green Building through Integrated Design: Designing and Delivering High Performance Projects, McGraw-Hill.

Zhang, Z., Wu, X., Yang, X., Zhu, Y. (2004) “BEPAS-a life cycle building environmental performance assessment model”, in: Building and Environment, 41(2206), 669-675.

Zhang, X., Shen, L., Wu, Y. (2010) “Green strategy for gaining competitive advantage in housing development: a China study”, in: Journal of Cleaner Production, 19 (2011), 157-167.

APPENDIX A

MOTIVATORS AND BARRIERS FOR GREEN BUILDING CONSTRUCTION IN TURKEY QUESTIONNAIRE

What is a Green Building?

A green building reduces the negative impacts of built environments while creating healthy, comfortable, and economical places for people to live, work, and play.

What are the Proposed Benefits of a Green Building?

It has been reported that green buildings can:

_ improve employee productivity,

_ reduce health and safety costs, and

_ offer other savings such as reducing energy, water, and maintenance costs.

What are we studying and surveying?

This questionnaire was developed with respect to the master's thesis "Green Building Market in Turkey", which is an on-going study at Graduate Program in Construction Management of Civil Engineering Department, Middle East Technical University. Currently the market for sustainable buildings is gaining momentum in the design and construction area. The purpose of this study is took a snapshot of the views of experienced people in green building area on the motivators and barriers of green buildings in Turkey.

The findings of this study support the growing importance of green building. Also, economics of green buildings shall be examined and then strategic keys that make green buildings cost effective shall be defined from the case studies in Turkey.

Initially, it is expected from you to fill out general information about you and your company. The main body of the questionnaire is composed of four parts, each with sub-components, as follows:

1. General Information about the respondent and knowledge about the green buildings

2. General Information about the company and its attitudes towards green buildings

3. General Perceptions about green buildings (Motivations & Barriers)

4. Green Building Projects in Turkey-Case Studies

- **4.1.** Financial considerations about the green buildings
- **4.2.** Lessons learned from the green building project
- **4.3.** Future Expectations about the green buildings

This green building survey, which you are about to complete, should take **approximately 20 to 30 minutes.** Any information provided from participators on behalf of their companies will be confidential and used only for academic purposes. We would like to thank for your time and contribution to our study!

1. RESPONDENT INFORMATION

1.1. Please state your job / professional: _____

1.2. How long have you been working in the green building field? _____

1.3. How many green building projects have you been involved with?

Name of the project / Position _____

1.4. Where did you get green building knowledge?(Mark all that apply)

- ❒ Attending conference
- ❒ Reading trade publications
- ❒ Internet research
- ❒ Working with consultants
- ❒ Sharing knowledge with my colleagues
- ❒ Taking courses about green buildings
- ❒ Other (specify): _____

2. GENERAL PERCEPTION ABOUT GREEN BUILDINGS

2.1. **What do you think about what kind of buildings should be green?** *(Rank according to importance, 1-most important, 8-least important)*

- _____ Education (Schools/Colleagues)
- _____ Office
- _____ Government
- _____ Institutional
- _____ Health care
- _____ Hospitality (Hotels)
- _____ Retail (Shopping Malls)
- _____ Private Houses
- _____ Other(specify): _____

2.2. **What types of people or skill sets in wider industry would be most useful for helping you manage and implement green building projects?** *(Rank according to importance, 1-most important, 8-least important)*

- _____ Engineers (Mechanical, electrical, civil)
- _____ Architects
- _____ Operations technicians
- _____ Financial experts
- _____ IT professionals
- _____ Mid-level managers
- _____ Government
- _____ Public
- _____ Other(specify): _____

2.3. **Please rate the importance of participants in making decision to build green?** *(Rank according to importance, 1-most important, 5-least important)*

- _____ Building Owner
- _____ Developer
- _____ Occupant(s)
- _____ Investor
- _____ General Contractor
- _____ Other(specify): _____

2.4. Do you agree the idea that Green Buildings total lifecycle costs can be lower than traditional buildings long-term cost over 20 years' time period?

❒ Strongly, disagree ❒ Disagree ❒ Neutral ❒ Agree ❒ Strongly, agree

2.5. What is the key strategy to make green buildings advantages bigger?

_____

_____

_____

2.6. According to your experience what can be the payback period of green building cost?

❍ 1-5 ❍ 6-11 ❍ 12-16 ❍ 16-20 ❍ >21

2.7. What is the additional/ premium cost of green building compared to conventional building in Turkey?

❍ -5-0% ❍ 1-6% ❍ 7-12% ❍ 13-18% ❍ >19%

2.8. **What are Motivational Factors for Green Buildings in Turkey according to you?** *Please check the appropriate box.*

A. ECONOMIC MOTIVATORS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	**Strongly Agree**
A.1. Initial costs of green buildings are lower or equal.	❒	❒	❒	❒	❒
A.2. Green buildings provide greater return on investment.	❒	❒	❒	❒	❒
A.3. Annual energy costs of green buildings are lower.	❒	❒	❒	❒	❒
A.4. Annual water cost savings of green buildings are higher.	❒	❒	❒	❒	❒
A.5. Maintenance and repair costs of green buildings are lower.	❒	❒	❒	❒	❒
A.6. Waste disposal costs of green buildings are lower.	❒	❒	❒	❒	❒
A.7. Environmental and emissions costs are lower.	❒	❒	❒	❒	❒
A.8. Profitability of the company increases by the help of improved environmental quality. (lower absenteeism and increased productivity)	❒	❒	❒	❒	❒
A.9. Costs of dealing with complaints are lower.	❒	❒	❒	❒	❒
A.10. Green buildings have higher rental and sale value.	❒	❒	❒	❒	❒
A.11. Economic life of green building is longer since plant and equipment are more robust to alternative uses and so more flexible and durable-ensuring a longer-life.	❒	❒	❒	❒	❒

A. ECONOMIC MOTIVATORS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	**Strongly Agree**
A.12. Green building projects need less time and less cost for sitting because getting permissions and project approvals are so easy.	❒	❒	❒	❒	❒
A.13. There are tax abatements/incentive payments from government and utilities for green buildings.	❒	❒	❒	❒	❒
B. SOCIAL MOTIVATORS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	**Strongly Agree**
B.1. Green buildings provide better health for building occupants due to improved indoor quality.	❒	❒	❒	❒	❒
B.2. Green buildings improve comfort, satisfaction and well-being of building occupants.	❒	❒	❒	❒	❒
B.3. Green buildings increase the occupant safety and security.	❒	❒	❒	❒	❒
B.4. Green buildings improve the quality of life for individuals.	❒	❒	❒	❒	❒
C. ENVIRONMENTAL MOTIVATORS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	**Strongly Agree**
C.1. Green buildings reduce the negative impacts of buildings on the environment.	❒	❒	❒	❒	❒
C.2. Green Buildings support the control of climate change.	❒	❒	❒	❒	❒
C.3. Green building increase water and air quality.	❒	❒	❒	❒	❒

C. ENVIRONMENTAL MOTIVATORS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
C.4. Green Buildings lead to decrease use of natural resources and so protects ecosystem.	❒	❒	❒	❒	❒
D. ORGANIZATIONAL MOTIVATORS	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
D.1. Green Buildings demonstrate corporate social responsibility.	❒	❒	❒	❒	❒
D.2. Green building strategies are an integrated part of corporate strategic planning and risk assessment.	❒	❒	❒	❒	❒
D.3. Companies have better-improved public image by the help of the green buildings.	❒	❒	❒	❒	❒
D.4. Green Buildings have ability to attract young and well-educated employees.	❒	❒	❒	❒	❒
D.5. Green buildings provide construction companies to take new projects by creating value within the compatible market.	❒	❒	❒	❒	❒
D.6. Green buildings make risk management easy (economic, financial, market, etc.).	❒	❒	❒	❒	❒
D.7. Green buildings lead to develop new, more energy-efficient products and services to expand sales.	❒	❒	❒	❒	❒
D.8. Green buildings make the advertising work of the company easy.	❒	❒	❒	❒	❒

D. ORGANIZATIONAL MOTIVATORS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
D.9. Green buildings allow opening other countries and selling green building know-how.	❒	❒	❒	❒	❒
E. MARKET MOTIVATORS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	***Strongly Agree***
E.1. Green buildings have positive impact on the Construction Industry Market (non-traditional processes, new materials and technologies)	❒	❒	❒	❒	❒
E.2. There is an increasing media attention on green building market.	❒	❒	❒	❒	❒
E.3. Prominence of green buildings increases at national conferences.	❒	❒	❒	❒	❒
E.4. There is an increase on client demand for green building projects in the market.	❒	❒	❒	❒	❒
E.5. There are code changes and environmental policies that lead to green building construction.	❒	❒	❒	❒	❒
E.6. Rating System (LEED, BREAM) of the green buildings gain popularity.	❒	❒	❒	❒	❒

2.9. Which of the following are the Barriers to Green Building Construction according to you? Please check the appropriate box.

A. ECONOMIC BARRIERS	*Strongly Disagree*	*Disagree*	*Neutral*	*Agree*	Strongly Agree
A.1. Green buildings provide lower return on investment.	❒	❒	❒	❒	❒
A.2. The length payback period of the initial cost of green buildings is too long.	❒	❒	❒	❒	❒
A.3. Initial construction costs of green buildings are very high.	❒	❒	❒	❒	❒
A.4. Operation, maintenance and repair costs of green buildings are higher.	❒	❒	❒	❒	❒
A.5. Cost of green technologies and materials are too high.	❒	❒	❒	❒	❒
A.6. Customers are unwilling to pay for the green building projects.	❒	❒	❒	❒	❒
A.7. Government incentives are not enough to encourage green building movement.	❒	❒	❒	❒	❒
A.8. Financial risk of the green building projects is too high because they require some additional time due to integrated system and new technologies approval processes.	❒	❒	❒	❒	❒

B. AWARENESS / EDUCATION BARRIERS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	**Strongly Agree**
B.1. What green means is not widely understood due to complexity issues and uncertainty about this area.	❒	❒	❒	❒	❒
B.2. There are not sufficient consultant and education program about green building concept.	❒	❒	❒	❒	❒
B.3. Researchers do not prove empirically the benefits of green buildings and so there is not accurate information to easily convince decision makers.	❒	❒	❒	❒	❒
B.4. Because green building knowledge (technologies, materials) is new, there are not enough resources or documentation.	❒	❒	❒	❒	❒
B.5. There is a shortage of professionals and workers with suitable experience.	❒	❒	❒	❒	❒
B.6. It is difficult to measure and to make identification, evaluation and verification of green buildings performance and so there is not reliable performance & saving data of green buildings.	❒	❒	❒	❒	❒
B.7. There is not a robust tracking and performance measurement system to evaluate environmental and financial performance data of green buildings.	❒	❒	❒	❒	❒
B.8. Life cycle cost assessment results for green building projects are not guaranteed.	❒	❒	❒	❒	❒

B. AWARENESS / EDUCATION BARRIERS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	**Strongly Agree**
B.9. There is not enough cost-benefit of green building studies.	❒	❒	❒	❒	❒
C. MARKET BARRIERS	***Strongly Disagree***	***Disagree***	***Neutral***	***Agree***	**Strongly Agree**
C.1. Building sector is resistance to change and innovation.	❒	❒	❒	❒	❒
C.2. There is not sufficient number of investors for the construction of green buildings.	❒	❒	❒	❒	❒
C.3. Building contracting and tendering process focus on low cost and less time rather than performance of the building.	❒	❒	❒	❒	❒
C.4. Regulations do not insist on a higher standard of building design and construction.	❒	❒	❒	❒	❒
C.5. There are barriers for system and product innovation due to regulations and existing standards.	❒	❒	❒	❒	❒
C.6. There is no available technology for green buildings in construction market.	❒	❒	❒	❒	❒
C.7. It is difficult to find greener recycled and certified green building materials.	❒	❒	❒	❒	❒
C.8. There is no certification system such as LEED, BREEAM for Turkey.	❒	❒	❒	❒	❒
C.9. There is a lack of consensus in the market about leading green standards.	❒	❒	❒	❒	❒

C. MARKET BARRIERS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
C.10. Companies in construction sector do not support each other in order to improve green building movement.	❒	❒	❒	❒	❒
C.11. Stakeholders involved over the lifetime of a building project have separate and distinct interests and so this makes it difficult to reach an agreement.	❒	❒	❒	❒	❒
C.12. Insurance companies do not have green building risk-specific policies.	❒	❒	❒	❒	❒
D. ORGANIZATIONAL BARRIERS	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
D.1. Senior management does not see green buildings as a priority.	❒	❒	❒	❒	❒
D.2. There is not a centralized management system for the green building process. (organizational disconnects, e.g. lack of coordination between engineering and finance departments, or procurement and operations)	❒	❒	❒	❒	❒
D.3. Most of the construction company's financial conditions are not appropriate for green building projects.	❒	❒	❒	❒	❒
D.4. Financial methods of the company are not appropriate to calculate life cycle costs of the building.	❒	❒	❒	❒	❒
D.5. Construction companies do not have enough experience.	❒	❒	❒	❒	❒

3. FUTURE EXPECTATIONS ABOUT GREEN BUILDINGS

3.1. **How will green building impact the construction industry in the future?**

_____

_____

_____

3.2. What can be done to accelerate green building movement in Turkish construction sector?

_____

_____

_____

APPENDIX B

GREEN BUILDING CASE STUDY PROJECTS INTERVIEW QUESTIONNAIRE

1. COMPANY INFORMATION

1.1. What kind of projects does your organization predominantly pursue? Please check the appropriate boxes.

❒ Building construction (Commercial buildings, hospitals, hotels, universities, governmental buildings, etc.)
❒ Industrial (Factories, refineries, powerhouses, etc.)
❒ Infrastructure (Sewerages, pipe lines, city infrastructure, etc.)
❒ Transportation (Roads, tunnels, bridges, etc.)
❒ Water Structures (Dams, irrigation systems, etc.)
❒ Architectural Design
❒ Engineering Design
❒ Consulting
❒ Other (Please state): _____

1.2. Number of employees within the organization, please check the appropriate box.

❒ < 100 ❒ 100-500 ❒ > 500

1.3. Is there any environmental management system in your company?

❒ Yes ❒ No

1.4. Is there any sustainability group or green team in the company?

❒ Yes ❒ No

If answer is yes, what is the size?

❒ 1-3 ❒ 4-6 ❒ 7-9 ❒ 10-12 ❒>12

If answer is no, do you want to create a green building division or a sustainability group, or does your company have such plans?

❒ Yes, definitely ❒ Yes ❒ Maybe ❒ No ❒ Definitely, not

1.5. Does your company make a contribution to accelerate green building movement? (Mark all that apply)

❒ Publishing educational materials on intranet or website
❒ Developing training green programs for employees
❒ Hosting green building conference, meetings
❒ Sponsoring of green building research
❒ Posting signs or posters about sustainability
❒ Publishing articles or reports
❒ Developing guidelines and resource
❒ Other (specify)

1.6. In what year was your green construction policy launched?

_____ year

1.7. How many green building projects has your company completed?

Names of the projects _____

2. GENERAL INFORMATION ABOUT THE GREEN BUILDING PROJECT

2.1. Name of the project: _____

2.2. Project Information:

Building Function

❒ Education (Schools/Colleagues)
❒ Commercial Office
❒ Government
❒ Institutional
❒ Health care
❒ Hospitality (Hotels)
❒ Retail (Shopping centers)
❒ Private Houses
❒ Other(specify) _____

Building Location: _____

Building Occupancy Date: _____

Total number of regular occupants and visitors: _____

Expected Building Life: _____

Total Building Site Area / Interior Area: _____

2.3. Building Performance Data:

Total Building Potable Water Use: _____ m^3/year _____ TL/year

Total Building Electricity Use: _____ m^3/year _____ TL/year

Total Building Natural Gas Use: _____ m^3/year _____ TL/year

2.4. Is the building certified?

❒ Yes, LEED Score: _____
BREEAM Score: _____

❒ No

2.5. At what phase of the Project green design goals established?

❒ Project Conceptualization
❒ Pre-Design
❒ Schematic Design
❒ Design Development
❒ Construction Drawings
❒ Construction

2.6. Was an integrated design process used during design and construction phases of the building?

❒ Yes ❒ No

If yes, who was part of the integrated design team? *(Check all that apply)*

❒ Building Owner
❒ Architect
❒ Project Manager
❒ General Contractor
❒ Mechanical Engineer
❒ Structural Engineer

- ❒ Electrical Engineer
- ❒ Interior Designer
- ❒ Commissioning Agent
- ❒ Landscape Architect
- ❒ Occupant
- ❒ Other(s): _____

2.7. Does your organization have a comparable conventional building with which to compare this green project?

❒ Yes ❒ No

2.8. Have you developed a Feedback Mechanism or Automation System for evaluating the benefits of buildings and measuring results? How?

- ❒ Yes, please explain _____
- ❒ No

2.9. What are the most significant green features of the building?

Energy _____

_____

Water _____

_____

Construction Site _____

_____

People _____

_____

Material _____

_____

3. FINANCIAL CONSIDERATIONS OF THE PROJECT

3.1. How was the project financed?

3.2. Did the building receive any economic incentive(s)?

❒ Yes, please explain _____

❒ No

3.3. How did you choose sustainable design features of the building? Did you make an assessment/prediction of green building performance? What kind of methods did you use?

_____

_____

3.4. What was total building cost?

Architecture Design Cost: _____TL _____m^2/TL

Mechanical Design Cost: _____ TL _____m^2/TL

Electrical Design Cost: _____ TL _____m^2/TL

Construction Cost: _____TL _____m^2/TL

Other /specify): _____TL _____m^2/TL

3.5. If you make the comparison between a non-green building and your green building, is there an additional cost?

❒ Yes ❒ No

If your answer is yes, how much is it? Why?

_____

_____

If your answer is no, what kind of design and construction strategies that the team used to reduce high initial cost for green buildings?

_____

_____

3.6. What are economic savings of the green building?

Annual electricity saving (%) / cost (TL): _____

Annual natural gas saving (%) / cost (TL): _____

Annual water saving (%) / cost (TL): _____

Annual waste reduction (%) / cost (TL): _____

Annual recycled materials (%) / cost (TL): _____

3.7. What is maintenance and repair costs per square meter?

Expected _____

Performed _____

3.8. What would the square meter operating costs have been for non-green? Was this comparison done?

❒ Yes, _____

❒ No

3.9. Is there rehabilitate system to increase energy efficiency of your building?

❒ Yes ❒ No

4. ENVIRONMENTAL CONSIDERATIONS OF THE PROJECT

4.1. Have the environmental benefits of the building been observed? How?

❒ Yes ❒ No

4.2. Did you calculate carbon emissions?

❒ Yes ❒ No

5. SOCIAL CONSIDERATIONS OF THE PROJECT

5.1. Did you calculate employee absenteeism and sick leaves days before and after the movement?

❒ Yes ❒ No

5.2. Has employee productivity been monitored after movement to new building?

❒ Yes ❒ No

5.3. Is there any complains or pleasure about the building from occupants?

❒ Yes, _____

❒ No

6. LESSONS LEARNED FROM THE GREEN BUILDING PROJECT

6.1. Did you apply "integrated design project management" on your project?

❒ Yes ❒ No

If you answer is yes, did you face any obstacles or difficulties? How did you overcome?

_____

If you answer is no, what can be done to achieve and improve it?

_____

6.2. What kind of obstacles or conflicts are you faced with?

_____

6.3. What were the most successful corrective solutions to faced problems?

_____

_____

6.4. What are the mistakes made during design or construction of green building according to you?

_____

_____

6.5. What were the most important lessons you have learned from implementing green building strategy?

_____

_____

6.6. What kind of innovative technologies did you use?

_____

_____

APPENDIX C

ESER GREEN BUILDING OCCUPIER INDOOR ENVIRONMENTAL SATISFACTION QUESTIONNAIRE

1. PERSONAL INFORMATION

1.1 Your Age _____

1.2 What is your gender?

- ❒ Male
- ❒ Female

1.3 How long have you been working in the new building?

_____ Year _____ Month

1.4 How many hours do you spend at work in a week?

- ❒ less than 25
- ❒ 25-50
- ❒ more than 50

1.5 Did being "green" of your working office play an effective role at your job application?

- ❒ Yes
- ❒ No

2. JOB DESCRIPTION

2.1 Which department do you work?

- ❒ Manager
- ❒ Professional and Technical staff
- ❒ Executive acts
- ❒ Other (please specify) _____

3. GENERAL OFFICE AREA AND SATISFACTION

3.1 At which floor is your office?

❒-1 ❒0 ❒1 ❒2 ❒3 ❒4

3.2 On which side of the building is your office?

❒ North ❒ South ❒ East ❒ West

3.3 What is the type of your office?

❒ Open-office (I can see and hear my colleagues)
❒ Only me
❒ Other _____

4. GENERAL BUILDING SATISFACTION

4.1 Please evaluate the complacence of building by marking the table below.

	Very Unsatisfied	Unsatisfied	Neutral	Satisfied	Very Satisfied
a) Location	❒	❒	❒	❒	❒
b) Design and appearance	❒	❒	❒	❒	❒
c) Fire Protection System	❒	❒	❒	❒	❒

4.2 I agree the idea that the quality of my life improved with green building.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

4.3 I think that our company has a great image to public and other firms by the help of the green building.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

5. INDOOR ENVIRONMENT QUALITY SATISFACTION

5. A) Please mark the following factors that you can adjust or control;

- ❒ Daylight level
- ❒ Electric light level
- ❒ Quantity of fresh air
- ❒ Temperature
- ❒ None of the above

5. B) What do you think about how the factors (you can control) that marked above affect your productivity?

Very reduced	Reduced	Neutral	Increased	Very increased
❒	❒	❒	❒	❒

5.1. THERMAL COMFORT

5.1.1 During hot weather my work area is:

Very cold	Cold	Normal	Hot	Very hot
❒	❒	❒	❒	❒

5.1.2 During cold weather my work area is:

Very cold	Cold	Normal	Hot	Very hot
❒	❒	❒	❒	❒

5.1.3 Thinking of the questions above about temperature and air flow speed, I am satisfied with thermal comfort of my work area in general.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

5.2. AIR QUALITY

5.2.1 Air quality in the building;

Stuffy/Stale	Variable in a bad way	Normal	Variable in a good way	Clean / Fresh
❒	❒	❒	❒	❒

5.2.2 I am satisfied with the air quality of my work area in general.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

5.3. LIGHTING QUALITY

5.3.1. What kind of lighting system is used for work area?

- ❒ Daylighting
- ❒ Ceiling lamp
- ❒ Reading lamp

5.3.2. My work area is:

Too dark	Dark	Normal	Bright	Very bright
❒	❒	❒	❒	❒

5.3.3. There is a glare problem in my work area.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

5.3.4. Thinking of the questions above, I am satisfied with lighting quality of my work area in general.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

5.4. WINDOWS AND DAYLIGHT

5.4.1. How far your desk to the nearest exterior window?

- ❒ Less than 3 meters
- ❒ More than 3 meters

5.4.2. I am contented with outside view of my work area and interaction with the external environment.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

5.4.3. I am satisfied with the amount of daylight and daylighting in my work area.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

5.5. ACOUSTIC QUALITY

5.5.1. Acoustic of your work area;

Too noisy	Noisy	Normal	Quiet	Very quiet
❒	❒	❒	❒	❒

5.5.2. I am satisfied with the acoustic quality in my work area.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒

6. WORK PRODUCTIVITY

6.1. Does starting to work in a "Green Office Building" affect your productivity? (when compared to your old office)

a) Personal productivity

Very reduced	Reduced	Neutral	Increased	Very increased
❒	❒	❒	❒	❒

b) Team work productivity

Very reduced	Reduced	Neutral	Increased	Very increased
❒	❒	❒	❒	❒

c) Job satisfaction

Very reduced	Reduced	Neutral	Increased	Very increased
❒	❒	❒	❒	❒

7. HEALTH

7.1. Have you ever take time off due to health problems defined above?

❒ Yes, _____ days in a month

Reason _____

❒ No

7.2. In working hours, I feel healthier compared to my old office.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
❒	❒	❒	❒	❒