ISTANBUL TECHNICAL UNIVERSITY ★ GRADUATE SCHOOL OF SCIENCE ENGINEERING AND TECHNOLOGY

IDENTIFICATION OF DRIVERS AND BARRIERS FOR GREEN BUILDINGS AND CREDIT ACHIEVEMENTS OF ENERGY AND ATMOSPHERE CATEGORY IN TURKEY

M.Sc. THESIS

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Department of Civil Engineering

Construction Management Programme

JUNE 2019

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Thesis Advisor: Prof. Dr. Gül POLAT TATAR

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ISTANBUL TEKNİK ÜNİVERSİTESİ ★ FEN BİLİMLERİ ENSTİTÜSÜ

TÜRKİYE'DEKİ YEŞİL BİNALAR VE ENERJİ VE ATMOSFER KATEGORİSİNİN ÖNÜNDEKİ MOTİVE EDİCİ VE ENGELLEYİCİ FAKTÖRLERİN SAPTANMASI

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HAZİRAN 2019

Naz YIKILMAZ, a M.Sc. student of ITU Graduate School of Science Engineering and Technology student ID 501161110, successfully defended the thesis/dissertation entitled "IDENTIFICATION OF DRIVERS AND BARRIERS FOR GREEN BUILDINGS AND CREDIT ACHIEVEMENTS OF ENERGY AND ATMOSPHERE CATEGORY IN TURKEY", which she prepared after fulfilling the requirements specified in the associated legislations, before the jury whose signatures are below.

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To my unique mother,

FOREWORD

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May 2019

Naz YIKILMAZ
Civil Engineer

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ABBREVIATIONS

ANOVA	**:** Analysis of Variance
BRE	**:** Building Research Establishment
BREEAM	**:** Building Research Establishment Assessment Method
DGNB	**:** German Sustainable Building Council
EA	**:** Energy and Atmosphere
EU	**:** European Union
GBRS	**:** Green Building Rating Systems
ID	**:** Innovation in Design
IEQ	**:** Indoor Environmental Quality
LEED	**:** Leadership in Energy and Environmental Design
MR	**:** Materials and Resources
RP	**:** Regional Priority
SS	**:** Sustainable Sites
TGBC	**:** Turkish Green Building Council
UK	**:** United Kingdom
WE	**:** Water Efficiency

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IDENTIFICATION OF DRIVERS AND BARRIERS FOR GREEN BUILDINGS AND CREDIT ACHIEVEMENTS OF ENERGY AND ATMOSPHERE CATEGORY IN TURKEY

SUMMARY

Nowadays, being environment-friendly is not an option, it is a necessity. Transformation of being environment-friendly also commenced in the construction field, as well as other areas. As an output of this transformation, green building concept was introduced to the construction industry. Within this thesis, firstly sutainability term was reviewed and then green building term was examined from many perspectives. It is seen that LEED and BREEAM are the most common green building rating systems in the world. Also Turkey has its own rating system which is called B.E.S.T Residence Certificate, it can certify only residential buildings. Due to LEED's extensity in Turkey, LEED is decided this thesis' relevant green building rating system.

After the literature review methodology was explained in details. According to needs of this thesis, Kruskal Wallis, Mann-Whitney U test, Wilcoxon signed rank test and Cronbach's alpha were applied. In the fourth section, evaluation of credit achievements of LEED-certified buildings of Turkey and evaluation of energy and atmosphere credit achievements of LEED-certified buildings in Turkey were done. According to these evaluations, questionnaire survey's content was decided.

The questionnaire survey consists of four main sections; in the first section there are demographical questions, in the second section there are factors to be evaluated in terms of green buildings, in the third section there are factors to be evaluated in terms of energy and atmosphere credit category and in the final section there are barriers to be evaluated in terms of green buildings and energy and atmosphere credit category.

During two months, respondents could answer to the questionnaire survey. Findings of this questionnaire survey are reviewed; motivators and barriers are identified for green buildings and EA credit category of LEED. In addition, recommendations of respondents of the questionnare survey are listed.

In conclusion, drivers and barriers for green buildings and EA credit category of LEED are one more time highlighted. As a result of the questionnaire survey, recommendations were done and limitations were explained.

TÜRKİYE’DEKİ YEŞİL BİNALARIN VE ENERJİ VE ATMOSFER KATEGORİSİNİN ÖNÜNDEKİ MOTİVE EDİCİ VE ENGELLEYİCİ FAKTÖRLERİN SAPTANMASI

ÖZET

21. yüzyılda çevre dostu olmak artık bir seçenek değil zorunluluk haline gelmiş durumdadır. Haliyle bu durumdan inşaat sektörü de etkilenmiş ve çevre dostu olma amacıyla değişim ve dönüşümün içine girmiştir. Bu amaçla yeşil binalar inşaat sektörüne tanıtılmıştır. Bu tezde de çevre dostu olmanın olmazsa olmaz dayanağı sürdürülebilirlik teriminin detaylı literatür araştırması yapılmıştır. Ardından inşaat sektöründeki değişimin en büyük örneklerinden yeşil bina konsepti için detaylı literatür araştırması yapılmıştır.

Sürdürülebilirlik en genel tanımıyla şöyle anlatılabilir: Bugünün ihtiyaçlarını karşılarken, gelecek nesillerin ihtiyaç kaynaklarını tehlikeye sokmamaktır. Sürdürülebilirliğin inşaat açısından önemi ise şöyle anlatılmaktadır: Yaklaşık olarak sera gazı salınımının %30’u, elektriğin %60’ı ve içme sularının %15’i tüketimi binalar, geleneksel methodlara bağlı kalarak yapılan binalar, tarafından yapılmaktadır. Bu tüketim de sektörde çevre dostu olana yönelme ihtiyacı doğurmaktadır. Sektördeki bu ihtiyacı da yeşil binalar karşılamaya çalışmaktadır.

Bir binanın yeşil bina olarak tanımlanabilmesi için bir yeşil bina değerlendirme sistemi tarafından değerlendirilip sertifikalandırılmış olması gerekmektedir. Dünyada pek çok gelişmiş ülkenin kendine ait bir değerlendirme sistemi bulunmaktadır. Bunlar arasında en bilinenler: Amerika Birleşik Devletleri’ne ait Leadership in Energy and Environmental Design, Birleşik Krallık’a ait Building Research Establishment Assessment Method ve Almanya’ya ait Deutsche Gesellschaft für Nachhaltiges Bauen’dir. Her ülkenin coğrafi ve iklimsel gereklilikleri birbirinden farklı olduğu için her ülkenin kendine ait yeşil bina değerlendirme sisteminin olması en ideal durumdur fakat gerçekte olan bu değildir. Yukarıda bahsedilen sistemler artık uluslararası sertifika sistemleri durumuna gelmiş ve birçok farklı ülke tarafından da kullanılmaktadır. Ülkemizin de kendine ait bir değerlendirme sistemi bulunmaktadır, B.E.S.T konut sertifika sistemi. Bu sertifika sistemi malesef sadece konutlar için geçerli olup yeşil binaların çokça kullanıldığı endüstriyel binalar veya ofisler için geçerli olmadığından henüz sertifikalandırılmış bir binası bulunmamaktadır. Ülkemizdeki bu ihtiyacı ise LEED ve BREEAM karşılamaktadır, ama aralarında açık ara ülkemizde en çok kullanılan sertifika sistemi LEED’dir. Bu sebeple bu tezde LEED sertifikası ile değerlendirilmiş binaların analizleri yapılmıştır.

Literatür araştırmasından sonra tezde kullanılan methodlardan bahsedilmiştir. Bunlar: Kruskall Wallis, Mann-Whitney U testi, Wilcoxon signed rank testi ve Cronbach alpha testidir. Aynı zamanda methodoloji başlığı altında anket çalışmasına ait detaylarda verilmiştir. Anket çalışması, anketin amacını anlatan bir yazıdan sonra dört ana bölümden oluşmaktadır. Birinci bölümdeki sorular, demografik sorulardır. İkinci bölümdeki sorular, yeşil binaların yaygınlaşmasındaki faktörleri saptamaya yöneliktir. Üçüncü bölümdeki sorular, eneji ve atmosfer kredi kategorisinden daha fazla kredi

aldırabilecek faktörleri saptamaya yöneliktir. Son bölümdeki sorular ise, bu iki başlığın önündeki bariyerleri saptamaya yöneliktir. Son üç bölümün soru soruş şeklinde Likert yönteminden faydalanılmıştır. Anketi cevaplayanlardan sorunun altında sıralanan faktörleri, “Hiç Önemli Değil”, “Çok Az Önemli”, “Az Önemli”, “Orta Önemli”, “Önemli” ve “Çok Önemli” olarak değerlendirilmeleri istenmiştir. Ankete katılanlar tek bir açıdan, yeşil bina sektöründe çalışmaları bakımından sınırlandırılmışlardır.

Bu tez kapsamında öncelikle Türkiye’de LEED sertifika sistemiyle sertifikalandırılmış olan binalar değerlendirilmiştir. Görülmüştür ki 366 bina arasınan en fazla başvurulan versiyon 3 nolu versiyondur ve 290 bina buna göre sertifikalandırılmıştır. Fakat sadece versiyona göre binaları birbirleriyle karşılaştırmak doğru bir sonuca ulaştırmaz çünkü farklı bina tipleri farklı değerlendirmelere tabidir. Bu 290 bina bir de bina tiplerine göre gruplandırıldığı zaman en fazla bina yeni inşaat alanına aittir. Bir de bu yeşil binalar versiyonlara göre tekrar gruplandırıldığı zaman en fazla örnek 172 bina ile versiyon 3 yeni inşaat altında bulunmaktadır. Dolayısıyla bu tez kapsamında 172 bina örnek havuzu olarak seçilmiştir. Bu 172 bina aldıkları sertifikalara göre gruplandırılmış ve bu grupların her bir kredi kategorisinde gösterdikleri başarı grafikler ile gösterilmiştir. Buna göre, enerji ve atmosfer kategorisi hem en çok puan alınabilecek kategori olarak saptanmış hem de en başarısız olunan kategorilerden biri olduğu ortaya konulmuştur. Dolayısıyla, Türkiye’deki LEED sertifika sistemine başvuranların enerji ve atmosfer kategorisinde yapacaklarının daha yüksek sertifika seviyelerine ulaşmalarında yardımcı olabileceği düşünülmüştür.

Bir sonraki araştırma ise eneji ve atmosfer kategorisine yönelik yürütülmüştür. Bu sefer de binaların enerji ve atmosferin alt kredi kategorilerindeki başarısı incelenmiştir. Bu çalışmalar doğrultusunda da anket soruları hazırlanmıştır. Anket iki ay boyunca yayında kalmış ve 45 kişi tarafından tamamlanmıştır.

Anket sonucları tezin beşinci bölümünde ele alınmıştır. İlk etapta demografik sonuçlar paylaşılmıştır. İkinci, üçüncü ve dördüncü etaplarda ise hem bütün yanıtlayanlara göre en önemli ve en az önemli faktörler sıralanmış; hem de yanıtlayanlar mimarlar ve mühendisler, danışmanlar ve diğer meslekler, 5 projeden daha fazla ve daha az deneyimi olanlar olarak gruplandırılıp farklı grupların değerlendirmeleri birbirleriyle uyumlu mu değil mi bu incelenmiştir. Tüm katılımcılara göre yeşil binalar için sırasıyla en önemli ilk üç motivatör devletin yeni bina teknolojilerindeki tedarik ve indirim desteği, yeşil bina inşa edeceklere verilebilecek düşük faizli krediler ve/veya hibeler, kamu projelerinde yeşil binaların zorunlu tutulması olmuştur. Enerji ve atmosfer kategorisi için sırasıyla en önemli ilk üç motivatör geleneksel binalara göre yeşil binaların enerji enerji tasarrufu sağlaması ve bunun enerji tüketim maliyetine yansıması, devlet tarafından farklı enerji çözümlerine yatırım ve/veya teşviklerin sağlanması, devlet tarafından yenilenebilir enerji sistemleri için gerekli altyapının sağlanması olmuştur. Tüm katılımcılar tarafından yeşil binalar ve enerji ve atmosfer kategorisi için sırasıyla en önemli ilk üç bariyer marketin sürdürülebilirlik merkezli olmaması, yenilenebilir enerji kullanımının yatırım maliyetini artırması ve sürdürülebilirlik ve enerji verimliliği konularında halkın yeterli bilince sahip olmaması olarak belirlenmiştir.

Cronbach alpha methodu kullanılarak ankette yer alan faktörlerin güvenilirlikleri test edilmiştir. Faktörler güvenli olarak değerlendirilebilecek sonuçlar almıştır. Wilcoxon signed rank test ile de her bir faktör için verilen yanıtların 4,5’tan (çok önemli 6, hiç önemli değil 1 olarak kabul edilmiştir) farklı olup olmadığına bakılmıştır. Aynı bölümde, anketi tamamlayanların görüşleri de paylaşılmıştır.

Sonuç bölümünde ise, tezde yapılanlar özet halinde anlatılmış olup ankette çıkan sonuçların bir kez daha altı çizilmiştir. Çalışma sonucunda ulaşılan sonuçlara göre devletin ve sektörün bundan sonra atabilecekleri adımlar paylaşılmıştır. Tezin son paragrafında bu çalışmanın limitlerine değinilmiş ve gelecekteki çalışmaların nasıl daha iyi yapılabileceğine yönelik öneriler paylaşılmıştır.

1. INTRODUCTION

1.1 Problem Statement

Green building concept is no more an alternative, it has become a need. Defining a building as green is based on a certification. Among all the green building certification systems, LEED is the most common certification system in Turkey. Polat et al. (2018) investigated the achievements in different credit categories of LEED certified green buildings, i.e., new construction, in Turkey. The results of their analyses revealed that 105 newly constructed and LEED-certified buildings in Turkey earned lowest credits from Energy and Atmosphere (EA), Materials and Resources (MR), and Indoor Environmental Quality (IEQ) credit categories. Among these categories, EA category has the biggest portion of the maximum obtainable credits (Polat et al., 2018).

1.2 Purpose of Thesis

The main purposes of this thesis are: 1) to evaluate the achievements of LEED-certified buildings, i.e., new construction, in different credit categories, 2) to evaluate the achievements of LEED-certified buildings, i.e., new construction, in the subcategories of EA category, and 3) to investigate the main reasons behind the low achievement in the EA category and make some recommendations to attain higher credits in future projects.

1.3 Outline of Research

This thesis consists of six sections in line with the purpose of the study. The general information about the parts of the thesis and the contents of the sections are given in Figure 1.1.

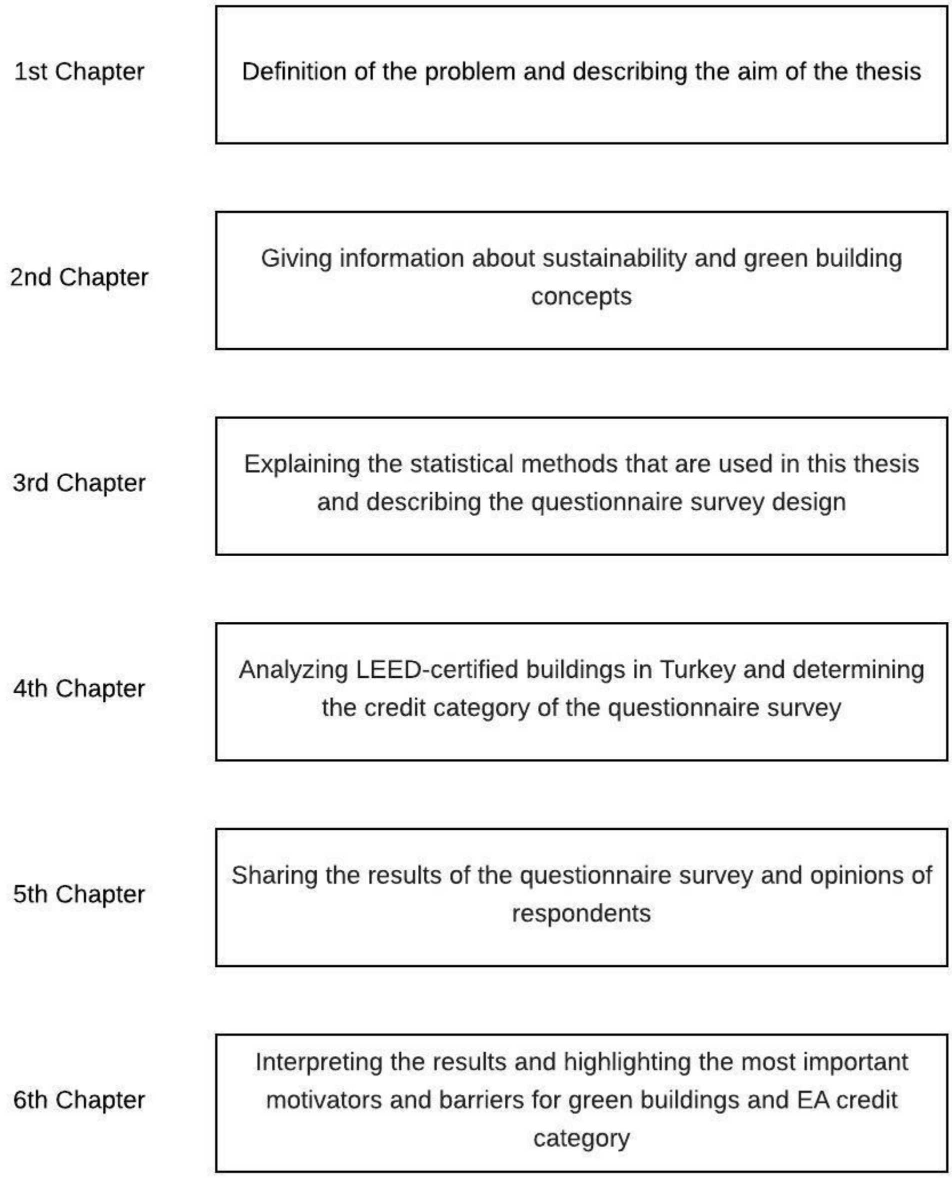

Figure 1.1 : Thesis methodology.

2. SUSTAINABILITY AND GREEN BUILDING

2.1 Sustainability

In connection with the increase of the world's population over the past 60 years, the demand for natural resources (water, minerals, fossil energy, etc.) has reasonably been augmented (Polat et al., 2018). During the construction and usage of buildings, there is a significant need for energy and water and huge amounts of solid waste are generated, contributing to global warming and to the reduction of Earth's biocapacity (Obata, Agostinho and Gianetti, 2019).

According to the Brundtland report, the concept of sustainability is described as supplying the necessities of today, without jeopardising the necessities of next generations (Yilmaz and Bakis, 2015). It is not clear what necessities will exist in the future (Werkheiser and Piso, 2015), although this concept can be applied to the civil engineering short term context by assuming that constructions will be similar to modern ones and that research for new technologies is vital for this sector.

Another definition of sustainability is the model based on three pillars – economy, society and environment (Awadh, 2017; Werkheiser and Piso, 2015). The Figure 2.1 shows this concept applied to a Venn diagram, from where it is possible to conclude that sustainability happens when all the three pillars overlap (Werkheiser and Piso, 2015).

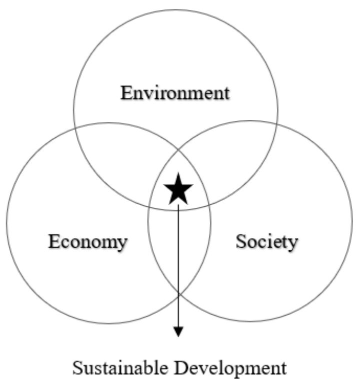

Figure 2.1 : Triple bottom line of sustainable development (Parkin, Sommer and Uren, 2003).

Following the previous definitions, it is possible to highlight some well-known topics for a more sustainable construction market, such as energy and water saving during a building's life cycle; use of renewable energy sources, such as wind and solar power; research for sustainable construction materials and waste reuse and recycling; creation of standards for sustainable buildings.

Wang, Wei and Sun (2014) state that both in developed countries and in developing countries, broad amounts of materials and energy are consumed by civil engineering projects. The market around the sector affects a nation's economy, society and environment. In response to the modern sustainable demands, the construction sector as a whole has engaged in changing its industry into a more eco-friendly one. Building regulations are strengthened in many countries to solve sustainability issues and bringing as revenue economic advantages, energy saving, and environmental conservation.

Sustainable construction has increasingly grown because of the public and private awareness of climate change and new regulations in the construction sector (Wang, Wei and Sun, 2014). In the European Union (EU), buildings consume 40% of energy as reported by Directive 2010/31/EU of the European Parliament and Council. Castro-Lacouture et al. (2009), Dwaikat and Ali (2016) state that approximately 30% of the greenhouse gas generation, nearly 60% of electricity and almost 15% drinking water usage are caused by buildings, which were constructed by sticking to traditional methods (as cited in Polat et al., 2018). Nowadays, decreasing the energy consumption and increasing the use of energy from renewable sources is necessary (Gurgun et al., 2016).

Kim and Haapio states that in the 1970s in order to create and build sustainable buildings, the idea of "green building" was acquired (as cited in Komurlu, Arditi, Gurgun, 2014). In this century, the concept of green building has evolved into a forefront of sustainable development which answers for adjusting long-term economic, environmental and social health (Qaemi and Heravi, 2012).

2.2 Definition of Green Building

Qaemi and Heravi (2012) say that in the 1960s, Paolo Soleri announced that green building ideology stemmed from "Arcology", which is a mixture of architecture and ecology (as cited in He et al., 2018). Zheng, et al. (2012) and Polat et al. (2018) say that the concept of green building is serving areas in good condition to the inhabitants. Besides realizing effective usage of resources and energy during their life cycle, green buildings should damage the environment at minimum levels (as cited in He et al., 2018). Dwaikat and Ali (2016) say that green buildings consume natural and non-waste materials, and use non-renewable resources as low as possible during their lifecycle.

In addition to the features above and according to the World Green Building Council (2019), a green building has to: use materials that are non-toxic, ethical and sustainable; apply pollution and waste reduction measures and the enabling of re-use and recycling; have a design that enables adaptation to a changing environment (URL-1).

There is a particular type of green building called the net zero buildings or zero energy buildings. These buildings produce their own energy on site from renewable sources and the energy generated is enough to attend the building's needs throughout the year (Sharma, 2018). Amongst modern building applications, energy efficient and net zero energy buildings are rapidly becoming popular (Zheng, et al., 2012).

Whereafter the negative effects of the construction industry on the environment are understood, the green building idea is naturally popularized all around the world (Ding et al., 2018). To determine if a building can be considered green, the certification systems were created. Green buildings are certified by the green building certification systems in numerous countries (Gurgun et al., 2016).

Nguyen and Altan defined Green Building Rating Systems (GBRS) as a tool that the construction sector utilizes to assess, improve and/or encourage developments in sustainability (as cited in Awadh, 2017). They aim to enable the following:

- Improve building's functional performance,
- Decrease environmental effects,
- Measure buildings' impacts on the environment,
- Equitably, assess and criticize buildings' development

Today, the idea of green building is a requirement, not an option. In Turkey, LEED makes extensive use of green building certification system field (Polat et al., 2018).

2.3 Certification Systems

Around the world ever since the early 90s, many countries developed their own building evaluation systems according to their legal, economic, and geographical conditions. Among these evaluation systems, the most developed ones are BREEAM and LEED (Diker, 2016).

2.3.1 LEED

Wang, Wei and Sun (2014) say that in 1994, LEED was introduced by the United States Green Building Council (as cited in Ding et al., 2018). Among the whole worldwide GBRS, LEED is the most extensively utilized one. Around the world, more than 150 countries recognize LEED, and on a daily basis 1.72 square meters of construction area are validated using it. In addition, vis-a-vis all GBRS in the world, LEED is recognized as the most prominent and ideal rating system (Ding et al., 2018).

Within the last ten years in Turkey, the amount of green buildings and the need for them have significantly risen, same as other developing countries (URL-7). In Turkey, LEED has an extensive use in green building certification system field. The Top 10 Countries for LEED except the U.S., where LEED was founded, were released by USGBC (Turkoglu, Polat and Damci, 2019). They are respectively listed in Table 2.1.

Since 1994, LEED was improved and had many versions, the latest one is v4. Until now LEED v4 has less projects than LEED v3 (2009). This situation is explained by Polat et al. (2018) as LEED v4 was initiated in 2013 nevertheless LEED v3 existed until October 2016.

Table 2.1 : Top 10 countries and regions list for LEED.

Ranking	Country/Region	Gross Square Meters (millions)
1	Mainland China	68.83
2	Canada	46.81
3	India	24.81
4	Brazil	16.74
5	Republic of Korea	12.15
6	Turkey	10.90

Table 2.1 (continued) : Top 10 countries and regions list for LEED.

Ranking	Country/Region	Gross Square Meters (millions)
7	Germany	8.47
8	Mexico	8.41
9	China, Taiwan	7.30
10	Spain	5.81

In order to have a better assessment for each type of building with respect to its characteristics, LEED split all of them into five main categories in v4. These building rating systems are listed as follows:

- LEED BD+C: The LEED for Building Design and Construction Rating System is used for extensive renovations in existing building or buildings which are going to be constructed.
- LEED Homes: The LEED for Homes Rating System helps the sustainable design and construction of family homes between one and eight stories.
- LEED O+M: The LEED for Building Operations and Maintenance Rating System has the objective of improve the sustainability in old buildings and building operations.
- LEED ID+C: The LEED for Interior Design and Construction Rating System has the objective of promoting the development of sustainable indoor spaces when the general building's project does not attend the LEED standard. Owners of companies working in the service industry such as hotels, inns and stores can find a great use for this rating system.
- LEED ND: The LEED for Neighborhood Development Rating System introduces an innovative standard for sustainable neighborhood design. This rating system was created to promote between the urban developers the ideas of smart growth, mobility and green buildings. Some improvements that are expected from neighborhoods following the LEED ND are: more efficient use of water and energy; waste treatment and optimized transport systems. Overall,

the LEED ND aims to enhance the quality of life of communities while preserving the environment.

In v2009, each building type has its own evaluation criteria and it is seen that in v4 they are grouped. Comparison between v2009 and v4 is listed in Figure 2.2.

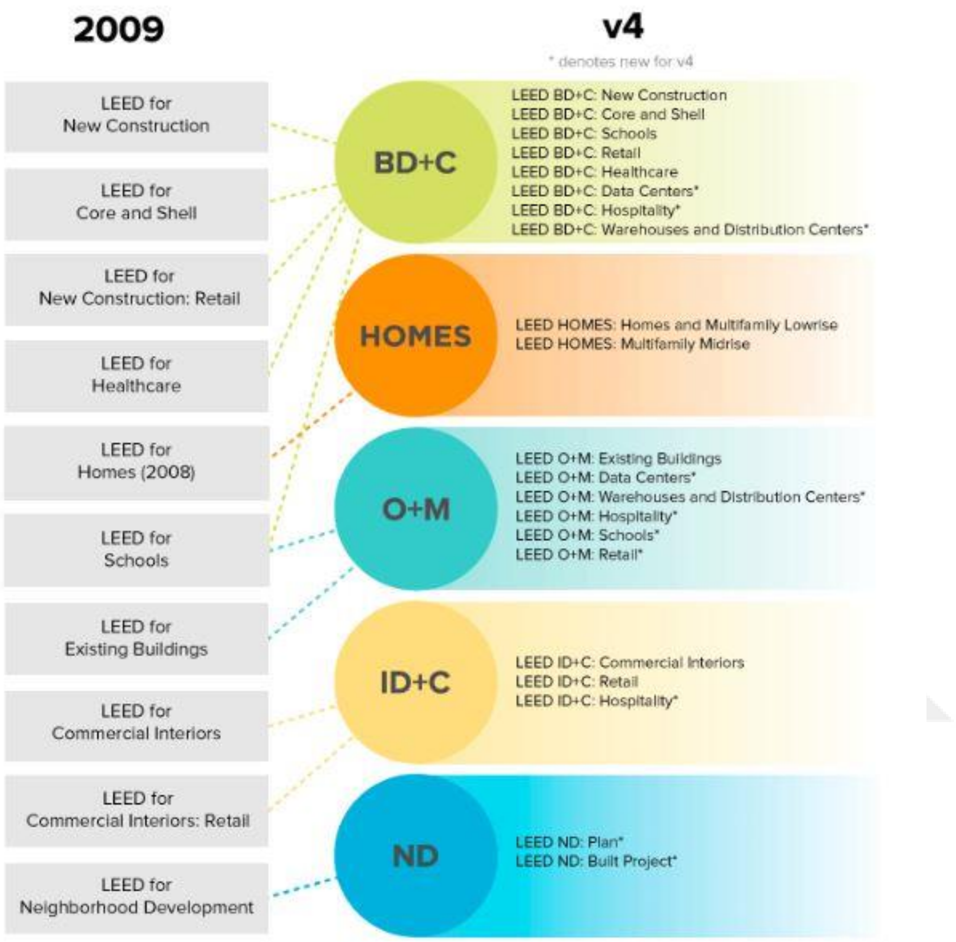

Figure 2.2 : Comparison of v2009 and v4 in terms of different rating systems (URL-8).

Energy and Atmosphere credit category obtains the maximum credits in LEED (Gurgun et al., 2016). The biggest section of the maximum achievable credits in LEED for New Construction in v3 belongs to energy and atmosphere credit category which amounts to roughly 32% of the total credits (Gurgun et al., 2016). There are four certification levels in LEED, it is listed in Table 2.2.

Table 2.2 : Certification levels of LEED (Gurgun et al., 2016).

Total Credits	Certification Levels	Certificate
40-49	Certified	
50-59	Silver	
60-79	Gold	
80-110	Platinum	

According to LEED official webpage, the LEED projects, which are based in Turkey, have high credit achievements in sustainable sites, water efficiency, innovation in design, and regional priority in spite of that have low credit achievements in energy and atmosphere, materials and resources, and indoor environmental quality (Polat et al., 2018).

Energy and atmosphere credit category in LEED certification system corresponds to 32% of the credits that a building can gain (Komurlu, Arditi and Gurgun, 2014).

2.3.2 BREEAM

BREEAM was developed to assess effects of a building on environment and economy and thus to reduce those effects, it is established in 1990 by Building Research Establishment (BRE) in the United Kingdom. Since then, it was improved and became very extensive and detailed method. According to BREEAM, there are 10 major topics to assess, they are listed as the following (URL-2):

1. Energy
2. Health and Wellbeing

3. Innovation

4. Land Use

5. Materials

6. Management

7. Pollution

8. Transport

9. Waste

10. Water

BREEAM has different evaluation criteria for communities, infrastructure, new construction, in-use, refurbishment & fit-out. There are five certification levels in BREEAM, it is listed in Table 2.3.

Table 2.3 : Certification levels of BREEAM (URL-2).

Total Credits	Certification Levels
30-44	Certified
45-54	Good
55-69	Very Good
70-84	Excellent
85 ≤	Outstanding

2.3.3 B.E.S.T Residence Certificate

In many papers, the importance and need for a national green building evaluation system according to the local parameters for Turkey are mentioned. Since 2000s, under the leadership of ministry and local municipalities the legal basis was started to be prepared. On the other hand, a number of independent association endorsed the efforts (Diker, 2016).

As environmental buildings become popular in Turkey, government-sponsored and independent establishments expedited their studies. Through examining the green building certification systems particularly United States of America and United Kingdom, finding unique criteria for Turkey is aimed (Diker, 2016).

Turkish Green Building Council (TGBC) was founded in order to contribute to the development of Turkey's construction sector in consideration of sustainability. TGBC aimed to establish a national green building certification system. The B.E.S.T Certificate System was created, thereby taking opinions from many academic institutions, academicians, professional chambers and non-governmental organizations. B.E.S.T Certification System was prepared based on the American green building certification system LEED, the U.K.'s green building certification system Building Research Establishment Assessment Method (BREEAM) and Germany's green building certification system German Sustainable Building Council (DGNB) (Diker, 2016).

Since all the green building certification systems were established, in each version they become more similar in terms of logic. Many countries developed their own rating systems based on LEED and BREEAM. In Turkey, TGBC took the lead by developing Turkey's individual rating system since 2007. For the first time, B.E.S.T Residence Certificate was presented in 2nd International Green Building Summit, 2013 (Aslan, 2015). B.E.S.T Residence Certificate was developed based on foundation members' guidance and international GBRS such as LEED, BREEAM, DGNB. This certification embraces five major life cycle phases: Planning, design, construction, operation and demolition. B.E.S.T Residence Certificate assesses 9 main topics as following:

1. Integrated Green Project Management
2. Land Use
3. Water Usage
4. Energy Usage
5. Health and Comfort
6. Material and Resources Usage
7. Residential Life
8. Operations and Maintenance
9. Innovations

Detailed assessment credits of B.E.S.T Residence Certificate are listed in Table 2.4.

Table 2.4 : Detailed evaluation criteria of B.E.S.T Residence Certificate.

Evaluation Criteria	Achievable Credits	Design	Construction
1. Integrated Green Project Management	9	6	3
Prerequisite-Integrated Design	Prerequisite	Prerequisite	Prerequisite
1.1 Integrated Design	1-2	2	-
1.2 Environmentally Conscious Contractor	2	1	1
1.3 Construction Waste Management	3	2	1
1.4 Noise Pollution	2	1	1
2. Land Use	13	8	5
2.1 Land Settlement	1-3	3	-
2.2 Disaster Risk	3	2	1
2.3 Population-Residential Type Relation	2	1	1
2.4 Reuse of Land	3	1	2
2.5 Accessibility to Urban Equipment	2	1	1
3. Water Usage	12	9	3
Prerequisite-Reduction of Water Usage	Prerequisite	Prerequisite	Prerequisite
3.1 Reduction of Water Usage	1-6	6	-
3.2 Prevention of Water Loss	2	1	1
3.3 Wastewater Treatment and Recycling	1-2	1	1
3.4 Surface Water Flow	2	1	1
4. Energy Usage	26	19	7
Prerequisite 1 – Control, Commisioning, Acceptance	Prerequisite	Prerequisite	Prerequisite
Prerequisite 2 – Energy Efficiency	Prerequisite	Prerequisite	Prerequisite
4.1 Energy Efficiency	1-15	15	-
4.2 Renewable Energy Usage	1-7	2	5
4.3 Exterior Lighting	1	1	-
4.4 Energy Efficient White Goods	1	-	1
4.5 Elevators	2	1	1
5. Health and Comfort	12	7	5
5.1 Thermal Comfort	3	3	-
5.2 Daylight Utilization	1-2	2	-
5.3 Fresh Air	3	1	2
5.4 Control of Pollutants	2	-	2
5.5 Acoustic Comfort	2	1	1
6. Material and Resources Usage	15	-	15
6.1 Environmentally Friendly Materials	3	-	3
6.2 Reuse of Existing Building Materials	1-3	-	3
6.3 Reuse of Material	1-3	-	3
6.4 Use of Local Materials	2-4	-	4
6.5 Durable Materials	1-2	-	2
7. Residential Life	14	1	13
7.1 Universal and Inclusive Design	1-2	-	2

Table 2.4 (continued) : Detailed evaluation criteria of B.E.S.T Residence Certificate.

Evaluation Criteria	Achievable Credits	Design	Construction
7.2 Security	1-2	1	1
7.3 Sports and Rest Areas	2	-	2
7.4 Art	1	-	1
7.5 Transportation	3	-	3
7.6 Car Parking Area	2	-	2
7.7 Home Office	2	-	2
8. Operations and Maintenance	7	1	6
8.1 Waste Sorting and User Access	3	1	2
8.2 Waste Technologies	1	-	1
8.3 Building and Maintenance Manual	1	-	1
8.4 Monitoring of Consumption Values	2	-	2
9. Innovations	2	2	-
9.1 Innovations	2	2	-
TOTAL	110	53	57

B.E.S.T Residence Certificate's levels are listed in Table 2.5.

Table 2.5 : Certification levels of B.E.S.T Residence Certificate (ÇEDBİK, 2018).

Total Credits	Certification Levels
45-64	Certified
65-79	Good
80-99	Very Good
100-110	Excellent

2.4 Comparison of Green Building Rating Systems

The most common GBRS in the world are BREEAM, which emerged in the United Kingdom in 1990, and LEED that appeared in the United States in 1998. Although the common goal of GBRS is parallel to each other, each system has its own methods. In addition to carrying a common purpose, the evaluation of the LEED or BREEAM GBRS for the same building, due to the different calculation systems, gives different results (Sermet and Ozyavuz, 2017). For example, LEED directly aims to calculate the building's energy expenditure potential in energy saving, while BREEAM links this to CO2 emissions (Akca, 2011).

The aim of these two systems is to ensure that people avoid product and practices that will adversely affect the lives of future generations while trying to increase their welfare levels. The buildings are evaluated with the green building criteria to ensure that they rise above the international and local standards by rewarding the structures that accomplish this. However, it is wrong to consider these certificates only for buildings. The main aim is to encourage manufacturers to develop environmentally sensitive products and to contribute to sustainability, starting with buildings (Sermet and Ozyavuz, 2017).

The main differences when examined in terms of general characteristics are summarized in Table 2.6.

Table 2.6 : General characteristics of three GBRS (Ding et al., 2018).

Description	LEED	BREEAM	B.E.S.T. Residence Certificate
Parent Organization	United States Green Building Council	Building Research Establishment	Turkish Green Building Council
Type of Ratings	• LEED Certified • LEED Silver • LEED Gold • LEED Platinum	• Pass • Good • Very Good • Excellent • Outstanding	• Certified • Good • Very Good • Excellent
Type of schemes available (latest in use)	LEED Version 4 • Building Design and Construction (BD+C) • Interior Design and Construction (ID+C) • Building Operations and Maintenance (O+M) • Neighborhood Development (ND)	BREEAM International • BREEAM International New Construction (NC) • BREEAM International Refurbishment & Fit-Out • BREEAM In-Use International • BREEAM Communitites Bespoke International	B.E.S.T. Residential Certification

Table 2.6 (continued) : General characteristics of three GBRS (Ding et al., 2018).

Description	LEED	BREEAM	B.E.S.T. Residence Certificate
	• Homes		
Widely used scheme	Building Design and Construction (BD+C)	BREEAM International New Construction (NC)	B.E.S.T. Residential Certification
Main credit categories Operational schemes	• Location and transport	• Management	• Integrated green project management
	• Sustainable sites	• Health and wellbeing	• Land use
	• Water efficiency	• Energy	• Water usage
	• Energy and atmosphere	• Transport	• Energy usage
	• Material and resources	• Water	• Health and comfort
	• Indoor environmental quality	• Material	• Material and resources usage
	• Regional priority	• Waste	• Residential life
	• Innovation	• Land use and ecology	• Operations and maintenance
		• Pollution	• Innovations
		• Innovation	

In our current period, the demand for green buildings, especially commercial and industrial buildings, is much higher than other building types. Our country does not yet have a local certificate that will guide every type of green building because of this LEED is the most preferred green building certification system in Turkey (Donmez, 2018).

3. METHODOLOGY

The main objectives of this thesis are to determine motivators to invest in green building, determine why green buildings get low credits in certification systems (especially in the EA category), and also to determine the motivators in order to achieve higher credits in the EA category. To gather the required data about the motivators and the barriers of green building and EA category, a questionnaire is designed and applied. Based on the literature review, data is obtained, and after reviewing with the thesis advisor, a final form of the questionnaire is decided upon.

3.1 Hypothesis Testing

In order to reach statistical decision by utilizing experimental data, a statistical procedure, called hypothesis testing, is used (URL-3). The data is evaluated through use of an inferential statistical test, resulting in a test statistic. The aim of hypothesis testing is to analyze the test statistic of a study to understand whether there are significant outcomes or not (i.e. if the results are statistically significant or not) (URL-4).

An inferential statistical test is a sequence of mathematical operations that is applied to the data and will yield a final value or a test statistic (Sheskin, 2003). The inferential statistical tests are divided into two distinct categories which can be listed as parametric and nonparametric, depending on the type of data available.

3.1.1 Parametric tests

Parametric tests are those used when specific assumptions are made about the population from which the sample was taken for the research. The inferential statistical tests in this category evaluate interval data or ratio data. Some examples of parametric tests can be listed as the following: independent sample t test; paired samples t test; one way analysis of variance (ANOVA); one way repeated measures analysis of variance (Sheskin, 2003).

3.1.2 Non-parametric tests

Following the definition for the parametric tests, the non-parametric tests are those used when there are no specific assumptions made about the population parameter. However, according to Sheskin (2003) nonparametric tests are not completely assumption free. Some examples of non-parametric tests can be listed as follows: Mann-Whitney test; Wilcoxon signed rank test; Kruskal Wallis test; Friedman's ANOVA.

Kurtz and Mayo (1979), point out that nonparametric tests are easier to apply and fewer assumptions are necessary. On the other hand, they have the disadvantage of discarding some of the information available in the data. Sheskin (2003) concludes the dilemma of using a parametric or a nonparametric test in most cases, because they analyze the same data and the final results are the same. For this project, three nonparametric tests are chosen, Mann-Whitney U, Kruskal Wallis and Wilcoxon signed rank test.

3.1.2.1 Mann-Whitney U test

Mann and Whitney established this test for examining probabilistic equality in 1947. Despite this, in practice, to understand whether there are differences in distributions of two groups or differences in locations of two groups, the Mann-Whitney U test is more widely utilized. The Mann-Whitney U test is utilized to find out whether there are differences in distributions of two groups when two distributions are different shapes; still the same test is utilized to find out whether there are differences in the medians of two groups, when the two distributions are the same shape (URL-5).

If the p-value is smaller than 0.05, which has the same meaning as the outcome of the test is meaningful, there is a statistically meaningful variation between two-sample medians (Chan et al., 2011).

In this thesis, Mann-Whitney U test is conducted in multiple sections, at first to determine whether there is a statistically significant difference in credit achievements of buildings certified according two different certification levels; secondly it is conducted to understand whether there is a statistically meaningful difference in Energy and Atmosphere credit achievements of buildings certified according to two different certification levels; and finally it is applied to the results of the questionnaire survey in order to see the difference in respondents’ answers.

3.1.2.2 Kruskal Wallis test

To contrast more than two samples which are independent or relevant, the Kruskal Wallis H test is used as a nonparametric statistical practice. If the Kruskal Wallis test results in meaningful outcomes, it determines that at least one of the samples is more diverse than the others. Still, how many variation(s) and where the variation(s) arise, the Kruskal Wallis test cannot determine, it merely indicates the presence of the variation. To analyze the distinct variations between the sample pairs, sample contrasts, or post hoc tests should be applied. One of the convenient practices for conducting sample contrasts between individual sample sets is Mann-Whitney U test (Nodoushan, 2012 and Corder and Foreman, 2014).

In this thesis the Kruskal Wallis test is used two times, at first time in order to determine whether there are statistically meaningful variations between the credit achievements of newly constructed buildings in Turkey which were certified according to four different levels, and secondly it is conducted for determining whether there are statistically meaningful variations between the EA credit achievements of newly constructed buildings in Turkey depending on four different levels of certification.

If the p values are less than 0.05, it indicates that there is a statistically significant difference in the credit achievements of buildings certified according to different certification levels at 95% significance level.

3.1.2.3 Wilcoxon signed rank test

The Wilcoxon signed rank test is a nonparametric statistic test used to evaluate a hypothesis and it can be applied for paired and unpaired data (Woolson, 2008). As put by Wilcoxon (1945), the objective of the test is to have a rapid approximate idea of the significance of the experiment.

The application of the test follows the five steps procedure described by Whitley and Ball (2002):

1- State the null hypothesis and the hypothesized value for comparison
2- Rank all observations in increasing order of magnitude, ignoring their sign. Ignore any observations that are equal to the hypothesized value. If two observations have the same magnitude they are given an average ranking
3- Allocate a sign (+ or –) to each observation according to whether it is greater or less than the hypothesized value
4- Calculate: R+ = sum of all positive ranks; R– = sum of all negative ranks; R = smaller of R+ and R–
5- Using the standard tables for nonparametric tests, calculate the probability (P) of the hypothesis being true or false

In this thesis it is used to understand whether respondents' answers for questionnaire survey's factors are different than 4.5 or not.

3.2 Cronbach's Alpha

Cronbach's alpha is used to test the internal consistency of factors of the questionnaire survey.

As stated in Cronbach (1951), every research based on a measurement have to be concerned about the accuracy of the results yielded from its survey. Cortina (1993) shows that the Cronbach's alpha is one the most important and cited statistics test to determine the reliability of measurement instruments. Cronbach (1951) developed the alpha making a generalization from the Kuder-Richardson Formula 20 with the idea of simplifying the process of having a reliability coefficient.

The Cronbach's alpha is given in Equation 3.1 (Carmines and Zeller, 1979):

$$\boldsymbol{\alpha = N/(N-1)[1-\frac{\Sigma\sigma^2(Y_i)}{\sigma_x^2}]} \quad (3.1)$$

- N is the number of items
- $\Sigma\sigma^2(Y_i)$ is the sum of item variances
- σ_x^2 is the variance of the total composite

The alpha value vary from 0 to 1. The relationship between the Cronbach's alpha value and internal consistency is given in Table 3.1.

Table 3.1 : The relationship between the Cronbach's alpha value and internal consistency (Polat et al., 2017).

Cronbach's alpha (α)	Internal Consistency
$0.9 \leq \alpha$	Excellent
$0.8 < \alpha < 0.9$	Good
$0.7 < \alpha \leq 0.8$	Acceptable
$0.6 < \alpha \leq 0.7$	Questionable
$0.5 < \alpha \leq 0.6$	Poor
$\alpha \leq 0.5$	Unacceptable

3.3 Relative Importance Index

The relative weight, or relative importance, is calculated by the following formula:

$$RII = \frac{\sum_{i=1}^{a} w_i x \left(\frac{f_i}{n}\right)}{a} \tag{3.2}$$

- i is the point given to each factor by the respondent
- a is the highest point of the scale
- f_i is the frequency of the point i by all respondents
- n is the total number of respondents

RII value can vary from 0 to 1. The relationship between the RII values and importance levels are shown in Table 3.2 (Polat et al, 2017).

Table 3.2 : The relationship between the RII values and importance levels (Polat et al., 2017).

RII values	Importance Level
$0.8 \leq RII \leq 1.0$	High
$0.6 < RII \leq 0.8$	High-Medium
$0.4 < RII \leq 0.6$	Medium
$0.2 < RII \leq 0.4$	Medium-Low
$0.0 \leq RII \leq 0.2$	Low

RII is used in this thesis to show the importance priorities between questionnaire survey's factors.

3.4 Questionnaire Survey

Questionnaire survey is a basic way for gathering data and for this thesis, a questionnaire survey is chosen as a data collection method. In opinion based researches, questionnaires are the most used method, since it was presented by an English polymath Sir Francis Galton. The Likert scale is used to show respondents' opinion. The scale included the responses, "Very Important", "Important", "Reasonably Important", "Low Important", "Very Low Important" and "Not Important". In the following sections this thesis's questionnaire details are shared (Serpel, 2016).

3.4.1 Survey objectives

By reason of asking the questions to the respondents based on their professional experiences at green building and LEED areas, a questionnaire survey is designed. This thesis's questionnaire survey aims to gather data about the motivators and barriers for green buildings and Energy and Atmosphere category of LEED based on the respondents' background. This survey is used to find out the actions to be taken for better credit achievements in Energy and Atmosphere category.

3.4.2 Population and sample

The target population of this thesis's questionnaire is the technical personnel who had experience in green building sector. Target population was not narrowed by defining the occupation, age, work location, profession or by the capital of the company.

The survey is restricted with only Turkish engineers and architects who work at green building sector, so the outcome is expected to demonstrate the necessary actions to be taken for better credit achievements in Energy and Atmosphere category in Turkey.

Through LEED consulting websites, websites of the companies which have realized green building projects and the social network website for professionals, the target population was reached.

3.4.3 Data collection

Data collection method of the research is based on online form of questionnaire. The respondents were informed with a prepared email text and questionnaire link was added into this email. Phone calls, face to face interviews and emails could be alternative ways of implementing data collection through the questionnaire (Ektesaby, 2018). This research is conducted via Google Forms, in Turkish. Advantage of a web-based survey is that the respondents can complete the survey at their convenience.

3.4.4 Questionnaire design

Questionnaire design of this thesis is realized with regard to Serkan and Bougie's three criteria (2010). According to Serkan and Bougie, the way of expressing the thoughts in a questionnaire has to be direct instead of complicated, the construction of the question should be minded because it affects the length and the type of the questions and finally the presence and general plan of the questionnaire should be meaningful. By taking these criteria into consideration, the design of questionnaire of the motivators and barriers for green buildings and EA category is prepared.

3.4.4.1 Questionnaire structure

The questionnaire contains five sections. In the first section, there is a text which includes the main objectives of the thesis, the aim of data collection, and a pledge of secrecy. Email addresses were asked from the respondents in order to prevent multiple responses.

In the second section, demographic information of the respondent was asked. Under this section, seven questions were asked. As seen in the questionnaire survey, which could be found under Appendix-A, the first question was the level of education of the respondents. The second one was the profession of the respondents, which was followed by the type of the company that is worked for such as owner, contractor, designer, etc. First two questions were asked in multiple choice format but third question was asked in check boxes format. The fourth, fifth and sixth questions were respectively: the number of the green building projects that respondent worked, type of these green building projects such as industrial plant, residence, commercial buildings, etc. and certification levels of these projects according to the LEED certification system. The format of fourth question was multiple choice, the format of fifth question was checkboxes but also respondents could add other options, the format of sixth question was checkboxes. The last question of this section ways of getting know-how about green buildings. For this question, options were listed in checkbox format but if respondents had any other way, they could add these different ways of learning.

In the third section of the survey, respondents were asked their judgment regarding factors/motivators affecting the prevalence of green building concept in Turkey.

In the fourth section of the survey, respondents were asked their judgment regarding factors/motivators affecting achievement of Energy and Atmosphere category of LEED in Turkey.

In the fifth section of the survey, respondents were asked their judgment with regards to barriers affecting prevalence of green building concept and achievement of Energy and Atmosphere category of LEED in Turkey.

In third, fourth and fifth sections, evaluations of the participants were asked in accordance with the Likert type ranking scale. There is one main question for each section and under these sections there are different factors to be evaluated. Also, at the end of each section, in order to gather different factors from the experienced respondents, a comment box was added.

4. EVALUATION OF CREDIT ACHIEVEMENTS OF LEED-CERTIFIED BUILDINGS OF TURKEY

In Turkey, LEED is the most popular green building certification system (Polat et al., 2018). According to LEED's official website, there are 366 certified projects by LEED (URL-6). Also, there are 458 projects registered in LEED's website that are waiting to be certified. On the other hand, BREEAM which is the closest one to the number of LEED certified projects, has around 50 certified projects in Turkey (URL-9). Due to this immense difference in the numbers of the certified projects, in this thesis, LEED is chosen as the certification system.

USGBC introduced LEED in 1998 (U.S. Green Building Council, 2016). In this thesis, all LEED scores of the buildings were downloaded from USGBC's official website. As it is mentioned in Section 2.3.1., LEED has different rating systems which are prepared for different type of buildings. LEED is providing rating systems for new or existing residential, commercial, and institutional buildings (U.S. Green Building Council, 2016).

Table 4.1 shows 366 certified LEED projects' version based distribution list.

Table 4.1 : LEED project's distribution in terms of version.

Version	Number of Projects
v2.0	4
v2.2	3
v2008	32
v2009	290
v4.0	37

In addition, LEED also has different versions however comparing different versions or rating systems is not meaningful, since different rating systems and versions have different assessment criteria and maximum achievable credits. To see the differences between versions and rating systems, some of different versions and rating systems' maximum achievable credits are shown in Table 4.2.

Table 4.2 : Differences between different versions and rating systems.

Versions and Rating Systems	Credits											
	SS	WE	EA	MR	IEQ	ID	RP	Smart Location and Linkage	Neighborhood Pattern and Design	Green Infrastructure and Buildings	Location and Transportation	Integrative Process
v2009 Commercial Interiors	21	11	37	14	17	6	4	N/A	N/A	N/A	N/A	N/A
v2009 Core and Shell	28	10	37	13	12	6	4	N/A	N/A	N/A	N/A	N/A
v2009 Data Centers-New Construction	26	10	35	14	15	6	4	N/A	N/A	N/A	N/A	N/A
v2009 Existing Buildings	26	14	35	10	15	6	4	N/A	N/A	N/A	N/A	N/A
v2009 Healthcare	18	9	39	16	18	6	4	N/A	N/A	N/A	N/A	N/A
v2009 Neighborhood Development Plan	N/A	N/A	N/A	N/A	N/A	6	4	27	44	29	N/A	N/A
v2009 New Construction	26	10	35	14	15	6	4	N/A	N/A	N/A	N/A	N/A
v2009 Retail-Commercial Interiors	21	11	37	14	17	6	4	N/A	N/A	N/A	N/A	N/A
v2009 Retail-New Construction	26	10	35	14	15	6	4	N/A	N/A	N/A	N/A	N/A
v2009-Schools-New Construction	24	11	33	13	19	6	4	N/A	N/A	N/A	N/A	N/A
v4-New Construction	10	11	33	13	13	6	4	N/A	N/A	N/A	32	1
v4-Core and Shell	11	11	33	14	10	6	4	N/A	N/A	N/A	40	1
v4-Commercial Interiors	N/A	12	38	14	17	6	4	N/A	N/A	N/A	36	2
v4-Healthcare	9	11	35	19	16	6	4	N/A	N/A	N/A	18	1

The reason of the difference between v2009 and v4 is their effective time interval: v4 started to be used in 2013 whereas v2009 was still in effect until October 2016 (Polat et al., 2018).

In Table 4.3, distribution of rating systems of all certified buildings is listed.

Table 4.3 : Distribution of rating systems of all LEED-certified buildings.

Rating System	Number of Projects
Commercial Interiors	28
Core and Shell	67
Data Centers - New Construction	1
Existing Buildings	20
Healthcare	7
Homes	33
Neighborhood Development Plan	1
New Construction	195
Retail - Commercial Interiors	7
Retail - New Construction	1
Schools - New Construction	6

Table 4.3 indicates that New Construction rating system has the maximum number of projects compared to other rating systems, therefore New Construction rating system's breakdown by versions has to be examined as well. In Table 4.4, distribution of versions of New Construction rating system is listed.

Table 4.4 : Distribution of versions of New Construction Rating System.

Versions	Number of New Construction Projects
v2.2	3
v2009	172
v4.0	20

Based on the analysis, the projects certified as New Construction v2009 are chosen as the thesis's data set. To discover whether there are statistically notable differences between the credit achievements of newly constructed buildings in Turkey, Kruskal-Wallis and Mann-Whitney U tests are performed and findings are interpreted. Similarly, to find out improvable credit achievements, statistical data analysis is performed. Average values, standard deviations, percentage of credit achievements, and the number of projects for each certification level are presented in Table 4.5.

Table 4.5 : Descriptive statistics of LEED-certified newly constructed buildings.

Credits and Max. Achievable Points	Certification Level and Number of Buildings											
	Certified (10)			*Silver (36)*			*Gold (111)*			*Platinum (15)*		
	Ave.	Std. Dev.	Ach. %	Ave.	Std. Dev.	Ach. %	Ave.	Std. Dev.	Ach. %	Ave.	Std. Dev.	Ach. %
SS (26)	15.11	2.95	58.11	17.98	2.58	69.17	18.58	3.10	71.46	19.47	3.27	74.87
WE (10)	4.60	2.63	46.00	5.75	2.47	57.50	8.18	1.90	81.80	9.27	0.96	92.67
EA (35)	8.40	2.76	24.00	10.15	3.22	29.21	14.29	4.83	40.82	25.76	7.91	73.60
MR (14)	4.40	1.26	31.43	4.83	1.50	34.52	5.70	1.16	40.73	6.20	1.15	44.29
IEQ (15)	4.62	1.98	30.78	5.69	2.10	37.96	7.41	2.38	49.39	9.87	2.68	65.78
ID (6)	3.10	1.20	51.67	4.61	1.13	76.85	5.00	0.99	83.33	5.47	0.64	91.11
RP (4)	2.60	0.70	65.00	2.47	0.94	61.81	3.50	0.70	87.61	3.93	0.70	98.33

The comparison of the percentages of credit achievements of 172 green buildings with respect to different certification levels is shown in Figure 4.1.

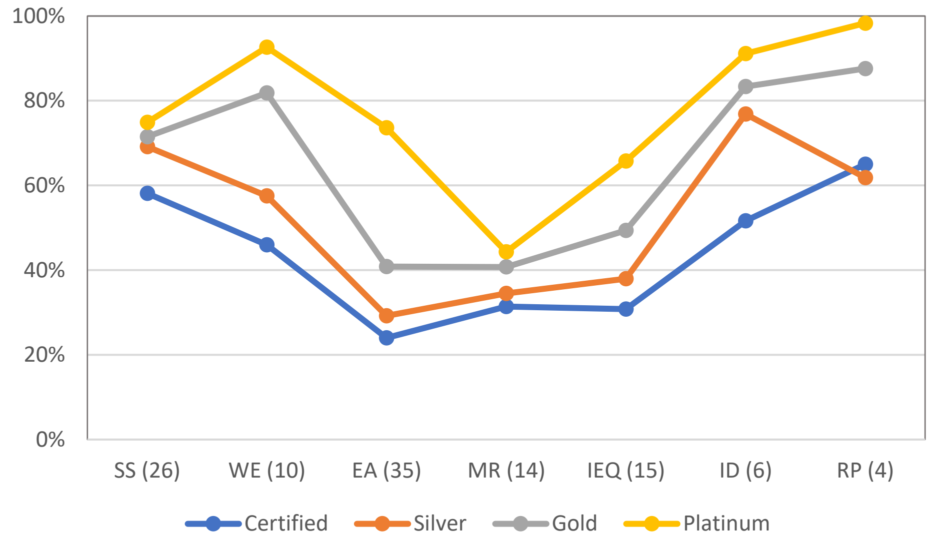

Figure 4.1 : Comparison of Percentages of Credit Achievements of LEED-NC 2009 Certified Buildings.

According to Figure 4.1, lowest percentages of credit achievements belong to Energy&Atmosphere (EA), Material and Resources (MR), Indoor Environmental Quality (IEQ). On the other hand, the most improvable area is EA, the difference between gold and platinum is around 23% and EA category has the highest achievable credits with 35 out of 110.

Another interpreted test within this study is Kruskal-Wallis. The test is applied in order to reveal statistically significant differences between the credit achievements of newly constructed buildings in Turkey, which were certified according to four different levels. For this aim, Kruskal-Wallis test was realized through Stat Tools v 7.5 software. The *p* values obtained from the Kruskal-Wallis test are presented in Table 4.6. If the *p* values are less than 0.05, it indicates that there is a statistically significant difference in credit achievements of buildings certified according to different certification levels at 95% significance level.

Table 4.6 : Kruskal-Wallis Test *p* Values of Credits.

Credit Categories	Kruskal -Wallis Test ***p*** Value
Sustainable Sites	**0.0033***
Water Efficiency	**0.0001***
Energy and Atmosphere	**0.0001***
Material and Resources	**0.0001***
Indoor Environmental Quality	**0.0001***
Innovation in Design	**0.0001***
Regional Priority	**0.0001***

As it is showed in Table 4.6, *p* values are less than 0.05 for each credit. This means that the credit achievements of buildings certified according to four certification levels are statistically significant different at 95% significance level. After Kruskal-Wallis test, Mann-Whitney U test was conducted to demonstrate the significance of differences between two different certification level. If the *p* values are less than 0.05, it indicates that there is a statistically significant difference in credit achievements of buildings certified according to two certification levels at 95% significance level. The *p* values obtained from the Mann-Whitney U test are presented in Table 4.7.

Table 4.7 : Mann-Whitney U test *p* values of credit categories.

Credit Categories	Certification Level	Mann-Whitney U Test *p* Values			
		Certified	Silver	Gold	Platinum
Sustainable Sites (SS)	Certified	-	**0.0093***	**0.0009***	**0.0041***
	Silver		-	0.1493	0.1549
	Gold			-	0.3937
	Platinum				-
Water Efficiency (WE)	Certified	-	0.4229	**0.0001***	**0.0002***
	Silver		-	**0.0001***	**0.0001***
	Gold			-	**0.0391***
	Platinum				-

Table 4.7 (continued) : Mann-Whitney U test *p* values of credit categories.

Credit Categories	Certification Level	Mann-Whitney U Test *p* Values			
		Certified	Silver	Gold	Platinum
Energy and Atmosphere (EA)	Certified	-	0.0658	**0.0001***	**0.0003***
	Silver		-	**0.0001***	**0.0001***
	Gold			-	**0.0001***
	Platinum				-
Materials and Resources (MR)	Certified	-	0.2160	**0.0032***	**0.0030***
	Silver		-	**0.0010***	**0.0015***
	Gold			-	0.1251
	Platinum				-
Indoor Environmental Quality (IEQ)	Certified	-	0.1210	**0.0015***	**0.0002***
	Silver		-	**0.0002***	**0.0001***
	Gold			-	**0.0016***
	Platinum				-
Innovation in Design (ID)	Certified	-	**0.0045***	**0.0001***	**0.0001***
	Silver		-	0.0687	**0.0109***
	Gold			-	0.1037
	Platinum				-
Regional Priority (RP)	Certified	-	0.4618	**0.0001***	**0.0001***
	Silver		-	**0.0001***	**0.0001***
	Gold			-	0.0591
	Platinum				-

According to all the analysis, below findings were revealed:

- In the sustainable sites credit, the average achievement of the certified buildings remained significantly lower than the silver, gold and platinum buildings and Mann-Whitney U test shows that there is a statistically significant difference between them. However, silver, gold and platinum buildings have almost the same level of achievement and there is no statistically significant difference among them.

- In water efficiency, energy and atmosphere and indoor environmental quality credits, certified and silver building's average achievements are close to each other and there is no statistically significant difference between them. However, gold and platinum buildings' average achievements vary greatly and because of this reason, among silver, gold, platinum and certified, gold, platinum there are statistically significant differences.

- In materials and resources and regional priority credits, the average achievements of platinum and gold buildings and certified and silver buildings are respectively at the same level and there is no statistically significant difference within each pair.

- In the innovation and design credit, the average achievement of the certified buildings remained significantly lower than the silver, gold and platinum buildings and there is a statistically significant difference between them. Between silver and platinum buildings, there is a statistically significant difference, their average achievements are not at the same level. However, other pairs are at the same avarage achievement and there is no statistically significant difference among them.

According to all the tests which were interpreted above, energy and atmosphere category has the biggest potential for the owners/companies who target higher certification level of LEED certification system. First of all, EA credit category has the biggest portion in terms of maximum achievable credits, out of 110, EA has 35 credits. Second of all, EA credit category is one of the least average achieved credit category among all the credit categories and there are statistically significant differences between silver, gold and platinum certification levels. This comparison is the same for the other certification levels, except certified and silver for which the reason of certification level difference is not EA credit. In the following paragraphs, same tests were applied to EA credit and also interpreted.

Increasing energy efficiency, observing energy usage to check whether there is difference between planned and actual values throughout the operation, promoting renewable energy usage and practicing technologies to decrease carbon emissions are the purposes of the energy and atmosphere credit category (Gurgun, 2016). In this thesis, energy and atmosphere credit achievements of LEED-certified green buildings in Turkey are assessed.

The largest share of the maximum achievable credits (110 credits) for NC in LEED v3 belongs to the EA credit category, which accounts for approximately 32% of the total credits. Prerequisites and points of EA credit category are given in Table 4.8 (Gurgun, 2016).

Table 4.8 : Energy and Atmosphere credits in LEED v3 2009 for new construction.

Energy and Atmosphere Credit and Its Prerequisites		Points
Prerequisite 1	Fundamental Commissioning of Buildings Energy Systems	Required
Prerequisite 2	Minimum Energy Performance	Required
Prerequisite 3	Fundamental Refrigerant Management	Required
Credit 1 (C1)	Optimize Energy Performance	1-19 Points

Table 4.8 (continued) : Energy and Atmosphere credits in LEED v3 2009 for new construction.

Energy and Atmosphere Credit and Its Prerequisites		Points
Credit 1 (C1)	The minimum energy cost savings percentages	1-19 Points
	12%	1
	14%	2
	16%	3
	18%	4
	20%	5
	22%	6
	24%	7
	26%	8
	28%	9
	30%	10
	32%	11
	34%	12
	36%	13
	38%	14
	40%	15
	42%	16
	44%	17
	46%	18
	48%	19
Credit 2 (C2)	On-site Renewable Energy	1-7 Points
	1%	1
	3%	2
	5%	3
	7%	4
	9%	5
	11%	6
	13%	7
Credit 3 (C3)	Enhanced Commissioning	2 Points
Credit 4 (C4)	Enhanced Refrigerant Management	2 Points
Credit 5 (C5)	Measurement and Verification	3 Points
Credit 6 (C6)	Green Power	2 Points
	Total	35 Points

Average values, standard deviations and percentage of EA credit achievements and the number of projects for each certification level are given in Table 4.9.

Table 4.9 : EA Credit Achievements of LEED-NC 2009 Certified Buildings in Turkey.

Credits and Max. Achievable Points	Certification Level and Number of Buildings											
	Certified (10)			*Silver (36)*			*Gold (111)*			*Platinum (15)*		
	Ave.	Std. Dev.	Ach. %	Ave.	Std. Dev.	Ach. %	Ave.	Std. Dev.	Ach. %	Ave.	Std. Dev.	Ach. %
C1 (19)	4,70	2,45	24,74	6,06	3,03	31,87	8,01	4,02	42,15	16,53	3,78	87,02
C2 (7)	2,60	2,76	37,14	0,11	0,52	1,59	0,96	2,08	13,77	4,47	3,04	63,81
C3 (2)	0,20	0,63	10,00	1,00	1,01	50,00	0,97	1,00	48,65	1,33	0,98	66,67
C4 (2)	0,20	0,63	10,00	0,89	1,01	44,44	1,42	0,91	71,17	1,60	0,83	80,00
C5 (3)	0,70	1,25	23,33	2,11	1,30	70,37	2,59	0,97	86,19	3,00	0,00	100,00
C6 (2)	0,00	0,00	0,00	0,06	0,33	2,78	0,34	0,76	17,12	0,27	0,70	13,33

The comparison of the percentages of EA credit achievements of 172 green buildings with respect to different certification levels is presented in Figure 4.2.

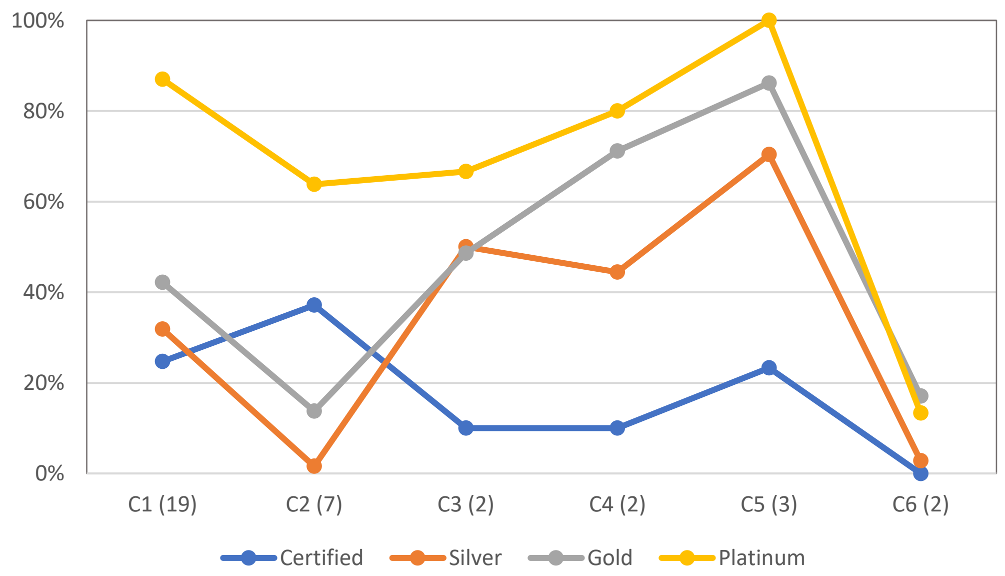

Figure 4.2 : Comparison of EA Credit Achievements of LEED-NC 2009 Certified Buildings.

According to Figure 4.2, the following results can be interpreted:

- In optimize energy performance (C1) credit, the percentages of achievements of certified, silver and gold buildings are very close. The percentages of achievements of platinum certified buildings are very high when compared to the ones in other certification levels.

- Unlike other credits in on-site renewable energy (C2), the percentages of achievements of certified buildings are high. The percentages of achievements of platinum buildings are very high and the percentages of achievements of silver the ones are very low when compared to the ones in other certification levels.
- In enhanced commissioning (C3) credit, the percentages of achievements of silver and gold buildings are almost same. The percentage of achievements of platinum buildings is high when compared to the ones in other certification levels. The percentage of achievements of certified buildings is very low by comparion with other certification levels.
- In enhanced refrigerant management (C4) credit, the percentages of achievements of gold and platinum buildings are very close. The percentage of achievements of silver buildings are relatively lower than gold and platinum buildings. The percentage of achievements of certified buildings are very low when compared to the ones in other certification levels.
- In optimize energy performance (C5), the percentages of achievements of silver, gold and platinum buildings are very close. The percentage of achievements of certified buildings are very low when compared to the ones in other certification levels.
- In green power (C6) credit, the percentages of achievements of platinum and gold certified buildings, and the percentages of achievements of certified and silver the ones are very close to each other.

Another interpreted test within this study is Kruskal-Wallis. The test is applied in order to reveal statistically significant differences between the Energy and Atmosphere credits achievements of newly constructed buildings in Turkey, which were certified according to four different levels. For this aim, Kruskal-Wallis test was realized through StatTools v 7.5 software. The *p* values obtained from the Kruskal-Wallis test are presented in Table 4.10. If the *p* values are less than 0.05, it indicates that there is a statistically significant difference in credit achievements of buildings certified according to different certification levels at 95% significance level.

Table 4.10 : Kruskal-Wallis Test *p* Values of EA Credits.

EA Credits	Kruskal-Wallis Test ***p*** Value
Optimize Energy Performance	**0.0000***
On-site Renewable Energy	**0.0000***
Enhanced Commissioning	**0.0480***
Enhanced Refrigerant Management	**0.0000***
Measurement and Verification	**0.0000***
Green Power	0.0880

Based on the results of Kruskal-Wallis test presented in Table 4.10, p values are less than 0.05 for 5 credits. This means that the credits, except green power (C6), achievements of buildings certified according to four certification levels are statistically significant different at 95% significance level. On the other hand, green power achievements of buildings certified according to four certification levels are not statistically significant different at 95% significance level.

After Kruskal-Wallis test, Mann-Whitney U test was conducted to demonstrate the significance of differences between two different certification level. If the *p* values are less than 0.05, it indicates that there is a statistically significant difference in credit achievements of buildings certified according to two certification levels at 95% significance level. The *p* values obtained from the Mann-Whitney U test are presented in Table 4.11.

Table 4.11 : Mann-Whitney U test results of EA credits.

EA Credits	Certification Level	Mann-Whitney U Test *p* Values			
		Certified	Silver	Gold	Platinum
Optimize Energy Performance (C1)	Certified	-	0.146	**0.006***	**0.000***
	Silver		-	0.012	**0.000***
	Gold			-	**0.000***
	Platinum				-
On-site Renewable Energy (C2)	Certified	-	**0.000***	0.051	0.062
	Silver		-	0.012	**0.000***
	Gold			-	**0.000***
	Platinum				-
Enhanced Commissioning (C3)	Certified	-	0.025	0.019	**0.006***
	Silver		-	**0.888***	**0.281***
	Gold			-	0.192
	Platinum				-
Enhanced Refrigerant Management (C4)	Certified	-	**0.048***	**0.000***	**0.001***
	Silver		-	0.004	0.021
	Gold			-	0.475
	Platinum				-

Table 4.11 (continued) : Mann-Whitney U test results of EA credits.

EA Credits	Certification Level	Mann-Whitney U Test *p* Values			
		Certified	Silver	Gold	Platinum
Measurement and Verification (C5)	Certified	-	0.005	**0.000***	**0.000***
	Silver		-	**0.023***	**0.012***
	Gold			-	0.094
	Platinum				-
Green Power (C6)	Certified	-	0.598	0.156	0.238
	Silver		-	0.030	0.148
	Gold			-	0.713
	Platinum				-

- In the optimize energy credit (C1), the average achievement of the platinum buildings remained significantly higher than the other certification levels, and there is a statistically significant difference among them. However, the average achievements of gold and silver buildings, and certified and silver buildings are respectively at the same level, and there is no statistically significant difference within each pair.
- In the on-site renewable energy credit (C2), the average achievements of platinum and certified buildings, and gold and silver buildings are respectively at the same level, and there is no statistically significant difference within each pair. There is a considerable difference among the average achievements of the other certification levels, and there is a statistically significant difference among them except gold and certified pair.
- In the enhanced commissioning credit (C3), the average achievements of platinum and gold buildings, gold and certified buildings, silver and certified are respectively at the same level, and there is no statistically significant difference within each pair. There is a considerable difference among the average achievements of the other certification levels, and there is a statistically significant difference among them.
- In the enhanced refrigerant management credit (C4), the average achievement of certified buildings is considerably lower than those of silver, gold and platinum buildings, and there is a statistically significant difference between them. Silver, gold and platinum buildings have the same average level of achievement and there is no statistically significant difference among them.

- In the measurement and verification credit (C5), the average achievements of platinum and gold buildings, and silver and certified buildings are respectively at the same level, and there is no statistically significant difference within each pair. There is a considerable difference among the average achievements of the other certification levels, and there is a statistically significant difference among them.
- In the green power credit (C6), the average achievements of all certification levels at the same level. For this reason, there is no statistically significant difference among all certification levels.

5. FINDINGS AND DISCUSSION

102 professionals were reached via email to complete an online survey, 45 of them completed the survey. The online survey was available for 9 weeks. The response rate of the survey questionnaire is 43% with 45 respondents in 9 weeks.

The data obtained in the questionnaire survey was processed as follows:

- Firstly, the demographic characteristics of all respondents were presented in graphics and interpreted.
- Then, the Cronbach's alpha test, which is a reliability test for the factors to be evaluated from the “Very Important” to the “Not Important”, was performed.
- Wilcoxon Signed Rank Test is applied to understand whether there is statistically significant difference between means of factors and 4.5 value.
- In order to determine different points of view of different groups, the respondents were categorized under 3 main groups. These are: “Architects vs. Engineers”, “more than 5 years of experience vs. less than 5 years of experience” and “only consultants vs. others”
- Mann-Whitney U tests and descriptive statistics methods were applied and interpreted.
- Finally, recommendations of the respondents are listed.

5.1 Statistics of Demographic Questions

28 people graduated from a master program, the majority of respondents, 14 people have bachelor degree and only 3 of the respondents have doctoral degree Figure 5.1.

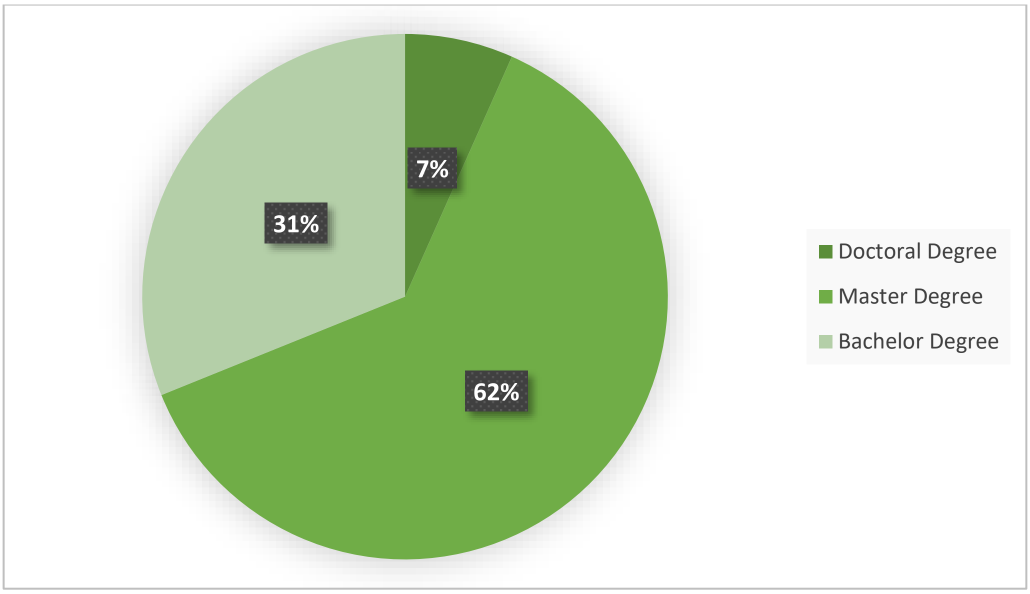

Figure 5.1 : Education level of respondents.

Among the respondents it is seen that architects answered the questionnaire survey more than other professions. Respectively, civil engineers, mechanical engineers and environmental engineers are following architects. Also among the respondents, there are two electrical engineers, one urban and regional planner and one aerospace engineer. Since there are no restrictions about professions, the only restriction was having experience in the green building sector. Respondents have variable professions. Detailed chart is given in Figure 5.2.

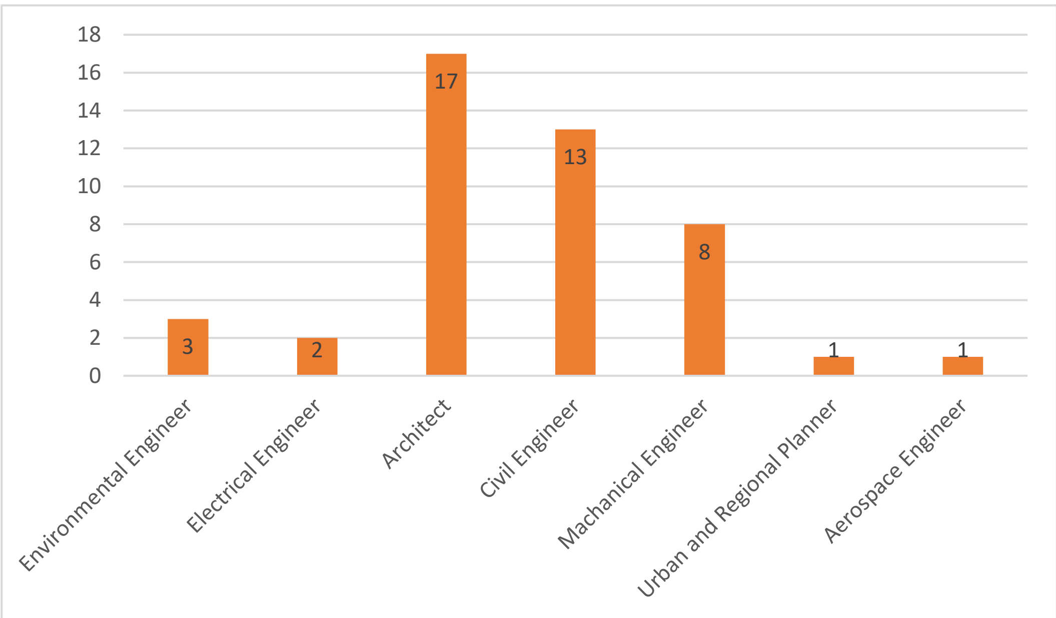

Figure 5.2 : Professions of respondents.

In response to the question related with type of the company that is worked for, there are multiple combinations. 29 respondents selected only one type of company where all types of companies could be selected. It can be seen that the rate of respondents who work for consultancy companies are 37% with 26 responses. Contractor and engineering/design options have same response number with 16 responses. The response rate for owner companies is 14%, and those who work for subcontractors are only 4% among all respondents. The distribution of the type of the companies that are worked for is given in Figure 5.3.

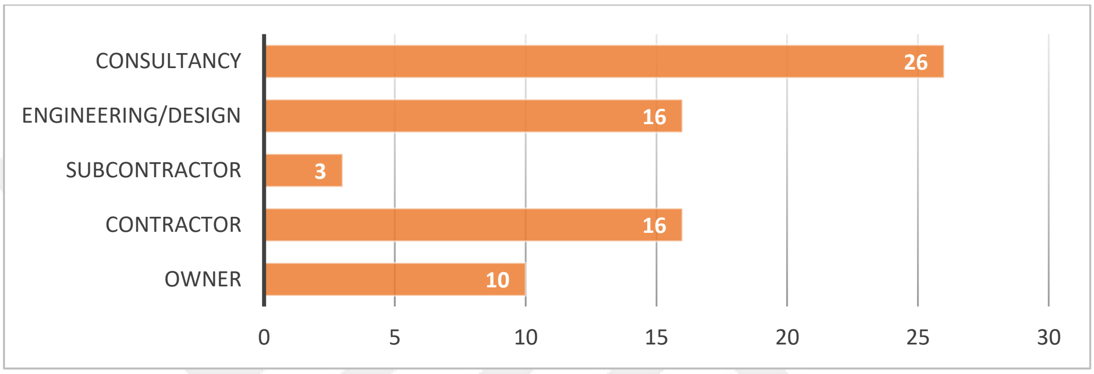

Figure 5.3 : Types of companies worked that is worked for by respondents.

In addition, respondents' experience is asked in terms of the number of completed green building projects. Most of them selected the highest option which is more than 10 projects. It is also seen that except one respondent, all have consultancy background. The second most selected option is 1-5 projects with 29%. Respectively, only 1 project and 5-10 projects follow them. A detailed chart is given below in Figure 5.4.

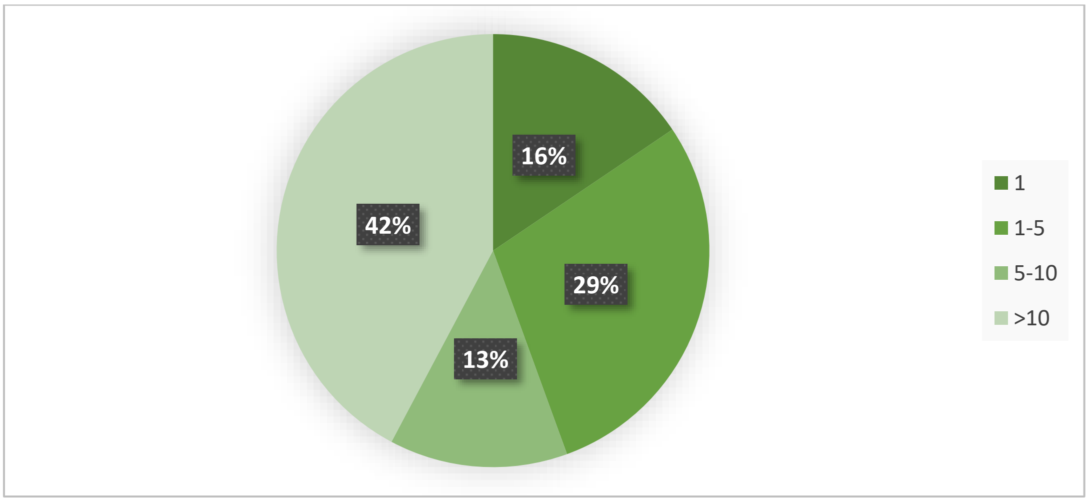

Figure 5.4 : Numbers of completed projects by respondents.

It is identified that most of respondents worked at commercial building projects. In this question, multiple options are available for respondents and commercial building option has 37 responses, which corresponds to 41%. Second highest is residences, and there is a slight difference with industrial plants. Some of the respondents wanted to highlight that they worked at airport projects. Rate of response for airport projects is 4.4%. Detailed distribution of responses are listed in Figure 5.5.

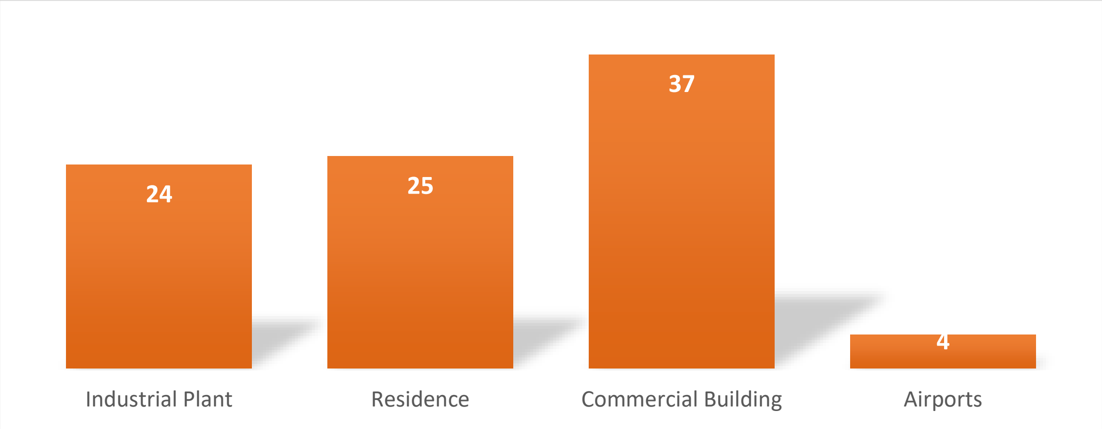

Figure 5.5 : Types of completed projects by respondents.

Certification level of completed LEED projects are asked to respondents, and gold is the first one which correspond with certification levels of LEED certified buildings in Turkey (Figure 5.6). 35 respondents completed gold certified projects. Detailed chart is given in Figure 5.7.

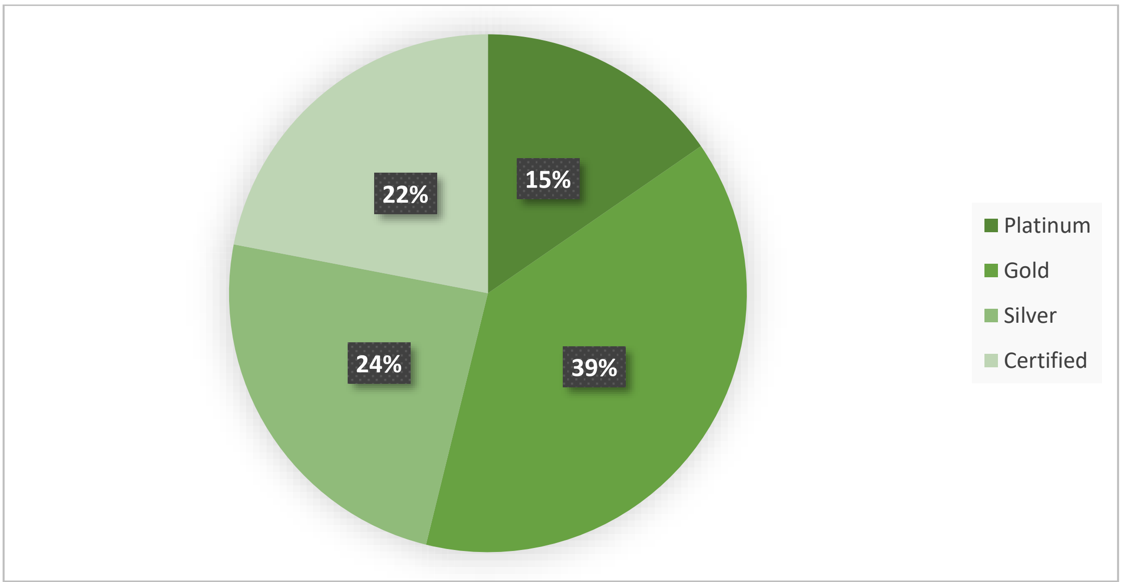

Figure 5.6 : Certification level distribution of LEED certified projects in Turkey.

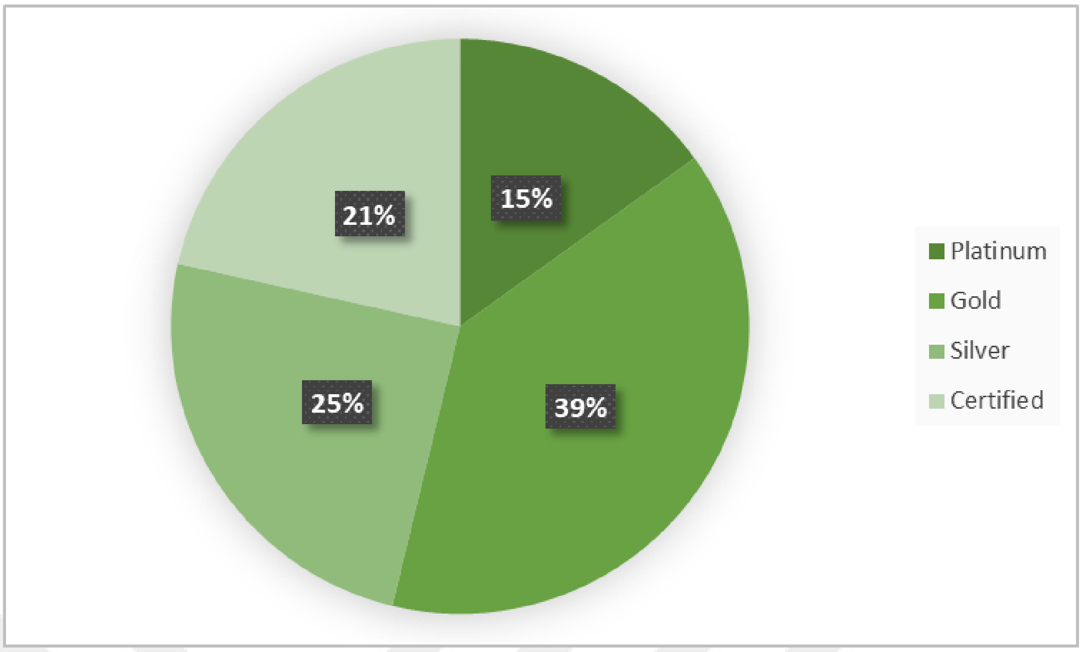

Figure 5.7 : Certification level distribution of respondents' completed LEED projects.

22% of respondents say that they get know-how about green buildings through their colleagues. Internet search and consultant firms are identified as two of the most important means of learning. Unfortunately, each respondent did not indicate university as a mean of learning, rate of responses of university is low. The other indicated mean of learnings are conferences (14%), publications (13%), experience (4%), certification programs (2%), Chamber of Architects (1%) and GBRS reference documents (1%). Detailed graphic is given below in Figure 5.8.

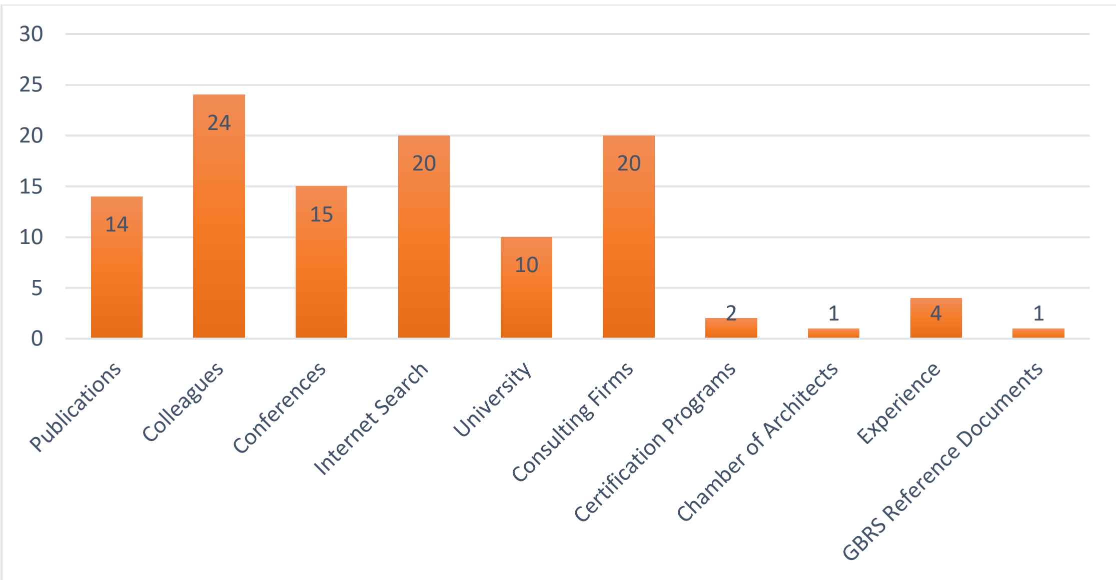

Figure 5.8 : Means of getting know-how of respondents.

5.2 Cronbach's Alpha Reliability Test Results

Cronbach's alpha values show the internal consistency of the factors. This thesis' questionnaire consists of three main factor groups excluding demographic questions. These main factor groups' Cronbach Alpha values are listed in Table 5.1.

Table 5.1 : Cronbach alpha values of factor groups.

Factor Groups	Number of Factors	Cronbach's Alpha Values
Motivators for green buildings	14	0.859
Motivators for EA credit category of LEED	8	0.821
Barriers for green buildings and EA credit category of LEED	20	0.876

Motivators for green buildings consist of 14 different factors, motivators for EA credit category of LEED consist of 8 different factors and barriers for green buildings and EA credit category of LEED consist of 20 factors. The relationship between Cronbach's alpha value and internal consistency is given in Section 3.2 Table 3.1. According to this relationship, Table 5.1 is interpreted as all factors in its own factor group are in internal consistency.

5.3 Mann-Whitney U Tests' Interpretations

Mann-Whitney U test is applied to reveal the different points of views of architects and engineers. p values of Mann-Whitney U test are presented in Table 5.2.

Table 5.2 : Mann-Whitney U test p values of architect and engineers' answers.

Factors	Architects (18)	Engineers (27)	Mann-Whitney U Test p Values
	Mean	Mean	
Motivators for green buildings			
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	5.389	5.148	0.474
Making it compulsory in public projects	5.556	5.148	0.446

Table 5.2 (continued) : Mann-Whitney U test *p* values of architect and engineers' answers.

Factors	Architects (18) Mean	Engineers (27) Mean	Mann-Whitney U Test *p* Values
State promotion and procurement of green building technologies	5.722	5.333	0.139
Giving low interest loans and / or grants to green building constructions	5.611	5.222	0.271
Providing tax advantages to green building constructions	5.444	4.889	0.235
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	5.667	4.556	**0.015**
Reduction of water and energy consumption costs that green building occupants need to pay	5.444	4.815	0.057
Conducting campaigns to increase environmental awareness	4.889	4.852	0.370
Training on design and construction of green buildings in universities and professional organizations	5.056	4.630	0.357
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	5.056	4.815	0.536
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	5.222	4.704	0.189
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	5.222	4.667	0.214
Providing prestige and/or brand value to occupants of green buildings	5.056	4.704	0.124
Higher rental and/or sales value of green buildings	5.000	4.519	0.082
Motivators for EA credit category			
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	5.500	5.333	0.642
By state providing the necessary infrastructure for the use of renewable energy systems	5.556	5.148	0.147
Investing and/or providing incentives for different energy solutions by state	5.556	5.185	0.058
Establishment of an independent organization for solar energy and making legal regulations for sustainability	5.222	4.926	0.411
Carrying out studies to reduce the environmental impacts of refrigerant gases	4.833	4.741	0.956
Increasing number of renewable energy companies	5.056	5.000	0.621
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	4.889	4.852	0.946
Providing loans to renewable energy buildings	5.222	4.963	0.205
Barriers for green buildings and EA credit category			
Considering that the use of environmentally friendly materials is more costly	5.056	4.963	0.902
Having less incentives in Turkey with compared to other countries	5.222	5.037	0.392
Existing energy agreements of Turkey	4.944	4.259	**0.031**
Low public awareness of sustainability and energy efficiency	5.222	5.074	0.221
The market is not sustainability centered	5.167	5.222	0.526
Limitation of adaptation of green energy	4.889	4.852	0.663
Construction of green buildings requires high quality workmanship	4.167	4.185	0.751

Table 5.2 (continued) : Mann-Whitney U test *p* values of architect and engineers' answers.

Factors	Architects (18)	Engineers (27)	Mann-Whitney U Test *p* Values
	Mean	Mean	
Energy-efficient systems are more technically complex and expensive than traditional systems	4.056	4.407	0.668
Increased investment cost of efficient HVAC systems	4.722	4.852	0.967
Renewable energy use increases the investment cost	4.944	5.259	0.402
Low number of experts to work on the design of green buildings	4.500	4.407	0.519
Deviations between planned energy efficiency and realized energy efficiency in green buildings	4.778	4.370	0.248
The cost of measurement and verification systems vary in size of the building	4.333	4.074	0.794
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	4.778	4.185	0.077
The documentation is very difficult and the bureaucracy is challenging	4.389	3.926	0.391
Unable to make financial planning effectively due to unpredictable costs in green buildings	4.500	4.037	0.343
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	4.556	4.296	0.423
Lack of awareness of the benefits of green buildings throughout the life cycle	4.833	4.926	0.609
Undeveloped building energy simulations area	4.333	4.037	0.255
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	4.889	4.222	**0.030**

According to Table 5.2, engineers and architects evaluated differently only the motivator "Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants" among the motivators for green buildings. Architects and engineers similarly assessed the importance levels of motivators for EA credit category. For third factor group, which is barriers for green buildings and EA credit category, "Existing energy agreements of Turkey" and "Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way" are evaluated differently by architects and engineers. For the rest of the factors, architects and engineers assigned similar importance levels.

The Mann-Whitney U test is applied to reveal the different point of views of respondents who are only consultants and who work at other jobs. *p* values of Mann-Whitney U test are presented in Table 5.3.

Table 5.3 : Mann-Whitney U test *p* values of consultants only and others' answers.

Factors	Consultants only (15) Mean	Others (30) Mean	Mann-Whitney U Test *p* Values
Motivators for green buildings			
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	5.267	5.233	0.154
Making it compulsory in public projects	5.600	5.167	0.873
State promotion and procurement of green building technologies	5.533	5.467	0.553
Giving low interest loans and / or grants to green building constructions	5.533	5.300	0.823
Providing tax advantages to green building constructions	5.533	4.900	0.157
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	5.200	4.900	0.736
Reduction of water and energy consumption costs that green building occupants need to pay	5.467	4.867	0.619
Conducting campaigns to increase environmental awareness	4.800	4.900	0.283
Training on design and construction of green buildings in universities and professional organizations	5.000	4.700	0.802
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	5.067	4.833	0.638
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	5.267	4.733	0.235
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	5.133	4.767	0.689
Providing prestige and/or brand value to occupants of green buildings	4.800	4.867	0.238
Higher rental and/or sales value of green buildings	4.800	4.667	0.864
Motivators for EA credit category			
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	5.667	5.267	0.070
By state providing the necessary infrastructure for the use of renewable energy systems	5.400	5.267	0.956
Investing and/or providing incentives for different energy solutions by state	5.467	5.267	0.878
Establishment of an independent organization for solar energy and making legal regulations for sustainability	5.067	5.033	0.659
Carrying out studies to reduce the environmental impacts of refrigerant gases	4.467	4.933	0.337
Increasing number of renewable energy companies	4.667	5.200	0.130
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	4.400	5.100	0.124
Providing loans to renewable energy buildings	5.133	5.033	0.355
Barriers for green buildings and EA credit category			
Considering that the use of environmentally friendly materials is more costly	5.200	4.900	0.989
Having less incentives in Turkey with compared to other countries	5.133	5.100	0.411
Existing energy agreements of Turkey	4.267	4.667	0.196
Low public awareness of sustainability and energy efficiency	5.200	5.100	0.735

Table 5.3 (continued) : Mann-Whitney U test *p* values of consultants only and others' answers.

Factors	Consultants only (15)	Others (30)	Mann-Whitney U Test *p* Values
	Mean	Mean	
The market is not sustainability centered	5.400	5.100	0.379
Limitation of adaptation of green energy	4.800	4.900	0.586
Construction of green buildings requires high quality workmanship	3.933	4.300	0.570
Energy-efficient systems are more technically complex and expensive than traditional systems	3.667	4.567	0.290
Increased investment cost of efficient HVAC systems	4.333	5.033	**0.071**
Renewable energy use increases the investment cost	4.933	5.233	0.317
Low number of experts to work on the design of green buildings	4.533	4.400	0.803
Deviations between planned energy efficiency and realized energy efficiency in green buildings	4.867	4.367	0.685
The cost of measurement and verification systems vary in size of the building	4.133	4.200	0.485
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	4.667	4.300	0.772
The documentation is very difficult and the bureaucracy is challenging	3.733	4.300	**0.025**
Unable to make financial planning effectively due to unpredictable costs in green buildings	3.733	4.467	**0.023**
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	3.800	4.700	**0.004**
Lack of awareness of the benefits of green buildings throughout the life cycle	5.000	4.833	0.269
Undeveloped building energy simulations area	4.000	4.233	0.069
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	4.600	4.433	**0.043**

According to Table 5.3, consultants and others similarly assessed the importance levels of the motivators for green buildings and motivators for EA credit category. They made different evaluations only for barriers. These two groups of respondents evaluated the following barriers differently: "Increased investment cost of efficient HVAC systems", "The documentation is very difficult and the bureaucracy is challenging", "Unable to make financial planning effectively due to unpredictable costs in green buildings", "Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad" and "Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way".

The Mann-Whitney U test is applied to reveal the different point of views of respondents who completed more than 5 projects and up to 5 projects in the green building sector. *p* values of Mann-Whitney U test are presented in Table 5.4.

Table 5.4 : Mann-Whitney U test *p* values of respondents who completed up to 5 projects and more than 5 projects.

Factors	< 5 projects (20)	≥ 5 projects (25)	Mann-Whitney U Test *p* Values
	Mean	Mean	
Motivators for green buildings			
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	5.500	5.040	0.667
Making it compulsory in public projects	5.250	5.360	0.087
State promotion and procurement of green building technologies	5.450	5.520	0.235
Giving low interest loans and / or grants to green building constructions	5.350	5.400	0.360
Providing tax advantages to green building constructions	4.850	5.320	**0.026**
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	4.950	5.040	0.419
Reduction of water and energy consumption costs that green building occupants need to pay	4.950	5.160	0.092
Conducting campaigns to increase environmental awareness	4.900	4.840	0.747
Training on design and construction of green buildings in universities and professional organizations	4.750	4.840	0.268
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	4.900	4.920	0.194
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	4.650	5.120	**0.037**
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	4.900	4.880	0.129
Providing prestige and/or brand value to occupants of green buildings	4.950	4.760	0.914
Higher rental and/or sales value of green buildings	4.600	4.800	0.435
Motivators for EA credit category			
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	5.200	5.560	0.103
By state providing the necessary infrastructure for the use of renewable energy systems	5.300	5.320	0.468
Investing and/or providing incentives for different energy solutions by state	5.400	5.280	0.246
Establishment of an independent organization for solar energy and making legal regulations for sustainability	5.150	4.960	0.957
Carrying out studies to reduce the environmental impacts of refrigerant gases	5.000	4.600	0.536
Increasing number of renewable energy companies	5.150	4.920	0.305
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	5.200	4.600	0.136
Providing loans to renewable energy buildings	5.050	5.080	0.346

Table 5.4 (continued) : Mann-Whitney U test *p* values of respondents who completed up to 5 projects and more than 5 projects.

Factors	< 5 projects (20)	≥ 5 projects (25)	Mann-Whitney U Test *p* Values
	Mean	Mean	
Barriers for green buildings and EA credit category			
Considering that the use of environmentally friendly materials is more costly	4.950	5.040	0.224
Having less incentives in Turkey with compared to other countries	5.000	5.200	0.893
Existing energy agreements of Turkey	4.850	4.280	0.318
Low public awareness of sustainability and energy efficiency	5.050	5.200	0.257
The market is not sustainability centered	5.050	5.320	0.092
Limitation of adaptation of green energy	4.800	4.920	0.648
Construction of green buildings requires high quality workmanship	4.200	4.160	0.707
Energy-efficient systems are more technically complex and expensive than traditional systems	4.400	4.160	**0.046**
Increased investment cost of efficient HVAC systems	4.950	4.680	**0.046**
Renewable energy use increases the investment cost	5.250	5.040	0.554
Low number of experts to work on the design of green buildings	4.400	4.480	0.687
Deviations between planned energy efficiency and realized energy efficiency in green buildings	4.400	4.640	0.305
The cost of measurement and verification systems vary in size of the building	4.050	4.280	0.809
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	4.300	4.520	0.268
The documentation is very difficult and the bureaucracy is challenging	4.700	3.640	0.224
Unable to make financial planning effectively due to unpredictable costs in green buildings	4.650	3.880	0.129
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	5.000	3.920	0.068
Lack of awareness of the benefits of green buildings throughout the life cycle	4.950	4.840	0.501
Undeveloped building energy simulations area	4.550	3.840	0.768
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	4.900	4.160	0.914

According to Table 5.4, more experienced respondents assessed differently two motivators for green buildings than other group. These are: “Providing tax advantages to green building constructions” and “Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings”. There was no statistically significant difference between these two groups evaluating the importance levels of motivators for EA credit category. In barriers for green buildings and EA credit category section, respondents of different groups divergently evaluated the following items: “Energy-efficient systems are more technically complex and expensive than traditional systems” and “Increased investment cost of efficient HVAC systems”.

To examine whether the answers of respondents are significantly different than 4.5 or not, Wilcoxon Signed Rank test was applied. Results of this test is listed in Table 5.5.

Table 5.5 : Wilcoxon Signed Rank Test results of answers.

Factors	Mann-Whitney U Test *p* Values
Motivators for green buildings	
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	**0.000**
Making it compulsory in public projects	**0.000**
State promotion and procurement of green building technologies	**0.000**
Giving low interest loans and / or grants to green building constructions	**0.000**
Providing tax advantages to green building constructions	**0.001**
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	**0.006**
Reduction of water and energy consumption costs that green building occupants need to pay	**0.004**
Conducting campaigns to increase environmental awareness	**0.009**
Training on design and construction of green buildings in universities and professional organizations	**0.017**
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	**0.002**
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	**0.007**
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	**0.012**
Providing prestige and/or brand value to occupants of green buildings	**0.020**
Higher rental and/or sales value of green buildings	0.107
Motivators for EA credit category	
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	**0.000**
By state providing the necessary infrastructure for the use of renewable energy systems	**0.000**
Investing and/or providing incentives for different energy solutions by state	**0.000**
Establishment of an independent organization for solar energy and making legal regulations for sustainability	**0.001**
Carrying out studies to reduce the environmental impacts of refrigerant gases	**0.019**
Increasing number of renewable energy companies	**0.002**
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	**0.030**
Providing loans to renewable energy buildings	**0.000**
Barriers for green buildings and EA credit category	
Considering that the use of environmentally friendly materials is more costly	**0.003**

Table 5.5 (continued) : Wilcoxon Signed Rank Test results of answers.

Factors	Mann-Whitney U Test *p* Values
Having less incentives in Turkey with compared to other countries	**0.000**
Existing energy agreements of Turkey	0.564
Low public awareness of sustainability and energy efficiency	**0.000**
The market is not sustainability centered	**0.000**
Limitation of adaptation of green energy	**0.006**
Construction of green buildings requires high quality workmanship	0.275
Energy-efficient systems are more technically complex and expensive than traditional systems	0.474
Increased investment cost of efficient HVAC systems	**0.037**
Renewable energy use increases the investment cost	**0.000**
Low number of experts to work on the design of green buildings	0.887
Deviations between planned energy efficiency and realized energy efficiency in green buildings	0.923
The cost of measurement and verification systems vary in size of the building	0.065
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	0.995
The documentation is very difficult and the bureaucracy is challenging	0.171
Unable to make financial planning effectively due to unpredictable costs in green buildings	0.283
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	0.908
Lack of awareness of the benefits of green buildings throughout the life cycle	**0.008**
Undeveloped building energy simulations area	0.219
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	0.923

According to Table 5.5, in the motivators for green buildings section there are statistically significant differences for almost all motivators except “Higher rental and/or sales value of green buildings”. In the motivators for EA credit category section, there are statistically significant differences for all motivators. In the barriers for green buildings and EA credit category section, for “Considering that the use of environmentally friendly materials is more costly”, “Having less incentives in Turkey when compared to other countries”, “Low public awareness of sustainability and energy efficiency”, “The market is not sustainability centered”, “Limitation of adaptation of green energy”, “Increased investment cost of efficient HVAC systems”, “Renewable energy use increases the investment cost” and “Lack of awareness of the benefits of green buildings throughout the life cycle” there are statistically significant differences. The rest of the barriers have no statistically significant differences.

5.4 Descriptive Statistics of Factors

All factors are evaluated in terms of descriptive statistics as well. For this aim, as it is done in Section 5 same respondent categories are used and same statistical tests are applied regardless respondent categories. First of all, the mean of respondent answers for each factor is calculated. Then, as it is explained in Section 3.3 RII the values are calculated and according to these values, the rank of the factors are listed within each group of factors. Finally, standard deviations of these factors are calculated.

In Table 5.6, descriptive statistics of 45 respondents are given.

According to Table 5.6, respondents identified that the most important motivator for green buildings is "State promotion and procurement of green building technologies" also two other motivator's RII is very close to the first one, these are: "Giving low interest loans and / or grants to green building constructions" and "Making it compulsory in public projects". The least important motivator according to the respondents in general is "Higher rental and/or sales value of green buildings".

The most important motivator for EA credit categories respectively are: "Having energy saving and reducing energy costs in green buildings when compared to traditional buildings", "Investing and/or providing incentives for different energy solutions by state" and "By state providing the necessary infrastructure for the use of renewable energy systems". According to the respondents the least notable motivator is "Carrying out studies to reduce the environmental impacts of refrigerant gases".

Respondents point out that the biggest barrier for green buildings and EA credit category is "The market is not sustainability centered". Following most important barriers are "Renewable energy use increases the investment cost" and "Low public awareness of sustainability and energy efficiency". The least important barrier is chosen as "The documentation is very difficult and the bureaucracy is challenging".

Same tests are applied to architects and engineers answers also. In Table 5.7 mean of their answers, RII values, rank of RII values and standard deviation details are shared.

According to architects and engineers the most important motivator for green buildings are the same and it is "State promotion and procurement of green building technologies" but their 2nd most important motivator is different.

Table 5.6 : Descriptive statistics of total sample (N=45).

Factors	Mean	RII	Rank	Std. Dev.
Motivators for green buildings				
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	5.244	0.874	4	0.981
Making it compulsory in public projects	5.311	0.885	3	1.083
State promotion and procurement of green building technologies	5.489	0.915	1	0.895
Giving low interest loans and / or grants to green building constructions	5.378	0.896	2	0.747
Providing tax advantages to green building constructions	5.111	0.852	5	1.005
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	5.000	0.833	7	1.297
Reduction of water and energy consumption costs that green building occupants need to pay	5.067	0.844	6	1.095
Conducting campaigns to increase environmental awareness	4.867	0.811	11	1.120
Training on design and construction of green buildings in universities and professional organizations	4.800	0.800	13	1.120
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	4.911	0.819	8	0.925
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	4.911	0.819	8	1.184
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	4.889	0.815	10	1.247
Providing prestige and/or brand value to occupants of green buildings	4.844	0.807	12	1.043
Higher rental and/or sales value of green buildings	4.711	0.785	14	1.236
Motivators for EA credit category				
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	5.400	0.900	1	0.618
By state providing the necessary infrastructure for the use of renewable energy systems	5.311	0.885	3	0.763
Investing and/or providing incentives for different energy solutions by state	5.333	0.889	2	0.674
Establishment of an independent organization for solar energy and making legal regulations for sustainability	5.044	0.841	5	0.952
Carrying out studies to reduce the environmental impacts of refrigerant gases	4.778	0.796	8	1.020

Table 5.6 (continued) : Descriptive statistics of total sample (N=45).

Factors	Mean	RII	Rank	Std. Dev.
Increasing number of renewable energy companies	5.022	0.837	6	1.076
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	4.867	0.811	7	1.217
Providing loans to renewable energy buildings	5.067	0.844	4	0.986
Barriers for green buildings and EA credit category				
Considering that the use of environmentally friendly materials is more costly	5.000	0.833	5	0.953
Having less incentives in Turkey with compared to other countries	5.111	0.852	4	0.745
Existing energy agreements of Turkey	4.533	0.756	9	1.100
Low public awareness of sustainability and energy efficiency	5.133	0.856	2	0.968
The market is not sustainability centered	5.200	0.867	1	0.919
Limitation of adaptation of green energy	4.867	0.811	7	0.991
Construction of green buildings requires high quality workmanship	4.178	0.696	17	1.419
Energy-efficient systems are more technically complex and expensive than traditional systems	4.267	0.711	15	1.338
Increased investment cost of efficient HVAC systems	4.800	0.800	8	1.057
Renewable energy use increases the investment cost	5.133	0.856	2	0.894
Low number of experts to work on the design of green buildings	4.444	0.741	12	1.253
Deviations between planned energy efficiency and realized energy efficiency in green buildings	4.533	0.756	9	1.120
The cost of measurement and verification systems vary in size of the building	4.178	0.696	17	1.072
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	4.422	0.737	13	1.234
The documentation is very difficult and the bureaucracy is challenging	4.111	0.685	20	1.496
Unable to make financial planning effectively due to unpredictable costs in green buildings	4.222	0.704	16	1.396
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	4.400	0.733	14	1.355
Lack of awareness of the benefits of green buildings throughout the life cycle	4.889	0.815	6	0.982

Table 5.6 (continued) : Descriptive statistics of total sample (N=45).

Factors	Mean	RII	Rank	Std. Dev.
Undeveloped building energy simulations area	4.156	0.693	19	1.445
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	4.489	0.748	11	1.254

Table 5.7 : Descriptive statistics of architects and engineers' answers.

Factors	Architects (18)				Engineers (27)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Motivators for green buildings								
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	5.389	0.898	7	0.778	5.148	0.858	3	1.099
Making it compulsory in public projects	5.556	0.926	4	0.856	5.148	0.858	3	1.199
State promotion and procurement of green building technologies	5.722	0.954	1	0.752	5.333	0.889	1	0.961
Giving low interest loans and / or grants to green building constructions	5.611	0.935	3	0.502	5.222	0.870	2	0.847
Providing tax advantages to green building constructions	5.444	0.907	5	0.705	4.889	0.815	5	1.121
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	5.667	0.944	2	0.485	4.556	0.759	13	1.476
Reduction of water and energy consumption costs that green building occupants need to pay	5.444	0.907	5	0.984	4.815	0.802	7	1.111
Conducting campaigns to increase environmental awareness	4.889	0.815	14	1.231	4.852	0.809	6	1.064
Training on design and construction of green buildings in universities and professional organizations	5.056	0.843	10	0.725	4.630	0.772	12	1.305
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	5.056	0.843	10	0.725	4.815	0.802	7	1.039

Table 5.7 (continued) : Descriptive statistics of architects and engineers' answers.

Factors	Architects (18)				Engineers (27)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	5.222	0.870	8	0.943	4.704	0.784	9	1.295
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	5.222	0.870	8	0.943	4.667	0.778	11	1.387
Providing prestige and/or brand value to occupants of green buildings	5.056	0.843	10	1.056	4.704	0.784	9	1.031
Higher rental and/or sales value of green buildings	5.000	0.833	13	1.188	4.519	0.753	14	1.252
Motivators for EA credit category								
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	5.500	0.917	3	0.514	5.333	0.889	1	0.679
By state providing the necessary infrastructure for the use of renewable energy systems	5.556	0.926	1	0.705	5.148	0.858	3	0.770
Investing and/or providing incentives for different energy solutions by state	5.556	0.926	1	0.705	5.185	0.864	2	0.622
Establishment of an independent organization for solar energy and making legal regulations for sustainability	5.222	0.870	4	0.943	4.926	0.821	6	0.958
Carrying out studies to reduce the environmental impacts of refrigerant gases	4.833	0.806	8	0.985	4.741	0.790	8	1.059
Increasing number of renewable energy companies	5.056	0.843	6	1.162	5.000	0.833	4	1.038
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	4.889	0.815	7	1.183	4.852	0.809	7	1.262
Providing loans to renewable energy buildings	5.222	0.870	4	1.003	4.963	0.827	5	0.980
Barriers for green buildings and EA credit category								
Considering that the use of environmentally friendly materials is more costly	5.056	0.843	4	0.998	4.963	0.827	5	0.940
Having less incentives in Turkey with compared to other countries	5.222	0.870	1	0.732	5.037	0.840	4	0.759
Existing energy agreements of Turkey	4.944	0.824	5	1.110	4.259	0.710	13	1.023
Low public awareness of sustainability and energy efficiency	5.222	0.870	1	1.003	5.074	0.846	3	0.958
The market is not sustainability centered	5.167	0.861	3	0.985	5.222	0.870	2	0.892
Limitation of adaptation of green energy	4.889	0.815	7	0.963	4.852	0.809	7	1.027

Table 5.7 (continued) : Descriptive statistics of architects and engineers' answers.

Factors	Architects (18)				Engineers (27)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Construction of green buildings requires high quality workmanship	4.167	0.694	19	1.618	4.185	0.698	15	1.302
Energy-efficient systems are more technically complex and expensive than traditional systems	4.056	0.676	20	1.434	4.407	0.735	9	1.279
Increased investment cost of efficient HVAC systems	4.722	0.787	12	1.179	4.852	0.809	7	0.989
Renewable energy use increases the investment cost	4.944	0.824	5	1.162	5.259	0.877	1	0.656
Low number of experts to work on the design of green buildings	4.500	0.750	14	1.200	4.407	0.735	9	1.309
Deviations between planned energy efficiency and realized energy efficiency in green buildings	4.778	0.796	10	0.878	4.370	0.728	11	1.245
The cost of measurement and verification systems vary in size of the building	4.333	0.722	17	1.029	4.074	0.679	17	1.107
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	4.778	0.796	10	1.166	4.185	0.698	15	1.241
The documentation is very difficult and the bureaucracy is challenging	4.389	0.731	16	1.614	3.926	0.654	20	1.412
Unable to make financial planning effectively due to unpredictable costs in green buildings	4.500	0.750	14	1.383	4.037	0.673	18	1.400
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	4.556	0.759	13	1.504	4.296	0.716	12	1.265
Lack of awareness of the benefits of green buildings throughout the life cycle	4.833	0.806	9	1.150	4.926	0.821	6	0.874
Undeveloped building energy simulations area	4.333	0.722	17	1.645	4.037	0.673	18	1.315
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	4.889	0.815	7	1.231	4.222	0.704	14	1.219

Architects chose “Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants” as 2nd most important motivator whereas engineers found this motivator as almost the least important. On the other hand, engineers point out that the 2nd most important motivator for green buildings is “Giving low interest loans and / or grants to green building constructions” whereas architects chose as 3rd most important motivator. The least important motivator for architects is “Conducting campaigns to increase environmental awareness” but engineers find this motivator relatively important. For engineers the least important motivator is “Higher rental and/or sales value of green buildings” whereas architects chose as the 2nd least important motivator.

Both groups determined most important motivators for EA credit category as follows: “Investing and/or providing incentives for different energy solutions by state”, “Having energy saving and reducing energy costs in green buildings with compared to traditional buildings” and “By state providing the necessary infrastructure for the use of renewable energy systems”.

Architects determined most important barriers for green buildings and EA credit category as “Low public awareness of sustainability and energy efficiency” and “Having less incentives in Turkey with compared to other countries”. On the other hand engineers say that “Renewable energy use increases the investment cost” is the most important barrier.

Consultants and other jobs’ results of same descriptive tests are shown in Table 5.8.

According to consultants, “Making it compulsory in public projects” is the most important motivator for green buildings, whereas it is the 4th most important motivator for others. Consultants consider that following three motivators are at the same importance level. These are: “State promotion and procurement of green building technologies”, “Giving low interest loans and / or grants to green building constructions” and “Providing tax advantages to green building constructions”. On the other hand, respondents, who are working at other jobs identified the following motivators as most important: “State promotion and procurement of green building technologies”, “Giving low interest loans and / or grants to green building constructions” and “To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)".

There are three least important motivators according to consultants, these are "Conducting campaigns to increase environmental awareness", "Providing prestige and/or brand value to occupants of green buildings" and "Higher rental and/or sales value of green buildings". For the others the least important motivator is "Higher rental and/or sales value of green buildings".

Both groups are evaluated following three motivators as the most important motivators for EA credit category: "Having energy saving and reducing energy costs in green buildings with compared to traditional buildings", "Investing and/or providing incentives for different energy solutions by state" and "By state providing the necessary infrastructure for the use of renewable energy systems". According to consultants the least important motivator is "Begin to produce HVAC systems, which should be used in green buildings, in Turkey", in spite of this "Carrying out studies to reduce the environmental impacts of refrigerant gases" is identified as the least important motivator for EA credit category by others.

Consultants consider that following barriers are respectively most important barriers for green buildings and EA credit category: "The market is not sustainability centered", "Considering that the use of environmentally friendly materials is more costly" and "Low public awareness of sustainability and energy efficiency". Other respondents consider that "The market is not sustainability centered", "Low public awareness of sustainability and energy efficiency" and "Having less incentives in Turkey when compared to other countries" are the 2nd most important barriers. The most important barrier for them is "Renewable energy use increases the investment cost". The least important barrier for consultants is "Energy-efficient systems are more technically complex and expensive than traditional systems" and for the others it is "The cost of measurement and verification systems vary in size of the building".

The same tests are applied to analyze the difference between points of view of respondents who have more than 5 years of experience and less than 5 years of experience. Results are presented in Table 5.9.

Table 5.8 : Descriptive statistics of consultants only and others' answers.

Factors	Consultants only (15)				Others (30)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Motivators for green buildings								
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	5.267	0.878	6	1.335	5.233	0.872	3	0.774
Making it compulsory in public projects	5.600	0.933	1	0.910	5.167	0.861	4	1.147
State promotion and procurement of green building technologies	5.533	0.922	2	1.125	5.467	0.911	1	0.776
Giving low interest loans and / or grants to green building constructions	5.533	0.922	2	0.640	5.300	0.883	2	0.794
Providing tax advantages to green building constructions	5.533	0.922	2	0.743	4.900	0.817	5	1.062
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	5.200	0.867	8	1.146	4.900	0.817	5	1.373
Reduction of water and energy consumption costs that green building occupants need to pay	5.467	0.911	5	0.834	4.867	0.811	8	1.167
Conducting campaigns to increase environmental awareness	4.800	0.800	12	1.424	4.900	0.817	5	0.960
Training on design and construction of green buildings in universities and professional organizations	5.000	0.833	11	1.069	4.700	0.783	13	1.149
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	5.067	0.844	10	1.033	4.833	0.806	10	0.874
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	5.267	0.878	6	0.961	4.733	0.789	12	1.258
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	5.133	0.856	9	1.125	4.767	0.794	11	1.305
Providing prestige and/or brand value to occupants of green buildings	4.800	0.800	12	1.082	4.867	0.811	8	1.042
Higher rental and/or sales value of green buildings	4.800	0.800	12	1.320	4.667	0.778	14	1.213
Motivators for EA credit category								
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	5.667	0.944	1	0.488	5.267	0.878	1	0.640
By state providing the necessary infrastructure for the use of renewable energy systems	5.400	0.900	3	0.737	5.267	0.878	1	0.785
Investing and/or providing incentives for different energy solutions by state	5.467	0.911	2	0.743	5.267	0.878	1	0.640

Table 5.8 (continued) : Descriptive statistics of consultants only and others' answers.

Factors	Consultants only (15)				Others (30)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Establishment of an independent organization for solar energy and making legal regulations for sustainability	5.067	0.844	5	0.961	5.033	0.839	6	0.964
Carrying out studies to reduce the environmental impacts of refrigerant gases	4.467	0.744	7	1.302	4.933	0.822	8	0.828
Increasing number of renewable energy companies	4.667	0.778	6	1.175	5.200	0.867	4	0.997
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	4.400	0.733	8	1.502	5.100	0.850	5	0.995
Providing loans to renewable energy buildings	5.133	0.856	4	0.990	5.033	0.839	6	0.999
Barriers for green buildings and EA credit category								
Considering that the use of environmentally friendly materials is more costly	5.200	0.867	2	0.941	4.900	0.817	6	0.960
Having less incentives in Turkey with compared to other countries	5.133	0.856	4	0.743	5.100	0.850	2	0.759
Existing energy agreements of Turkey	4.267	0.711	13	1.387	4.667	0.778	10	0.922
Low public awareness of sustainability and energy efficiency	5.200	0.867	2	1.265	5.100	0.850	2	0.803
The market is not sustainability centered	5.400	0.900	1	1.121	5.100	0.850	2	0.803
Limitation of adaptation of green energy	4.800	0.800	8	1.265	4.900	0.817	6	0.845
Construction of green buildings requires high quality workmanship	3.933	0.656	16	1.668	4.300	0.717	16	1.291
Energy-efficient systems are more technically complex and expensive than traditional systems	3.667	0.611	20	1.543	4.567	0.761	11	1.135
Increased investment cost of efficient HVAC systems	4.333	0.722	12	1.175	5.033	0.839	5	0.928
Renewable energy use increases the investment cost	4.933	0.822	6	1.223	5.233	0.872	1	0.679
Low number of experts to work on the design of green buildings	4.533	0.756	11	1.302	4.400	0.733	14	1.248
Deviations between planned energy efficiency and realized energy efficiency in green buildings	4.867	0.811	7	1.060	4.367	0.728	15	1.129
The cost of measurement and verification systems vary in size of the building	4.133	0.689	14	0.743	4.200	0.700	20	1.215
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	4.667	0.778	9	1.291	4.300	0.717	16	1.208
The documentation is very difficult and the bureaucracy is challenging	3.733	0.622	18	1.751	4.300	0.717	16	1.343
Unable to make financial planning effectively due to unpredictable costs in green buildings	3.733	0.622	18	1.624	4.467	0.744	12	1.224

Table 5.8 (continued) : Descriptive statistics of consultants only and others' answers.

Factors	Consultants only (15)				Others (30)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	3.800	0.633	17	1.699	4.700	0.783	9	1.055
Lack of awareness of the benefits of green buildings throughout the life cycle	5.000	0.833	5	1.000	4.833	0.806	8	0.986
Undeveloped building energy simulations area	4.000	0.667	15	1.690	4.233	0.706	19	1.331
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	4.600	0.767	10	1.183	4.433	0.739	13	1.305

Table 5.9 : Descriptive statistics of respondents who completed up to 5 projects and more than 5 projects.

Factors	< 5 projects (20)				≥ 5 projects (25)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Motivators for green buildings								
To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)	5.500	0.917	1	0.688	5.040	0.840	7	1.136
Making it compulsory in public projects	5.250	0.875	4	1.251	5.360	0.893	3	0.952
State promotion and procurement of green building technologies	5.450	0.908	2	0.887	5.520	0.920	1	0.918
Giving low interest loans and / or grants to green building constructions	5.350	0.892	3	0.813	5.400	0.900	2	0.707
Providing tax advantages to green building constructions	4.850	0.808	11	1.226	5.320	0.887	4	0.748
Reduction in taxes (environmental cleaning tax, property tax etc.) for green building occupants	4.950	0.825	5	1.572	5.040	0.840	7	1.060
Reduction of water and energy consumption costs that green building occupants need to pay	4.950	0.825	5	1.234	5.160	0.860	5	0.987
Conducting campaigns to increase environmental awareness	4.900	0.817	8	1.294	4.840	0.807	11	0.987
Training on design and construction of green buildings in universities and professional organizations	4.750	0.792	12	1.293	4.840	0.807	11	0.987
Training on the life cycle costs of green buildings and their impact on the environment in universities and professional organizations	4.900	0.817	8	0.912	4.920	0.820	9	0.954

Table 5.9 (continued) : Descriptive statistics of respondents who completed up to 5 projects and more than 5 projects.

Factors	< 5 projects (20)				≥ 5 projects (25)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Bureaucracy related costs, such as construction permit, residence permit, is more advantageous than traditional buildings	4.650	0.775	13	1.309	5.120	0.853	6	1.054
Procedures for bureaucracy, such as construction permits and residence permits, are simpler and faster than traditional buildings	4.900	0.817	8	1.334	4.880	0.813	10	1.201
Providing prestige and/or brand value to occupants of green buildings	4.950	0.825	5	1.146	4.760	0.793	14	0.970
Higher rental and/or sales value of green buildings	4.600	0.767	14	1.353	4.800	0.800	13	1.155
Motivators for EA credit category								
Having energy saving and reducing energy costs in green buildings with compared to traditional buildings	5.200	0.867	3	0.696	5.560	0.927	1	0.507
By state providing the necessary infrastructure for the use of renewable energy systems	5.300	0.883	2	0.865	5.320	0.887	2	0.690
Investing and/or providing incentives for different energy solutions by state	5.400	0.900	1	0.681	5.280	0.880	3	0.678
Establishment of an independent organization for solar energy and making legal regulations for sustainability	5.150	0.858	5	0.988	4.960	0.827	5	0.935
Carrying out studies to reduce the environmental impacts of refrigerant gases	5.000	0.833	8	0.858	4.600	0.767	7	1.118
Increasing number of renewable energy companies	5.150	0.858	5	1.182	4.920	0.820	6	0.997
Begin to produce HVAC systems, which should be used in green buildings, in Turkey	5.200	0.867	3	0.951	4.600	0.767	7	1.354
Providing loans to renewable energy buildings	5.050	0.842	7	1.191	5.080	0.847	4	0.812
Barriers for green buildings and EA credit category								
Considering that the use of environmentally friendly materials is more costly	4.950	0.825	6	1.050	5.040	0.840	4	0.889
Having less incentives in Turkey with compared to other countries	5.000	0.833	4	0.795	5.200	0.867	2	0.707
Existing energy agreements of Turkey	4.850	0.808	10	1.040	4.280	0.713	12	1.100
Low public awareness of sustainability and energy efficiency	5.050	0.842	2	0.945	5.200	0.867	2	1.000
The market is not sustainability centered	5.050	0.842	2	0.945	5.320	0.887	1	0.900
Limitation of adaptation of green energy	4.800	0.800	11	0.894	4.920	0.820	6	1.077
Construction of green buildings requires high quality workmanship	4.200	0.700	19	1.508	4.160	0.693	14	1.375

Table 5.9 (continued) : Descriptive statistics of respondents who completed up to 5 projects and more than 5 projects.

Factors	< 5 projects (20)				≥ 5 projects (25)			
	Mean	RII	Rank	Std. Dev.	Mean	RII	Rank	Std. Dev.
Energy-efficient systems are more technically complex and expensive than traditional systems	4.400	0.733	15	1.188	4.160	0.693	14	1.463
Increased investment cost of efficient HVAC systems	4.950	0.825	6	1.146	4.680	0.780	8	0.988
Renewable energy use increases the investment cost	5.250	0.875	1	0.716	5.040	0.840	4	1.020
Low number of experts to work on the design of green buildings	4.400	0.733	15	1.314	4.480	0.747	11	1.229
Deviations between planned energy efficiency and realized energy efficiency in green buildings	4.400	0.733	15	1.142	4.640	0.773	9	1.114
The cost of measurement and verification systems vary in size of the building	4.050	0.675	20	1.356	4.280	0.713	12	0.792
The availability of fewer qualified people in the maintenance and repair of renewable energy systems and the cost to be more expensive than traditional methods	4.300	0.717	18	1.380	4.520	0.753	10	1.122
The documentation is very difficult and the bureaucracy is challenging	4.700	0.783	12	1.302	3.640	0.607	20	1.497
Unable to make financial planning effectively due to unpredictable costs in green buildings	4.650	0.775	13	1.309	3.880	0.647	18	1.394
Cost increases due to delays and exchange rate increases in supply of materials and equipment used in green buildings due to importation from abroad	5.000	0.833	4	1.124	3.920	0.653	17	1.352
Lack of awareness of the benefits of green buildings throughout the life cycle	4.950	0.825	6	1.099	4.840	0.807	7	0.898
Undeveloped building energy simulations area	4.550	0.758	14	1.356	3.840	0.640	19	1.463
Mechanical engineers who make HVAC designs of the building cannot follow the developing technology and therefore continue to design in the traditional way	4.900	0.817	9	1.210	4.160	0.693	14	1.214

According to respondents who have more experience in this sector, the most important motivators for green buildings are respectively: “State promotion and procurement of green building technologies”, “Giving low interest loans and / or grants to green building constructions” and “Making it compulsory in public projects”. These are following motivators for other respondents. The most important motivator is “To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)” for who has completed less than 5 projects. The least important motivator according to more experienced respondents is “Providing prestige and/or brand value to occupants of green buildings”, for others the least important motivator is “Higher rental and/or sales value of green buildings”.

According to both groups, the first three important motivators for EA credit category are “Having energy saving and reducing energy costs in green buildings with compared to traditional buildings”, “By state providing the necessary infrastructure for the use of renewable energy systems” and “Investing and/or providing incentives for different energy solutions by state”. The least important ones according to less experienced respondents are “Carrying out studies to reduce the environmental impacts of refrigerant gases” and “Providing loans to renewable energy buildings”. According to more experienced respondents least important motivators are “Carrying out studies to reduce the environmental impacts of refrigerant gases” and “Begin to produce HVAC systems, which should be used in green buildings, in Turkey”.

Respondents who have completed more than 5 projects specified that most important barriers for green buildings and EA credit category are respectively “The market is not sustainability centered”, “Having less incentives in Turkey with compared to other countries” and “Low public awareness of sustainability and energy efficiency”. On the other hand, respondents who completed less than 5 projects determined that most important barriers are “Renewable energy use increases the investment cost”, “Low public awareness of sustainability and energy efficiency” and “The market is not sustainability centered”. The least important barrier according to more experienced respondents is “The documentation is very difficult and the bureaucracy is challenging” and for the other group it is “The cost of measurement and verification systems vary in size of the building”.

5.5 Recommendations of Respondents

In the questionnaire survey, besides selective questions, at the end of each section there were commentary parts. Some of the respondents filled this part out with their comments. Their comments on motivators for EA credit category are listed as follows:

- First of all, isolation is important. The production of devices of refrigerant gases and mechanical takes place in our country, but they have to complete the international certification processes. The performance values, for instance, must be proven in independent accredited places instead of by the companies' own tests. Carbon credit trade is established, but awareness raising is necessary. It is also necessary to install the electrical load shedding scenarios, energy monitoring systems.
- The minimum achievement from this credit category is due to the low level of labor quality and knowledge.
- Producing renewable energy through cooperatives.

The comments on barriers for green buildings and EA credit category are listed as follows:

- Energy modeling reporting with carbon footprint, LCC and LCA analyses are very important for a structure. I want to underline that it is necessary to make it compulsory as soon as possible. In addition, energy studies in buildings should be carefully done, not only as electrical outputs, test, adjustment, balancing and commissioning. It is absolutely necessary to add commissioning factors to this survey. The commissioning is the mechanical sub-branch of the LCA. It is the first step to the carbon footprint.
- The biggest limiting factor in green building construction is that green building increases the cost of building. Especially, design and implementation of a building in line with the requirements of LEED will bring additional costs under the conditions of Turkey.
- The most important barrier is inadequate qualified employee.
- Employers and project owners do not have a lifelong cost perspective.

6. CONCLUSION

Nowadays, being environmental friendly is not an option it is a necessity. Transformation of being environment-friendly also commenced in the construction field, as well as other areas. As an output of this transformation, green building concept was introduced to the construction industry. Many components of this concept exist within the construction industry from materials to wastes. To define a building as green, it needs to be certified by a GBRS. Many countries around the world has their own GBRS. According to the conditions and necessities, developed countries built up their own GBRS. Among these GBRS, LEED and BREEAM are the most popular ones in the world. Turkey has not yet part of national GBRS, because the lack of international GBRS, that needs to be used. With around 11 million certified squaremeters, LEED is the most preferred GBRS in Turkey.

In this thesis, LEED certified projects in Turkey was examined. There are 366 LEED certified projects in Turkey. However, 366 projects could not be chosen as population due to the characteristic differences between projects such as rating system and version. Firstly, in order to obtain a group of projects to compare, these projects were classified according to their versions. It has been indicated that majority of these projects, which corresponds to 290 of these were certified according to LEED v3. Afterwards, it is classified according to their rating system, and it is revealed that New Construction rating system has the maximum number of projects compared to other rating systems, therefore New Construction rating system’s breakdown by versions har to be examined as well. Finally, it is obtained that 172 projects, which are certified according to v3 New Construction rating system, could be used as a sample of this thesis. According to all the tests which were interpreted above, energy and atmosphere category has the biggest potential for the owners/companies who target higher certification level of LEED certification system. To discover the least successful credit category of LEED certified projects of Turkey descriptive statistics were applied and whether there were statistically notable differences between the credit achievements of newly constructed buildings in Turkey, Kruskal-Wallis and Mann-Whitney U tests were performed and findings were interpreted. According to the tests, around 33% of the credits of LEED can be obtained from EA credit category. In spite of this, when examined, this category is where the projects failed most; and there are statistically significant differences between certification levels. As a result of these tests, it is seen that EA credit category can enable future projects to achieve higher credits from LEED, thus they can have higher certification levels.

Likewise, same tests were applied to sub credit categories of EA credit category and it is revealed that sub credit categories, except green power (C6), achievements of buildings certified according to four certification levels are statistically significant different at 95% significance level.

After revealing EA credit category has a major effect on LEED certified buildings in Turkey, within the scope of thesis a questionnare survey was conducted in order to determine the barriers for green buildings and EA credit category and also motivators for green buildings and EA credit category.

45 professionals from different specialities contributed to the questionnaire survey. According to the respondents, most important motivators for green buildings are “State promotion and procurement of green building technologies”, “Giving low interest loans and / or grants to green building constructions” and “Making it compulsory in public projects”. Most important motivators for EA credit categories are: “Having energy saving and reducing energy costs in green buildings with compared to traditional buildings”, “Investing and/or providing incentives for different energy solutions by state” and “By state providing the necessary infrastructure for the use of renewable energy systems”. Respondents point out that most important barriers for green buildings and EA credit category are “The market is not sustainability centered”, “Renewable energy use increases the investment cost” and “Low public awareness of sustainability and energy efficiency”.

Furthermore, respondents were grouped and these groups were compared in pairs to reveal whether there are different point of views. First pair of these groups were architects and engineers. According to architects and engineers the most important motivator for green buildings is same and it is “State promotion and procurement of green building technologies”. Both groups determined most important motivators for EA credit category as follows: “Investing and/or providing incentives for different energy solutions by state", "Having energy saving and reducing energy costs in green buildings with compared to traditional buildings" and "By state providing the necessary infrastructure for the use of renewable energy systems". Architects determined most important barriers for green buildings and EA credit category as "Low public awareness of sustainability and energy efficiency" and "Having less incentives in Turkey with compared to other countries". On the other hand engineers say that "Renewable energy use increases the investment cost" is the most important barrier.

Second pair was consultants and others. According to consultants, "Making it compulsory in public projects" is the most important motivator for green buildings, whereas it is the 4th most important motivator for others. Consultants consider that following three motivators are at the same importance level. These are: "State promotion and procurement of green building technologies", "Giving low interest loans and / or grants to green building constructions" and "Providing tax advantages to green building constructions". Whereas, respondents, who are working at other jobs identified the following motivators as most important: "State promotion and procurement of green building technologies", "Giving low interest loans and / or grants to green building constructions" and "To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)". As well as having three crucial points, there are also three least important motivators according to consultants, these are "Conducting campaigns to increase environmental awareness", "Providing prestige and/or brand value to occupants of green buildings" and "Higher rental and/or sales value of green buildings". For the others the least important motivator is "Higher rental and/or sales value of green buildings".

Both groups are evaluated following three motivators as the most important motivators for EA credit category: "Having energy saving and reducing energy costs in green buildings with compared to traditional buildings", "Investing and/or providing incentives for different energy solutions by state" and "By state providing the necessary infrastructure for the use of renewable energy systems". According to consultants the least important motivator is "Begin to produce HVAC systems, which should be used in green buildings, in Turkey", in spite of this "Carrying out studies to reduce the environmental impacts of refrigerant gases" is identified as the least important motivator for EA credit category by others.

Consultants consider that following barriers are respectively most vital barriers for green buildings and EA credit category: "The market is not sustainability centered", "Considering that the use of environmentally friendly materials is more costly" and "Low public awareness of sustainability and energy efficiency". Other respondents consider that "The market is not sustainability centered", "Low public awareness of sustainability and energy efficiency" and "Having less incentives in Turkey when compared to other countries" are the 2nd most important barriers. The most important barrier for them is "Renewable energy use increases the investment cost". The least important barrier for consultants is "Energy-efficient systems are more technically complex and expensive than traditional systems" and for the others it is "The cost of measurement and verification systems vary in size of the building".

Third pair was respondents who has more than 5 projects of experience and less than 5 projects of experience. According to respondents who have more experience in this sector, the most important motivators for green buildings are respectively: "State promotion and procurement of green building technologies", "Giving low interest loans and / or grants to green building constructions" and "Making it compulsory in public projects". These are following motivators for other respondents. The most important motivator is "To make investments for the use of countries', which are dependent on other countries in terms of energy, own resources (renewable energy sources)" for who has completed less than 5 projects. The least important motivator according to more experienced respondents is "Providing prestige and/or brand value to occupants of green buildings", for others the least important motivator is "Higher rental and/or sales value of green buildings".

According to both groups, the first three important motivators for EA credit category are "Having energy saving and reducing energy costs in green buildings with compared to traditional buildings", "By state providing the necessary infrastructure for the use of renewable energy systems" and "Investing and/or providing incentives for different energy solutions by state". The least important ones according to less experienced respondents are "Carrying out studies to reduce the environmental impacts of refrigerant gases" and "Providing loans to renewable energy buildings". According to more experienced respondents least important motivators are "Carrying out studies to reduce the environmental impacts of refrigerant gases” and “Begin to produce HVAC systems, which should be used in green buildings, in Turkey”.

Respondents who have completed more than 5 projects specified that most important barriers for green buildings and EA credit category are respectively “The market is not sustainability centered”, “Having less incentives in Turkey with compared to other countries” and “Low public awareness of sustainability and energy efficiency”. On the other hand, respondents who completed less than 5 projects determined that most important barriers are “Renewable energy use increases the investment cost”, “Low public awareness of sustainability and energy efficiency” and “The market is not sustainability centered”. The least important barrier according to more experienced respondents is “The documentation is very difficult and the bureaucracy is challenging” and for the other group it is “The cost of measurement and verification systems vary in size of the building”.

In conlusion, according to these findings of the questionnaire survey, state is having a very important role in this area. In addition to all mentioned factors, cost is the most considerable factor in this area such as savings, incentives, loans etc. On the other hand, according to the respondents trainings, prestige or higher rentals are not great motivators for this area. When it is approached from barrier perspective traditional construction centered market is a great barrier, also the expenses which increase the investment cost of a project. As it is highlighted by some respondents construction market does not consider green buildings or new technologies from the point of life long benefits. In terms of EA credit category, limitation in green energy and being expensive are most important barriers. According to the findings of the questionnaire survey,

1. Government should take more responsibility to encourage all parties of this sector.
2. There should be more incentives or economical benefits at green building or EA credit category areas, this can make it more attractive to the companies to invest in these subjects.

Limitations of this thesis are as follows: The research was focused only EA credit category and completed by 45 professionals. In future, it is suggested to examine other credit categories and realize a questionnaire survey with more respondents.

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APPENDICES

APPENDIX A

Sayın İlgili,

İnşaat yapım sürecinin ve binaların, çevreye vermiş olduğu zararlar gün geçtikçe daha çok tartışılmaya başlamıştır. Bu bağlamda, yeşil binalar; sürdürülebilir kalkınma, küresel ısınma ve tükenen doğal kaynaklar açılarından büyük bir önem taşımaktadır. Yeşil binaların belgelenmesi için kullanılan pek çok sertifikasyon sistemi olmasına rağmen, ülkemizde en yaygın olarak kullanılan LEED'dir. "LEED-Enerji ve Atmosfer" kategorisinden alınan krediler incelendiğinde ise, bu kategoriden alınan kredilerin diğer kategorilerden çok daha düşük olduğu görülmektedir. Bu anket çalışması ile "LEED-Enerji ve Atmosfer" kategorisinden düşük kredi alınmasının nedenleri incelenecektir. Bu anket çalışmasının bulguları, bir yüksek lisans tezi için kullanılacaktır.

Bu tezin başlıca amaçları;

- Türkiye'de yeşil binalara yatırım yapılmasının nedenlerini saptamak.
- Türkiye'de Yeşil Binalar ve özellikle "Enerji ve Atmosfer" kategorisinden düşük puan alınmasının nedenlerini saptamaktır.
- LEED yeşil bina sertifikasyon sisteminde en çok puan kazanılabilecek kategori "Enerji ve Atmosfer" olmasına rağmen, en başarısız olunan kategoridir. "Enerji ve Atmosfer" kategorisinden daha yüksek kredi alınabilmesi için neler yapılması gerektiğini saptamaktır.

Söz konusu çalışma doğrultusunda hazırlanan ankette yer alan sorular, daha önceden yapılan benzer çalışmalarda ortaya konulan faktörlerle ilgilidir. Sorulara verdiğiniz cevaplar sadece akademik amaçlar doğrultusunda kullanılacak olup üçüncü şahıslarla kesinlikle paylaşılmayacaktır. Katılımınız ve desteğiniz için şimdiden teşekkür ederiz.

Saygılarımızla,

Prof. Dr. Gül POLAT TATAR — Naz YIKILMAZ

İTÜ İnşaat Fakültesi / Yapı İşletmesi Birimi Öğretim Üyesi — İnş. Müh.

GENEL BİLGİLER

1-Eğitim durumunuz nedir?

☐Lisans

☐Yüksek Lisans

☐Doktora

2-Mesleğiniz nedir?

○İnşaat Mühendisi

○Mimar

○Makine Mühendisi

○Elektrik Mühendisi

○Çevre mühendisi

○Şehir Bölge Planlamacı

○Diğer…..

3-Çalıştığınız firma türü ne hizmet vermektedir?

☐İşveren

☐Ana Yüklenici

☐Alt Yüklenici

☐Mühendislik/Tasarım

☐Danışmanlık/Müşavirlik

4-Şimdiye kadar kaç adet yeşil inşaat projesinin tasarım ve/veya yapım aşamasında yer aldınız?

○1

○1-4

○5-9

○≥10

5-Yer aldığınız yeşil inşaat projesinin türü neydi?

☐Endüstriyel Tesis

☐Konut/Toplu Konut

☐Ticari ve Kurumsal Yapılar

☐Diğer….

6-Yer aldığınız yeşil inşaat projeleri, LEED'e göre hangi derece(ler)de belgelenmişti?

☐Sertifikalı

☐Gümüş

☐Altın

☐Platin

7-Yeşil binalarla ilgili bilgi birikiminizi nasıl edindiniz?

☐Yüksek Öğretim

☐Konferanslar

☐Sektörel Yayınlar

☐İnternet Araştırması

☐Danışman Firmalar

☐Çalışma Arkadaşları

☐Diğer….

MOTİVATÖRLER

8-Aşağıdaki faktörler/teşvikler, yeşil inşaat yaklaşımının yaygınlaşmasında ne ölçüde etkili olur?

FAKTÖRLER	Hiç Önemli Değil	Çok Az Önemli	Az Önemli	Orta Önemli	Önemli	Çok Önemli
Enerji konusunda dışa bağımlı halde olan ülkenin kendi kaynaklarını kullanmak (yenilenebilir enerji kaynakları) için yatırımlar yapması	○	○	○	○	○	○

Kamu projelerinde zorunlu hale getirilmesi	○	○	○	○	○	○
Yeşil bina teknolojilerinin devlet tarafından teşvik edilmesi ve tedarik edilmesi	○	○	○	○	○	○
Yeşil bina inşaatlarına düşük faizli krediler ve/veya hibeler verilmesi	○	○	○	○	○	○
Yeşil bina inşaatlarına bazı vergi avantajları sağlanması	○	○	○	○	○	○
Yeşil bina kullanıcılarının ödemesi gereken vergilere (çevre temizlik vergisi, emlak vergisi gibi) indirim uygulanması	○	○	○	○	○	○
Yeşil bina kullanıcılarının ödemesi gereken su ve enerji tüketim bedellerine indirim uygulanması	○	○	○	○	○	○
Çevre bilincinin arttırılmasına yönelik kampanyaların yürütülmesi	○	○	○	○	○	○
Üniversitelerde ve Meslek Kuruluşlarında yeşil binaların tasarım ve yapımı ile ilgili eğitimlerin verilmesi	○	○	○	○	○	○
Üniversitelerde ve Meslek Kuruluşlarında yeşil binaların yaşam döngüsü maliyetleri ve çevre üzerindeki etkileri ile ilgili eğitimlerin verilmesi	○	○	○	○	○	○
İnşaat ruhsatı, iskan izni gibi bürokrasiye ilişkin maliyetlerin geleneksel binalara göre daha avantajlı hale gelmesi	○	○	○	○	○	○
İnşaat ruhsatı, iskan izni gibi bürokrasiye ilişkin prosedürlerin geleneksel binalara göre daha sade ve hızlı olması	○	○	○	○	○	○
Yeşil binaların kullanıcılarına prestij ve/veya marka değeri sağlaması	○	○	○	○	○	○

Yeşil binaların kiralama ve/veya satış değerinin yükselmesi	○	○	○	○	○	○
Bu başlık altında eklemek istediğiniz başka faktörler varsa lütfen belirtiniz.						

9-Aşağıdaki faktörler/teşvikler, LEED Enerji ve Atmosfer kategorisinden daha fazla kredi kazanılmasında ne ölçüde etkilidir?

FAKTÖRLER	Hiç Önemli Değil	Çok Az Önemli	Az Önemli	Orta Önemli	Önemli	Çok Önemli
Yeşil binalarda, geleneksel binalara göre enerji tasarrufu sağlanması ve enerji maliyetlerinin de azalması	○	○	○	○	○	○
Devletin, yenilenebilir enerji sistemlerinin kullanılabilmesi için gerekli altyapıyı sağlaması	○	○	○	○	○	○
Devletin, farklı enerji çözümleri için yatırım yapması ve/veya teşvik sağlaması	○	○	○	○	○	○
Güneş enerjisi için bağımsız bir kurulun kurulması ve sürdürülebilirlik için yasal düzenlemelerin yapılması	○	○	○	○	○	○
Soğutucu gazların çevresel etkilerinin azaltılmasına yönelik çalışmaların yapılması	○	○	○	○	○	○
Yenilenebilir enerji üreten firma sayısının artması	○	○	○	○	○	○
Yeşil binalarda kullanılması gereken HVAC sistemlerinin Türkiye'de üretilmeye başlaması	○	○	○	○	○	○

Yenilenebilir enerji kaynaklı yapılan binalara kredi sağlanması	○	○	○	○	○	○
Bu başlık altında eklemek istediğiniz başka faktörler varsa lütfen belirtiniz.						

BARİYERLER

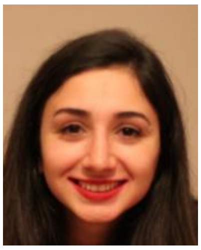
10-Aşağıdaki faktörler, yeşil inşaat projelerinin ve LEED Enerji ve Atmosfer kategorisinden daha fazla kredi kazanılmasının önünde ne ölçüde engeldir?

FAKTÖRLER	Hiç Önemli Değil	Çok Az Önemli	Az Önemli	Orta Önemli	Önemli	Çok Önemli
Çevreye duyarlı malzemelerin kullanımının daha maliyetli olduğunun düşünülmesi	○	○	○	○	○	○
Türkiye'de teşviklerin diğer ülkelere kıyasla daha az olması	○	○	○	○	○	○
Türkiye'nin hali hazırda olan enerji anlaşmaları	○	○	○	○	○	○
Sürdürülebilirlik ve enerji verimliliği konularında toplum bilincinin yüksek olmaması	○	○	○	○	○	○
Pazarın sürdürülebilirlik merkezli olmaması	○	○	○	○	○	○
Yeşil enerjinin adapte edilmesindeki sınırlılık	○	○	○	○	○	○
Yeşil binaların inşaatının kaliteli işçilik gerektirmesi	○	○	○	○	○	○

Enerji verimli sistemlerin, geleneksel sistemlere göre teknik açıdan daha karmaşık ve maliyet açısından da daha pahalı olması	○	○	○	○	○	○
Verimli HVAC sistemlerinin yatırım maliyetini arttırması	○	○	○	○	○	○
Yenilenebilir enerji kullanımının yatırım maliyetini arttırması	○	○	○	○	○	○
Yeşil binaların tasarımı konusunda çalışacak uzmanların sayısının az olması	○	○	○	○	○	○
Yeşil binalarda, tasarım aşamasında planlanan enerji verimliliği ile gerçekleşen enerji verimliliği arasında sapmalar olması	○	○	○	○	○	○
Ölçme ve doğrulama sistemlerinin maliyetlerinin binanın büyüklüğüne farklılık göstermesi	○	○	○	○	○	○
Yenilenebilir enerji sistemlerinin bakım ve onarımında daha az sayıda yetkin kişinin bulunması ve maliyetinin geleneksel yöntemlere göre daha pahalı olması	○	○	○	○	○	○
Dokümantasyonun çok ve bürokrasinin zorlayıcı olması	○	○	○	○	○	○
Yeşil binalarda sıkça öngörülemeyen maliyetlerin çıkması sebebiyle finansal planlamanın etkin bir şekilde yapılamaması	○	○	○	○	○	○
Yeşil binalarda kullanılan malzemenin ve donanımın yurtdışından ithal edilmesinden ötürü temininde gecikmeler ve kur artışlarından dolayı maliyet artışlarının yaşanması	○	○	○	○	○	○
Yeşil binaların yaşam döngüsü boyunca getireceği faydalardan haberdar olunmaması	○	○	○	○	○	○

Bina enerji simülasyonlarının gelişmemiş bir alan olması	○	○	○	○	○	○
Binanın HVAC tasarımlarını yapan makine mühendislerinin gelişen teknolojiyi takip edememeleri ve bu sebeple geleneksel şekilde tasarlamaya devam etmeleri	○	○	○	○	○	○
Bu başlık altında eklemek istediğiniz başka faktörler varsa lütfen belirtiniz.						

CURRICULUM VITAE



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