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EVALUATION OF LEED CERTIFIED GREEN BUILDINGS

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Leadership in Environmental and Energy Design, LEED, is one of the most recognized green building certification systems in the world. Turkey is also one of the countries, where it is widely used. It offers different rating groups to address varying requirements of building and project types. LEED-v3 NC, the rating group for new construction, includes seven categories of credits: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor air quality, innovation, and regional priority. The maximum achievable point is 110. Local conditions significantly affect the achievement of some of the credits, as LEED is originated in the USA. This study focuses on the assessment of 122 LEED-v3 NC certified buildings in Turkey, considering the points achieved in each category. The aim is to understand which categories are successfully fulfilled and more challenging for implementation. Analysis results show that buildings receive higher points from water efficiency, sustainable sites, innovation and regional priorities, when compared to indoor environmental quality, energy and atmosphere and material and resources categories in Turkey. The lowest category is identified as material and resources. This situation should lead the new projects taking precautions to this individual area especially at the beginning of "planning step" in construction process. Recognizing the successful implementations for earning points and the challenging issues in Turkish construction industry regarding green buildings can be of benefit for professionals in this area.

Keywords: Green building sector, v3-LEED NC, Success ratio, Material and resources.

1 INTRODUCTION

Use of Green Building certification systems is becoming more popular in construction industry in the world. These systems provide numerous environmental and economic benefits. As a developing country, there are efforts to develop a national certification system in Turkey like Çedbik, TSE and Seeb-TR (Aytaç 2013, Çetik 2014). Green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by efficiently using energy, water, and other resources, protecting occupant health, improving employee productivity, reducing waste, pollution and environmental degradation (Table 1).

Environmental-friendly projects are approved by several certification systems and the most commonly used certification system in Turkey is LEED. In this study, LEED-certified buildings in Turkey are analyzed to identify the achievement of LEED points. The aim is to make an assessment by implementations and highlight the challenges during certification.

Table 1. Potential benefits of green buildings.

Environmental Benefits	• Enhance and protect biodiversity and ecosystems • Improve air and water quality • Reduce waste streams • Conserve and restore natural resources
Economic Benefits	• Reduce operating costs • Create, expand, and shape markets for green product and services • Improve occupant productivity • Optimize life-cycle economic performance
Social Benefits	• Enhance occupant comfort and health • Heighten aesthetic qualities • Minimize strain on local infrastructure • Improve overall quality of life

2 ENERGY AND WATER CONSUMPTION IN TURKEY

As a growing Organization for Economic Co-operation and Development (OECD) member country, energy consumption in Turkey is increasing every day (Candemir *et al*. 2012, IEA 2010, IEA 2011). For example, Turkish electricity consumption was 242.4 billion kWh in 2012, in 2013, this number raised by 1.3% and became 245.5 billion kWh (Republic of Turkey Ministry of Energy and Natural Resources 2015). In 2010, 89.3% percentage of primary energy demand funded by fossil fuels in Turkey as; 31.9% natural gas, 26.7% petroleum, 16.6% coal, 14.1% lignite (Kıncay 2014). If this consumption trend tends to continue, statistics show that in 40 years fossil fuels could be insufficient to meet the increasing demand. The primary energy demand in Turkey will be raised by 160% in 2020, which is three times more than world average (ETKB 2009).

Given its growing population, rapid urbanization and industrialization, Turkey is expected to become a water stressed country by 2030 despite its water resources (DSİ 2010, WWF 2014). The amount of water per capita of Turkey is far below the average amount of water per capita in European countries (Doğan 2014). Water rich countries are those, which have 10,000 cubic meters of water per capita yearly. This is well above the 1,500 cubic meters per capita in Turkey (T. C. MINISTRY OF FOREIGN AFFAIRS 2015). Therefore, Turkey is obliged to use water resources sustainable, both at the national level and especially in the transboundary context because of its aggressive geopolitical position.

These statistics show the great need of saving from resources not only for today, but for future requirements as well. The first step of the saving policy should start with buildings, since buildings account for more than 40% of total energy consumption, and the construction sector as a whole is responsible for approximately 40% of all human-produced wastes (UNEP 2003). Green buildings can save around 30% of energy bills, around 35% of carbon emissions, 35% of water usage and nearly 70% of waste utilization (Capital E 2013). With all these facts, dissemination of green buildings is a must for Turkey like the rest of the world (Yeşil Bina 2013, Yeşil Bina 2014).

3 LEED IN TURKEY

Leadership in Energy & Environmental Design (LEED) is a green building certification program that recognizes best-in-class building strategies and practices, which has wide-spread usage around the globe (USGBC 2015). The major feature of this certification system is its applicability to various projects for different location and characteristics. In USGBC official website, there are nearly 83,000 projects around the globe and 441 projects in Turkey are certified or in a certification process. Today's certified project number is 143 inside the Turkish borders yet, 122 of them could be examined according to the availability of the project scorecards online from where it is the only basis of the data gathered (USGBC 2015).

Projects have been examined from 16 different cities in Turkey (İstanbul, Kocaeli, Ankara, Izmir, Mugla, Balikesir, Elazıg, Eskisehir, Cankırı, Konya, Hatay, Sakarya, Antalya, Kayseri, Balikesir, and Adana) and Istanbul is the city including most of the projects with 73 projects. The widely used version (v3-LEED2009) had 5 different subheadings in order to describe the building more accurately. LEED BD+C: New Construction (v2009) and LEED BD+C: Core and Shell (v2009) are the mostly used subheadings to describe Turkish LEED certified buildings. These subheadings apply to buildings that are being newly constructed or going through a major renovation. (New Construction, Core and Shell, Schools, Retail, Healthcare, Data Centers, Hospitality, Warehouses and Distribution Centers) In 122 different projects (11 platinum, 82 gold, 20 silver and 9 certified) that have been examined, 70 of them are certified according to LEED BD+C: New Construction and 28 of them are certified according to LEED BD+C: Core and Shell. This situation shows the majority of green certification usage is in new buildings and transformation of old buildings are not commonly used yet.

In this study, achievement of LEED categories of these buildings is analyzed. As most of the LEED certified buildings are certified with LEED BD+C: New Construction and LEED BD+C: Core and Shell, the study focuses on the characteristics of these two systems. The findings are shown in Table 2.

The analysis results showed that regional priority (88%) and water efficiency (77%) are the two categories that can be considered as the most successful ones. Regional priority had such high achievement related to its scoring which consists of other categories and saliency of the environmental issues. Water category includes three type of credit as water efficient landscaping, innovative wastewater technologies and water use reduction in LEED v2009. Among 70 projects certified with LEED BD+C: New Construction, water efficient landscaping (67.9%), innovative wastewater technologies (82.9%) and water use reduction (82.9%) had high achievements, among them both water use reduction and innovative wastewater technologies are successful headlines with the achievement of 82.9%. 28 projects were certified with LEED BD+C: Core and Shell, and the achieved percentages were determined for innovative wastewater technologies and water use reduction as 89.3% and (85.7%), respectively. The water efficient landscaping credit was calculated as 57.1%.

Water efficient building design has 5 components especially in residential projects; submetering, installation of pressure reducing valves, install water saving devices / use of water efficient labeled products, water substitution / recycling of used water and water efficient landscaping. As the main problem occurs in water efficient landscaping,

using water efficient plants, reused water, water efficient irrigation systems and rainwater harvesting would help to have higher points in that field.

The two categories with lowest average were material & resources (39%) and energy & atmosphere (44%). Material and resources category includes eight type of credits as two of them about building reuse, construction waste management, materials reuse, recycled content, regional materials, rapidly renewable materials and certified wood. (USGBC 2015) Among 70 projects certified with LEED BD+C: New Construction, three categories were successful; regional materials (85%), recycled content (84.3%) and construction waste management (75%). Remaining 5 categories had relatively lower achieved percentages; certified wood (2.9%), materials reuse and building reuse - maintain interior nonstructural elements (4.3%), building reuse - maintain existing walls, floors and roof (9%) and rapidly renewable materials (10%). 28 projects were certified with LEED BD+C: Core and Shell. The credits, building reuse - maintain existing walls, floors and roof (0%), materials reuse (3.6%) and certified wood (10.7%) had very low percentage values. Construction waste management (73.2%), recycled content (94.6%) and regional materials (96.4%) had quite high achievement with respect to others.

Even though LEED system was developed in the U.S., the supply and use of sustainable materials are quite challenging for projects in countries both inside and outside of North America. For example; one of the highest rated projects in the world, Pixel from Australia got 105 points out of 110 (LEED BD+C: New Construction v3 - LEED 2009). In its scorecard, the missing 5 points are all from Material & Resources component (USGBC 2015, Greenbuildings.com Team 2012). Similar issues related sustainable materials are also seen in Turkey.

Several solutions can be addressed to receive higher point in Material & Resources such as, using new type – green concrete, utilizing from recycled materials and existing buildings. The selection of appropriate material can differ depending on project conditions such as; choosing local manufacturing products and try to find the material from local producers, evaluating the using eco-technology, evaluating the recyclability of materials and using durable materials, making sure that the material is not toxic over time, using certified materials and waste management and reduction should be managed wisely. The average of the achievement of the categories can be seen in Table 2.

Table 2. Results of achievement ratio according to 122 projects.

CATEGORY	CERTIFICATION LEVEL(%)				
	Platinium	Gold	Silver	Certified	Total Average
Sustainable Sites	88	77	73	59	76
Water Efficiency	89	80	66	52	77
Energy & Atmosphere	50	45	36	22	44
Material & Resources	50	39	33	35	39
Indoor Environmental Quality	76	51	30	33	49
Innovation	91	78	65	54	76
Regional Priority	98	91	76	67	88

4 CONCLUSION

The aim of this study was forming a database and evaluate the results about LEED-certified buildings in Turkey which would create a baseline for further and more comprehensive studies. According to analysis results, Turkish LEED Certified projects scored higher points in "Water Efficiency" with 77% percent compared to other credit categories. The results also present that, LEED Certified projects in Turkey received lower achievement percentage in "Material & Resources" with 39%. Especially the following subcriteria have developmental needs; building reuse - maintain existing walls, floors and roof, building reuse - maintain existing walls, floors and roof, building reuse - maintain interior nonstructural elements, materials reuse, rapidly renewable materials and certified wood. In addition to these, water efficient landscaping can also be improved to provide better solutions requiring less use of water.

Turkish green building sector has an important potential in the world related to growing Turkish construction sector. In 2013, the cost of electricity import was 56 billion dollars in Turkey (EPDK 2015). A new regulation for buildings to perform as a green building can save up to 30% of this expense. Green building construction dissemination would have greater benefits on a larger scale.

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