Case Study

Green Building Certification Process of Existing Buildings in Developing Countries: Cases from Turkey

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Abstract: Sustainability has become a major concern for the construction industry. There has been a growing emphasis on green buildings in the last decade. Renovation is critical in terms of improving the energy efficiency of the building stock. In this paper, the green building certification process of existing buildings in developing countries is investigated. A qualitative case study methodology has been employed to gain a better understanding of the critical success factors of the greening and certification process. In this respect, six leadership in energy and environmental design (LEED)-certified projects in Turkey are examined. A framework is used to analyze the components of this process, including the drivers, resources, green implementations, barriers, enablers, benefits, and impacts. Unavailability of approved materials, poor design of the buildings, and difficulties with the documentation process have been major barriers. The barriers have been overcome through the commitment of the owners, top management support, and collaborative working among project parties. The findings of this study are expected to guide construction professionals in certifying existing buildings in an effective manner. Similar studies may be conducted for existing buildings in different countries, where different regulations and conditions exist. The proposed framework can also be employed to investigate the certification process of new construction projects. **DOI: 10.1061/(ASCE)ME.1943-5479.0000358.** *© 2015 American Society of Civil Engineers.*

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Introduction

Environmental sustainability has become a major concern for the construction industry. Buildings are the world's heaviest consumers of natural resources and account for 40% of total global CO_2 emissions and 30% of global raw material consumption and solid waste output (McGraw-Hill Construction 2008). Therefore, the construction sector has a huge potential for carbon dioxide reduction [Department for Communities and Local Government (DCLG) 2007; Department of Trade and Industry (DTI) 2007; Shorrock et al. 2007; Lomas 2010]. To reduce the environmental impacts of buildings, green buildings that are environmental friendly and energy efficient structures are proposed. Green buildings do not only save energy and water but also contribute to the occupant's health and comfort through measures taken in terms of temperature and humidity control, indoor air quality, natural lighting, and waste management (Clevenger 2008).

There has been a vast amount of research on green buildings in the last decade. These studies focus on but are not limited to the cost and benefits of green buildings (Kats 2003, 2006; Tatari and Kucukvar 2011), energy performances (Bell 2004; Diamond et al. 2006; Sinou and Kyvelou 2006; Fowler et al. 2010), green project delivery (Lapinski et al. 2006; Korkmaz et al. 2010; Robichaud and Anantatmula 2011), and green building certification (Fuerst 2009; Da Silva and Ruwanpura 2009; Zuo et al. 2013). In addition to studies investigating new construction projects, there is limited work on energy efficiency in existing building stock (Brook et al. 2005; Waide 2007; Holness 2008; Jones et al. 2013).

Approximately 86% of building construction expenditures in the United States relate to the renovation of existing buildings and not to new construction, and it is expected that more than half of the building stock must be renewed in developed countries (Holness 2008). It is also reported that the most appropriate opportunity for green design and construction activity lies not in constructing new buildings but in engaging in the retrofit and renovation of the existing building stock (McGraw-Hill Construction 2009).

In terms of green buildings, as a developing country, Turkey has limited experience. The first regulation concerning energy efficiency, i.e., Standard of Thermal Insulation Requirements for Buildings, was issued in 1998, and the regulation of energy performance in buildings became effective in 2011. Building research establishment environmental assessment methodology (BREEAM) and leadership in energy and environmental design (LEED) are the most frequently used green building certification systems in Turkey. The LEED 2009 for New Construction and Major Renovations assesses buildings on the basis of seven categories, including sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, innovation, and regional priority. Similarly, BREEAM uses a scoring system to measure different criteria, including energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology, and management processes. Among a total of 89 certified buildings, there are 32 BREEAM- and 57 LEED-certified buildings in Turkey as of December 2013 [U.S. Green Building Council (USGBC) 2013].

The major objective of this research is to analyze the greening process of existing buildings and thereby explore the critical success factors of the greening and certification process in developing countries. In this respect, six projects completed in Turkey were selected as case studies. Interviews were conducted with key participants of those projects. The lessons learned from the case studies will increase awareness among construction professionals

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in terms of green retrofitting and guide them in the certification process. The findings of the research will also allow for comparison of the certification process of existing buildings and new construction projects.

Research Methodology

This research adopts a qualitative methodology, in which semi-structured interviews are used for data collection. Multiple projects were investigated to gain a better understanding of the project-based practices and corporate policies on achieving energy efficient solutions. Case studies try to answer the how and why questions in research, allowing a more in-depth analysis (Yin 2003). There are four quality measures required to conduct case studies, as explained by Yin (2003): (1) construct validity, i.e., the quality of conceptualization or operationalization of the relevant concept; (2) internal validity, i.e., the causal relationships between variables and results; (3) external validity, i.e., the extent to which the findings can be generalized; and (4) reliability, i.e., repeatability with the same results.

To improve the construct validity, both interview data and company documents on energy consumption provided by the interviewees are used in the analysis. A research framework has been established on the basis of the literature to satisfy the internal validity. To address the external validity, multiple case studies are performed. A case study database is constructed, including interview transcripts and all available documents, to allow replication of the study and ensure reliability. The steps of the case study approach are explained in detail subsequently.

In this study, only existing buildings that are upgraded in terms of operation and maintenance or buildings that went through a major renovation are considered. Only LEED-certified buildings are qualified for the study because all of the BREEAM-certified buildings in Turkey are new build. There are 10 LEED-certified green retrofit or renovation projects, four of which were certified on the basis of Existing Buildings of Version 2009 (EB:OM v2009), and six were on the basis of New Construction and Major Renovations of Version 2009 (NC v2009) (USGBC 2013). The LEED applicants can achieve four levels of certification depending on the points achieved: certified (40–49 points), silver (50–59 points), gold (60–79 points), and platinum (80 points and above) (USGBC 2014). Among the 10 buildings, five of them have gold, four have silver, and one of them has a platinum certificate. A total of six of them are in Istanbul (the biggest city in Turkey), two of them are in Kocaeli (one of the biggest industrial regions), one is in Izmir (the third biggest city), and another one is in Ankara (the capital). After identifying all qualified buildings for the research, key project participants, including building owners, constructors, and designers, were contacted. The representatives, e.g., project managers, business development managers, civil engineers, and architects, of the six buildings accepted were involved in a case study. Therefore, this study investigates 6 out of 10 existing buildings that were converted to green in Turkey.

Ozorhon (2013a) developed a framework to analyze the innovation process in a construction project setting by using components, including drivers, inputs, barriers, enablers, innovative activities, and outputs. This framework investigates innovation activities by adopting a system view, in which the inputs and outputs are defined in detail to help better understand the whole process. In that respect, the framework provides a comprehensive analysis at a project level unlike other frameworks that are developed for the firm level. It aims at understanding the innovation experience in projects by trying to answer the questions of why (drivers), what (inputs, activities, and outputs), and how (barriers and enablers). It takes into account the role of the participating organizations, external environment, and project-specific factors. Other studies on greening of buildings have not developed a generic framework to analyze the certification and greening process; rather, they investigated the individual components, such as the barriers, enablers, and benefits of greening. In the study by Ozorhon (2013a), the innovative activities were primarily driven by environmental sustainability and therefore related to energy efficiency and green implementations. Building on this previous work, a similar framework is proposed to investigate the greening process of existing buildings (Fig. 1). In this framework, drivers and resources lead owners or tenants to apply energy efficient (green) implementations. During the implementation stage, several barriers are encountered and these are overcome through a number of factors that are referred to as the enablers. The greening process results in project level (benefits) and organizational level achievements (impacts). The major advantage of using this framework is that it enables a complete analysis of the multidimensions of the greening process and helps to establish the links between the successive components. For example, the enablers act as a catalyst in the system and determine the rate at which green activities are implemented. They work together with the resources against the barriers. The framework offers a path to investigate the greening process that starts with the drivers and finally arrives at the outcomes (benefits and impacts). It is useful to track back the greening experiences in a more organized and systematic manner rather than analyzing the interrelated components individually.

Semistructured interviews were conducted with key project parties in each case. On the basis of the research framework, interview questions were prepared. Table 1 shows the issues discussed during the interviews.

In all cases, at least two individuals were interviewed and each interview took approximately 2 h. The owners of the buildings, who are in most cases the end users as well, the contractors, and the designers were asked to provide information on the cases. Interviews were conducted with as many respondents as possible for each case. The participation of multiple respondents was critical in terms of obtaining the contradicting opinions and/or commonalities on the basis of different perspectives and was helpful for preventing possible biases. Table 2 shows the interviewee information. A total of 14 interviews were conducted for six projects. The majority of the interviewees are civil engineers, architects, and business development managers. A total of three LEED AP civil engineers who acted as consultants were involved in the study. All of the participants are the key people to provide information on the projects and are highly experienced in the building sector. All of the interviews were tape recorded. In addition, the

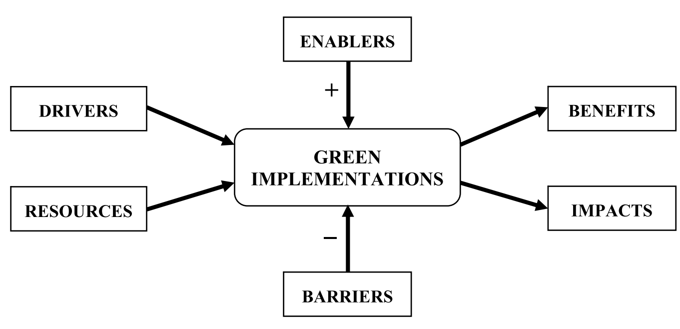

Fig. 1. Framework to investigate greening process of existing buildings

Table 1. Issues Discussed during the Interviews

Questions	Explanation
What were the reasons for greening the building and applying for LEED certification? (Drivers)	Clients' and architects' considerations about green building concept; organization's social and environmental responsibility policy; owner's expectations; improvement of energy efficiency; building regulations
What kinds of resources were used during the whole process? (Resources)	Financial (renovation and incremental cost of LEED application process) and human resources (assignment of a specific team for the process); research and development on green buildings; consultancy services
Which energy efficient tools were implemented? (Green implementations)	Types of energy efficient tools that were adopted in the project
What were the main challenges that were encountered? (Barriers)	Challenges during both construction and legal/administrative processes; cultural, financial, technical, material, and labor related problems
What were the factors that helped overcome those barriers? (Enablers)	Leadership; support from senior management; using technical knowledge or financial resources; receiving support from the consulting firm or help from material suppliers; value engineering; taking advantage of the building's existing properties; employing experts or qualified personnel
What are the achievements of the process at the project level? (Benefits)	Savings in electricity, water, and gas consumption; increase in occupant satisfaction and comfort, reduction in carbon emission and lower operating costs
What are the achievements of the process at the organizational level? (Impacts)	Gaining experience in green building implementation and certification; recognition; awards; better corporate image; market growth

Table 2. Information on the Interviewees

			Experience (years)		
Case	Interviewee number	Title	Construction sector	Green buildings	Expertise
Building A	1	Civil Engineer	13	6	Housing, real estate development
	2	Business Development Manager	15	8	Housing, urban and regional planning
Building B	3	Architect, M.Sc.	22	14	Housing, ecological architecture
	4	Consultant, Civil Engineer, LEED AP	12	9	Project and operation management, green building certification
Building C	5	Mechanical Engineer, M.Sc.	10	6	Mechanical installations and energy efficiency
	6	Architect, M.Sc.	16	8	Acoustics, lightening, and heat isolation
	7	Architect	12	7	Housing, project management
	8	Consultant, Civil Engineer, LEED AP	15	12	Green building certification, project management
Building D	9	Business Development Manager	17	9	Housing, procurement
	10	Architect	24	11	Housing, procurement
Building E	11	Technical Manager	18	8	Electronics, facility management
	12	Electrical Engineer	17	5	Electrical installations
Building F	13	Business Development Manager	22	11	Business administration
	14	Consultant, Civil Engineer, LEED AP	13	10	Project management, LEED certification

interviewees provided both written and visual data, e.g., reports, conference talks, photographs, and presentation files.

The interviews took place in the investigated buildings to allow direct observation and inspection of the buildings. Table 3 shows relevant information on the case study buildings. The building's location, type, year it was built, construction area, LEED certificate type and points earned, and certification year are specified.

Findings and Discussion

The findings of the study are presented on the basis of seven components of the framework, namely, the drivers, resources, green implementations, barriers, enablers, benefits, and impacts. The findings are also compared with the findings reported in the literature concerning both new construction projects and existing buildings. Table 4 presents a brief summary of the greening process of the selected cases.

Drivers

On the basis of previous research, according to both tenants and owners, lowering operation costs is the prime motivation for engaging in a green retrofit project, followed by high return on investment, improved tenant satisfaction, higher asset values, and competitive advantage (McGraw-Hill Construction 2009). The corresponding interviewees suggested that the main driver for the green implementations in Building A was the company's corporate responsibility. Being a member of the Turkish Green Building Council (TGBC), the company is very keen on sustainability and wants to lead the market. With the intention of increasing environmental awareness and increasing employee comfort, they certified their headquarters and received a LEED Silver certificate. A client-driven approach was also observed in Building B. This hotel building was going to go under renovation, and the owners considered applying for a LEED certificate. The student residence hall, having a LEED Gold certificate, is no exception

Table 3. Key Information on Selected Projects

Case	Name	Type, year built, area (m^2)	Location	LEED certificate	Class/points	Award year
1	Building A	Headquarters, 1987, 7,500	Istanbul	EB:OM v2009	Silver/53	2011
2	Building B	Hotel, 1880, 330	Istanbul	NC v2009	Silver/55	2011
3	Building C	Residence hall, 1871, 8,000	Istanbul	NC v2009	Gold/66	2012
4	Building D	Office building, 1998, 1,950	Istanbul	NC v2009	Gold/69	2012
5	Building E	Headquarters, 2010, 20,000	Ankara	EB:OM v2009	Gold/71	2012
6	Building F	Office building, 1989, 15,000	Istanbul	EB:OM v2009	Silver/50	2013

in terms of the environmental policy of the client. Developing a green and sustainable campus is one of the tenets of the university's vision. The interviewees stated that the future new buildings in the university will be designed on the basis of green principles as well. Building D was certified on the basis of the strict environmental responsibility policy of the client (owner of the building) as well. This office building also received a gold certificate. The specific thing about Building E is that it was already equipped with fully automated electromechanical systems, which provide control of all HVAC, air quality, and indoor/exterior lighting units so that the building saves water and energy. The owner of the building operates in the energy sector and they are highly committed to energy efficiency. They also wanted to create an atmosphere where employee satisfaction is high. The building needed almost no additional modification or construction work to be certified, and they obtained a LEED Gold certificate. The owners of Building F are known for their devotion to sustainability. They promote the use of renewable resources, which are hydroelectric and wind power.

All six organizations have a common organizational strategy or approach that they have written environmental responsibility policies. The private clients also believe that with increasing environmental awareness in society, their corporate image will improve. This finding is similar to what has been previously reported in the literature for new construction projects (Osmani and O'Reilly 2009; Hakkinen and Belloni 2011). Employee satisfaction is another reason why private companies choose to green their buildings. A client-driven approach is observed in terms of greening existing buildings. In this respect, there is a similarity with new build green projects, as reported by several researchers (Dewick and Miozzo 2002; Hakkinen and Belloni 2011; Ozorhon 2013a). However, regulation does not play a role as it does for new construction projects (Brandon and Lu 2008; Osmani and O'Reilly 2009; Ozorhon 2013b). This might be because most of the investigated cases are commercial buildings, for which there is yet to be an obligation in Turkey regarding carbon dioxide reduction.

Resources

Greening requires a number of human, financial, and material resources. Among these, the additional budget to be allocated is the most significant. The green premium, which is the initial extra cost to implement green building tools compared with a conventional building (Kats 2006) is calculated as 3–5% for the Australian Green Star rating system (Davis Langdon 2007), 6% for BREEAM (Rawlinson 2007), and 1–8% for LEED (Fowler and Rauch 2008). Building A went through a major renovation before the LEED certification process; therefore, the conversion process did not consume many financial resources. However, documentation took 10 months. A consultant was hired, and the real estate development team of the company was in charge of the LEED certification process. A LEED consultant was responsible for the greening process of Building B. All necessary construction work took 9 months. The project team calculated the extra cost of greening the structure as 5%, which included a qualified labor force and energy efficient and local materials. It took 1 year to complete all construction works for Building C. The university hired a subcontractor for the whole architectural and civil works via its Directorate of Construction. A consultant was hired in this case as well. The main expenses were related to change and renewal of mechanical installations. Building D went through a major renovation, in which the architectural design was renewed extensively. The majority of the extra cost was associated with LEED consultancy. In addition, high-quality materials and equipment were supplied by the local subcontractors. Because of the fact that Building E was already equipped with energy efficient systems, the company did not spend much for the certification process, and only an extra US$15,000 was allocated. For additional changes, a cost benefit analysis was performed and energy efficient tools were chosen accordingly. Again, a consultant was in charge of the process. Building F was again converted with the help of a LEED consultant. The majority of the expenses were related to labor force and ventilation.

Human resources are crucial in LEED-certified building projects. There are not many practitioners in Turkey who have comprehensive knowledge of LEED certification. It is important to have professionals in the project team from different disciplines because LEED criteria include different requirements from many fields. In all cases, a LEED consultant led the conversion process. It is obvious that Turkish companies do not have any experience in LEED certification and therefore cannot carry out the process solely. The importance of a lack of knowledge and technical difficulty has been mentioned in previous work for new projects as well (e.g., Zhang et al. 2010). The financial resources allocated for the certification process vary considerably on the basis of the existing situation and performance of the facility. In some cases, it took approximately 1 year to complete necessary construction work, whereas in some cases, there was little to do to apply for certification. The green implementations in public buildings are limited by the public resources; however, in the case of the private sector, the clients are more flexible with their budgets. As the interviewees suggested, if the building went through a major renovation or retrofit before the certification process, then greening becomes less expensive and complicated for the clients.

Green Implementations

The major categories of green retrofit activities are upgraded building envelope, installed environmentally friendly finishes, installed water efficient plumbing, improved occupancy comfort, installed energy efficient electromechanical systems, and use of daylight (McGraw-Hill Construction 2009). All of the green implementations in Building A were chosen depending on the payback period calculations. These include but are not limited to white tiles in the roof; light-emitting diode (LED) bulbs; carbon dioxide detectors, ozone-friendly gases for heating, and cooling strict waste management in the building. In addition, waste management was introduced and a new irrigation system was established for the green

Table 4. Greening Process of Selected Projects

Case	Drivers	Resources	Green implementations	Barriers	Enablers	Benefits	Impacts
Building A	• Environmental responsibility of the company • Employee comfort	• Real estate development team • Use of consultant • A total of 10 months for the certification process	• LED lamps, mechanical ventilation, light-colored roof • Waste management • Extensive use of public transportation	• Unavailability of LEED-certified cleaning consumables • Documenting in English	• Support of the senior management • Commitment of all departments	• Recycled materials • Savings of electricity (6%), gas (25%), and water (11%) • Increase in thermal comfort (63%) and internal air quality (76%)	• The first LEED-EB certified building in Turkey • Improved corporate image
Building B	• Owner's commitment to environmental sustainability	• Use of consultant • A 5% additional cost • A total of 9 months for construction	• Self-cleaning paint • Green roof • Extensive use of daylight	• No permit for any major change in the building	• Smart procurement planning • Effectiveness of the subcontractor • Experience of the architect	• Savings of energy (25%) and water (28%)	• Less operational cost • Low insurance cost
Building C	• University's aim to create a sustainable campus	• A total of 1 year for construction works • Use of consultant • Use of local suppliers	• Bicycle parks • Recycle bins • Graywater recycling system	• Lack of communication about LEED requirements • Budgetary constraints • Lack of qualified personnel	• Devotion of the university • Effectiveness of the consultant • Architecture and location of the building	• Savings of energy (26%) and water (43%) • Improved students' satisfaction and comfort	• Experience in green implementations and lessons learned
Building D	• Strict environmental responsibility policy of the company	• Use of consultant • Use of local and high-quality materials	• Air conditioners • Sensor faucets with low flow rates • Local plants in landscaping	• Lack of material content reports from suppliers • Failure of the subcontractor in technical infrastructure	• Effectiveness of the consultant in terms of documentation and material supply	• Savings of energy (23%) and water (40%) • Improved employee satisfaction	• Improved corporate image • Award from TGBC
Building E	• Strict environmental responsibility policy of the company	• Use of consultant	• Full automation of all electromechanical systems • Treatment of city water • Waste management system	• Unavailability of LEED-certified cleaning consumables	• Familiarity of the employees with energy efficiency • Existence of relevant energy efficient systems	• Savings of gas (27%), electricity (20%), and water (31%)	• Increased environmental awareness among the employees • Award from TGBC
Building F	• Strict environmental responsibility policy of the company	• Use of consultant	• Providing electricity from a renewable energy company • Submetering devices in all installations • Encouraging public transportation	• Poor design of the structure • Unavailability of LEED-certified materials	• Effectiveness of the consultant • Top management support	• Savings of energy (10%) and water (40%)	• Experience in green implementations and lessons learned

Note: LEED-EB = LEED existing buildings.

areas. Because the building is located in the city center where bus and metro lines run densely, the employees (70%) extensively used public transportation. By this means, motor vehicle use was reduced. Energy efficiency was key to the greening process of Building B. Self-cleaning paint, a green roof, and high-insulation windows were among the green implementations. In addition, the design allows 100% of the living spaces to receive daylight. The specific elements in Building C are as follows: two bicycle parks; recycle bins; use of local materials; user control for heating and lighting systems; graywater recycling system; and carbon dioxide detectors. In addition, 75% of the living spaces receive daylight. In Building D, gas installation was removed; acclimatization was provided with air conditioners; and ovens were run on electricity. Local plants were used for landscaping, and local suppliers were chosen for new furniture. In addition, the parking lot is in the basement floor to avoid the heat island effect that is the thermal absorption by nonreflective buildings and its radiation to surrounding areas. Besides, 90% of the living spaces receive daylight. Building E stands out with its fully automated electromechanical systems. The company established a green purchasing policy for consumables and a strict waste management. City water is treated before it is consumed, and the intensity of the whole lighting system was reduced by 15%. The most interesting point in Building F is that electricity is provided by a private company generating power from renewable resources like wind or geothermal energy. In addition, measuring devices were placed in all sanitary, ventilating, electrical, and natural gas installations. Public transportation was encouraged and aimed to reduce gas emissions and air pollution by reducing motor vehicle use because the building has good connections to multimodal transportation choices.

In terms of the common practices in the six cases, it is observed that energy efficient tools were utilized to save in water, electricity, and gas; waste management was established; and use of public transportation was encouraged. In this respect, implementations are similar to those of new construction. However, on the basis of the architecture or because they are historic buildings, it was not always possible to realize all of the intended changes. In that respect, existing buildings involve additional challenges and a range of different conditions compared with new construction on the basis of their original designs.

Barriers

The major barriers affecting the green building implementations are reported as higher costs for green design and energy saving material, technical difficulty during the construction process, lack of knowledge and awareness of green technologies, and conflict of interest between various stakeholders (Zhang et al. 2010). The investigated cases in this study have experienced a wide range of barriers. For example, the main difficulty in the case of Building A was related to documentation. Because LEED documents are prepared in English, the company asked the English-speaking personnel to be responsible for the documentation. Another issue was related to the availability of LEED-approved cleaning consumables in the market. In the case of Building B, the major challenge was related to the architectural limitation. The project team could not attend certain points because it is a historical building and therefore the general structure cannot be changed. The most difficult conversion process was experienced in Building C. There was a communication problem between the owner and the construction team. Although the university was keen on building a sustainable campus and the student residence building was going to be renovated on the basis of green principles, project specifications were not prepared considering LEED requirements. After the renovation work started, the contractor and subcontractors were informed that the work would satisfy LEED criteria. Therefore, documentation started late and was finished 9 months after the project was completed. The consultancy firm also had difficulties in supplying qualified and experienced personnel for the project primarily because of the language barrier. The project team was granted a tight budget by the university, which created pressure on the team. In the case of Building D, the main barriers were related to the suppliers and subcontractors. There is a lack of awareness in terms of ecomaterials in the market so the suppliers would not be able to present material content reports. Because of the inexperience of the subcontractor who is responsible for the technical infrastructure, despite being included in the project specifications, full automation was not achieved. The project team of Building E was luckier compared with the others. The only difficulty that the team encountered was the unavailability of LEED-approved cleaning consumables. The major challenge of Building F was the architectural design. This office building was very old, the design did not allow the team to benefit from daylight, and the ventilation system was outdated. Although there was no financial constraint, the team could not realize some of its plans. There was also a problem of finding timber and cleaning consumables in compliance with LEED standards.

When all six cases are reviewed, it is observed that one of the major barriers is the unavailability of LEED-approved materials. This is one of the challenges, especially for developing countries, where such materials are not sold. Green cleaning consumables are the most difficult ones to supply in the Turkish market. Although project teams intended to work with local suppliers, sometimes global companies were chosen because of the innovative solutions they offer. The unavailability of products is reported as a barrier in other research for new construction as well (Ozorhon 2013a). Another barrier specific to only existing buildings is the original design of the building. Poorly designed buildings may not receive daylight properly, they have poor thermal insulation, and they may be equipped with inefficient electrical or mechanical systems. Such buildings have disadvantages in green retrofit or renovation projects because it is expensive to green them. Heritage buildings also have some disadvantages arising from prohibition of changing their appearance. Another critical issue is related to documentation and language. Not all employees in those projects could speak English, and the number of LEED experts in Turkey is very limited. Therefore, receiving a LEED consultancy service from third parties was inevitable. It is nearly impossible for a project team to complete a certification process without any support. A local certification system could be a solution to this problem. The first version of a Turkish green building rating system for residences has been prepared by TGBC and published in June 2013. However, diffusion of this system will take some time and some of the difficulties will still be present. An interesting finding is that the owners do not perceive cost as a barrier for greening their existing buildings. However, in the case of new construction, this is one of the main reasons for the companies to be reluctant (Dewick and Miozzo 2004; Zhang et al. 2010; Hakkinen and Belloni 2011; McGraw-Hill Construction 2013). The reason why cost is not considered a barrier in these cases is primarily because of the fact that the converted buildings are mostly commercial, and the owners see the certification as an opportunity to enhance their corporate image so they are more flexible with their budget.

Enablers

The barriers encountered in the greening process are overcome through various mechanisms. For example, project management is critical because green buildings require integration in the delivery process and owner commitment toward sustainability, as suggested by Korkmaz et al. (2010) and Robichaud and Anantatmula (2011). The main success factor was continuous support by the senior management of the owner company in the case of Building A. The business development team also received help from other departments within the company. The main principle was to internalize the green building concept during the implementation process. Unlike other cases, during renovation of Building B, the project team did not have any difficulties in procuring environmentally friendly construction materials. It was enabled owing to smart procurement planning. On the basis of this, a purchase policy was established before the construction phase and suppliers were found in advance. Another critical success factor was the experience of the subcontractors; they were willing to learn the greening process and were very helpful. Another advantage of this case was the architect who was experienced in LEED certification. The consultant firm overcame the barriers encountered in the case of Building C. The firm prepared a comprehensive cost benefit analysis to choose among energy efficient tools. The university was devoted to the greening process as well. The university benefitted from the location of the building, which allowed the use of local transportation. The architecture of the building also helped to achieve energy savings. In the case of Building D, the consultant firm played a very critical role as well. They helped with the documentation and certification processes and assisted the team in choosing proper suppliers. Because of the difficulties with material specifications in the Turkish market, the necessary materials were supplied by foreign firms. Familiarity with energy efficiency was key to successful implementations in Building E. The building already had the relevant electromechanical systems, and little work was done to certify the building. The LEED certification process was quick and smooth. Being an engineering design company and investing in the energy sector, the project team and employees did not face any difficulties in applying LEED principles. The main enablers have been the experience of the consultant and the owner company's top management support in Building F, as observed in many other cases.

On the basis of the findings, it can be stated that the project team is the most crucial party in a green building project. Devotion of the team is one of the critical success factors in the LEED-certification process. When the top management of the organization supports the process starting from the beginning and motivates the personnel, then the project team works in a more independent, motivated, and efficient way. The experience of the consultants and subcontractors should also be noted. The commitment of the owners, support of senior management, and collaborative working are also reported in many studies concerning sustainable buildings (Beheiry et al. 2006; Robichaud and Anantatmula 2011; Mollaoglu-Korkmaz et al. 2013).

Benefits

A number of benefits at the project level have been observed in each case, including recycled materials and saving in electricity, water, and gas consumption. In the case of Building A, paper, plastic, metal, debris, glass, and batteries were among the items that were delivered to the municipality for recycling. The project team achieved saving of electricity (6%), gas (25%), and water (11%). They also achieved increased employee satisfaction through improved thermal comfort (63%) and internal air quality (76%). In the case of Building B, savings were calculated as 25% in energy consumption and 28% in water consumption. In the case of Building C, water (43%) and energy (26%) savings were achieved. Student satisfaction was also improved. In Building D, there was energy (23%) and water (40%) saving. They also achieved an increase in employee satisfaction. Through the energy efficiency measures, savings of gas (27%), electricity (20%), and water use (31%) were achieved in Building E. The savings were estimated as 40% in water use and 10% in energy consumption in Building F. There were certain savings in gas, electricity, and water after green implementations, which in most cases satisfied the private sector owners. However, the level of achievement in energy efficiency was directly related to the amount of work that could be done, given the constraints of the existing building, as mentioned previously. Increased comfort and satisfaction of the occupants was another benefit derived from the greening process, which was a similar benefit of new green buildings (McGraw-Hill Construction 2009; Fowler et al. 2010).

Impacts

The outcomes of the certification process can also be observed at the organizational level. Being the first LEED-certified existing building in Turkey, Building A stands out among the other cases. This helped the owner of the building improve his corporate image and lead the market in environmental awareness. In the case of Building B, the long-term impact of being certified will be fewer operational and insurance costs. The major motivation behind the certification process of Building C has been the University's aim to create a sustainable campus. The university gained experience and learned lessons to transfer to similar green implementations in the future. In the case of Building D, certification was helpful to improve the corporate image of the owner, as the interviewees suggested. In addition, the building received a best practice award among the green buildings in Turkey in the International Summit of Green Buildings in 2011 that was organized by the TGBC. Building E also received an award in the same event. Another achievement was the increase of environmental awareness among the employees. The conversion of Building F taught lessons to the owners and increased their confidence to green three additional buildings in the near future. Among the long-term benefits that the organizations gain as a result of the certification process, an improved corporate image is the most emphasized, which is also one of the main impacts observed in the case of new construction (McGraw-Hill Construction 2009; Ozorhon 2013a).

Conclusions

This study investigates the greening and certification process of existing buildings. In this context, a framework is presented to analyze seven different components of this process, including the drivers, resources, barriers, enablers, green implementations, benefits, and impacts. A case study methodology is employed to understand the critical success factors of the certification of existing buildings on the basis of data collected from six projects in Turkey. A total of six cases out of a set of 10 available projects were investigated in this study. A total of five of these projects were undertaken by private companies. A total of four projects that are not included in this study are also owned by the private sector. It can be stated that the private sector has been taking an initiative and is leading the green renovation activities in Turkey. This may be attributed to the availability of financial resources they can allocate and the expected competitive advantage because of enhanced public opinion. This is an expected finding for developing countries, where the public sector is more focused on new construction rather than renovation projects, but the private sector works on both. Because this study includes the single existing LEED-certified public project, it was possible, to a certain extent, to observe the differences and communalities between the perceptions

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and practices of public and private clients. It is no coincidence that the certified buildings are located in Istanbul, Ankara, Izmir, and Kocaeli, which are the most industrialized and developed cities of Turkey, where private companies heavily invest. Despite the financial constraints, there have been attempts by the public sector to promote sustainability within the construction sector through energy regulations, meetings/seminars, and demonstration projects as well.

The analysis of the cases indicates that (1) strict environmental policies of the clients have been the major reason to convert existing buildings into green buildings; (2) LEED consultancy has been the major component of the investments; (3) renovations involved various energy efficiency measures as long as permitted by the current design and performance of the facilities; (4) unavailability of LEED-approved materials and difficulties in documentation have been the major barriers; (5) commitment of the owners, top management support, and collaborative work among project parties have been the most important enablers; (6) varied savings were achieved in water, electricity, and gas consumption; and (7) the corporate image of the organizations was improved and critical lessons were learned. Use of a national certification system may be a solution to overcome some of the problems that are related to unfamiliarity with international standards and language. The TGBC has currently released a rating system that considers the local conditions, but this system has not been tried yet. Even if a national certification is followed, effective team work, coordination, and improved facility management skills will still be the issues to be taken into account. Besides, interviewees suggested that proper procurement planning, supply chain partnering, and selection of experienced contractors help to overcome barriers to implementing green building tools.

When compared with new construction projects, there are some distinctive characteristics of existing buildings in terms of the greening process that needs special consideration. First of all, self-regulation has been the key factor to initiate greening, as opposed to regulations imposed by the governments in the case of new buildings. A client-driven approach seems to be an important component of the process; however, for the green retrofit projects to increase in number, the public sector should start converting their buildings and encourage the tenants to do so. Second, the building architecture limits the process considerably. The level of renovation and thereby the certification class highly depends on the architectural design and existing performance of the buildings. Therefore, for each existing building, a tailor-made solution should be provided, which makes it slightly more difficult compared with new construction for which the design is more flexible. Third, for existing buildings, the owners do not perceive cost as a factor to inhibit the greening process, as opposed to new buildings, because the expected benefits outweigh the expenses. Their own environmental policies shape their greening process and they can allocate sufficient funds. Finally, the major impact of certification is recognition and an enhanced corporate image, whereas besides these outcomes, there are additional impacts for new buildings, such as experience and increase in technical and organizational capability.

The cases investigated in this paper reflect the experiences of project teams in Turkey. Depending on the conditions and regulations of different countries, the findings may vary. However, the findings are expected to be helpful to those firms from other countries that do not have their national systems and therefore apply for LEED certification. The framework proposed in this study can be applied to investigate the green renovation and certification process of existing buildings in other countries as well. In addition, a similar study may be conducted, with more cases and buildings certified by a certain LEED rating system.

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