Business Management in Sustainable Buildings: Ankara-Turkey Case

IOP Conf. Series: Materials Science and Engineering **245** (2017) 062008 doi:10.1088/1757-899X/245/6/062008

Business Management in Sustainable Buildings: Ankara-Turkey Case

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Abstract. The concept of the sustainability is described as efficiently and effectively consuming of exhaustible and recyclable sources of the world. A sustainable building implements sustainability criteria in its life cycle, and business management is the process by which an organization uses its resources in the most efficient way to reach its goal. From the beginning, sustainable building proves their differences from the conventional buildings. Sustainable buildings are resource-efficient and environmentally responsible structures in terms of energy consumption, construction principles, siting, renovation and maintenance throughout its life cycle while conventional buildings are more traditional in these matters. The differences are observable especially in costs and expenditures. It is possible and feasible to compare and contrast the design, construction and management costs of both types of structures. Thence, contributions of sustainable buildings are priced favourably in terms of ecological and sociological aspects. In this context, a prospective projection can be made considering the extra costs of sustainable structures, as well as the consumption profits due to the use of less energy than conventional construction. Considering this, it is possible to project consumption savings in long term. By calculating a forward-looking net cash flow projection, it can be forecasted how much time it will take to cover the extra cost. When making decisions, investors always contemplate maximum profitability. Within the scope of this study, costs of sustainable and conventional buildings will be compared and contrasted through precedence of a sustainable building certificated and non-certificated building. It will be analysed in which time period the initial cost difference between them will be compensated totally and partially. Furthermore, an efficiency analyses will be done in the scope of the necessities and expenses of these businesses.

1. Introduction

Maximizing the monetary value of a property through its life cycle is the number one objective of constructing a building. Companies aim to minimize the cost of construction while targeting the maximum output. Of course this is the logical perspective from the business angle. Enterprises need to optimize the cost and expenses in order to achieve the maximum Net Present Value (NPV) of a construction project. The concept of NPV is the brick of a normative building deep-rooted in the maximizing tradition of economics [1]**.** Keeping the costs and operating expenses at a low level is very crucial for businesses since it's a very sensitive job to manage the cash inflow, operating capital and debts in this highly volatile industry/market to keep competing with rivals and not to be bankrupted. At this point it should be examined whether or not minimizing the costs and expenses of construction is the only matter to be worried about, while putting economic gains in the first place would cause not to have any healthy environment to construct a building in the near future and putting monetary gains as the

primary priority is the right path for the construction industries' future. Construction industry has developed quite impressively in terms of construction techniques, environmentally friendly materials and sustainable systems. Constructing a sustainable building which is resource-efficient and environmentally responsible in terms of energy consumption, construction principles, siting, renovation and maintenance throughout its life cycle rather than constructing a conventional building –which is more traditional in these matters- has certain differences. These differences are observable especially in costs and expenditures. As the result of Leblebici's study, 7,43% and 9,43% additional construction costs have been found for the Leadership in Energy and Environmental Design (LEED) gold and the platinum certified buildings respectively comparing to a conventional building [2]. It is possible to compare the design, construction and management costs of both types of structures. Constructing a sustainable building is notably more expensive, more demanding and more gruelling than just simply constructing a conventional building. Yet, after the construction phase, sustainable buildings have more to bring to the table. First of all, operating a sustainable building is quite cheaper and convenient comparing to a conventional one thanks to its energy, water, emission/indoor air quality, and material management systems. It is more expensive to construct but by courtesy of these high tech systems, sustainable buildings are getting to the break-even point much faster. Back in 2003, a study which consists of 33 sustainable buildings in California, USA reached that the average cost of building sustainable comparing conventional methods was around 2%, which is approximately $4 per square foot. The average energy savings from 33 constructions is 30% which makes savings eligible to pay back the initial 2% in less than 9 years. The study also reached that in a twenty-year period the net savings for a sustainable building is $48 - $67 per square foot according to the buildings' LEED rating. Hence, an additional cost of 2% of the initial investment results in savings worth ten times the additional cost [3]. In this case, the ecological and sociological gains are whole other issues that conventional buildings cannot be compared to the sustainable buildings in terms of these matters.

In Turkey, the construction industry is one of the leading industries of the nation's economy. It provides great amount of employment, being a centre part of high-volume supply chain of construction materials, provides cash and liquidity to the trading market and is crucial party of the banking industry because of high amounts of investment and mortgage credits. In 2016, construction industry has 227 Billion TL, has 8.8% share in the Gross Domestic Product (GDP) with 19.3% growth comparing to the 2015 data [4]. Since construction sector has a significant share in GDP, it can be stated that the Turkish construction companies are very influential in Turkish private sector and Turkey's politics. Constructing a sustainable building is extra demanding in Turkey because of the imported construction materials cost, the high construction expenditures and legislations. Despite these negative matters, there are successful examples of sustainable buildings in Turkey. Within the scope of this study, two of sustainable building examples in Ankara, Turkey; Ostim Headquarters (OHQ) building and Turkish Contractors Association Headquarters (TCAHQ) building will be assessed in the context of energy management, water management, air quality management, material management and financial management topics. Costs of sustainable and conventional buildings will be compared through precedence of a sustainable building certificated TCAHQ and non-certificated OHQ buildings. Furthermore, an efficiency analyses will be done in the scope of the necessities and expenses of these businesses.

2. Sustainable business management criteria for buildings

The design essentials and the volume of construction has a substantial effect on the ecology, environment, business and economy. At present, conventional buildings are responsible for the following issues [5]:

- 45% of the global energy consumption,
- 50% of the consumption of all the materials produced,
- 50% of the overall wood consumption in North America,
- 35% of the global CO_2 emissions;
- 80% of potable water consumption,

- 25% of the world's freshwater withdrawal,
- 40% solid waste belongs to municipalities which destined for local landfills, and
- 50% of ozone-depleting isolation materials (CFCs) are still in use.

Additional to the abovementioned issues, buildings have also effects on numerous components of human daily lives; habitat, air quality, watersheds and even public transportation routes [6]. For instance, a 1,700-square-foot wood frame home requires the exact same amount of clear-cutting one acre of forest [7]. Based on these facts, it be can stated that construction industry must be revolutionized in terms of sustainability. With utilizing renewable systems, construction sector parties must embrace sustainability in whole level of the business. Integrating passive and active systems, adopting green materials, embracing sustainability essentials in design and operating phase should be the number one vision for the industry. When it comes to Turkey, nothing is easy or usual. As mentioned in the introduction, Turkey has a very powerful construction industry. According to Engineering News Record, Turkey is the second biggest construction contractor in the world with 43 companies in the top 250, right after China [8]. Turkey's construction culture is much diversified in terms of design and understanding. Of course the majority of the contractors aim to make "fast-buildings"; bringing perfect location, low cost materials and quick construction to produce fast selling, median priced buildings. Construction industry profit margin is quite high, especially comparing it to the industrial manufacturing business. It is relatively easy to start a construction business; it consists rather low entry barriers. If one investor has capital, he/she can easily find a land and a sub-contractor and start a construction business. Investors cannot easily enter for example to automotive industry. It requires high level education, extensive industry know-how and great amount of experience. We can say that since construction industry requires low level entry barriers and high returns related to other industries, investors in Turkey are very interested in doing construction business. One can observe the growth in the construction sector from early 2000s till now. Construction sector has grown 6,7% per year on average between 2002-2014 [9]. Out of these, we can state that the industry is consistent in terms of growth. However, one should be careful when entering this business. Constructing phase is the easiest phase comparing to the operating phase a building. Constructing phase is the shortest and the easiest stage of the business. The crucial part is managing and operating a building. Poorly-managed buildings can be bankrupted very easily, since a real estate business has a wide range of expenses. In order to manage these expenses well, one should be well organized within the following criteria: energy management (Which is probably the most important matter for a real estate business in terms of sustainability and costs.), water management, air quality management, material management, and financial management.

2.1. Energy management (EM)

Energy requirement increases approximately 5% every year mainly due to industrialization, rapidly growing population and improvement in the living standards [10]. Factors such as ever-increasing consumption of fossil fuel reserves -foremost petroleum and natural gas- providing the major portion of the energy needs, directly or indirectly affect the thinning of the ozone layer, increasing air pollution, greenhouse gases and climatic change; it can be said that efficient utilization of energy became more crucial than ever [11]. There is nothing but ascension in energy demand and energy market in terms of financial commodity is highly speculated, so it is possible to state that energy has become very strategic for nations, and efficient usage of energy resources is among the most important vision. Since construction industry globally expresses a significant presence for energy consumption and economy, new developments has emerged in the context of energy efficiency in construction industry. As stated above, with an 8.8% alone portion in GDP, it is possible to indicate that construction industry players are deeply influential and powerful in both business and politics in Turkey. Which means the big real estate players should adopt the new and green techniques, systems and materials first to truly revolutionize the industry but it is does not seem very likely due to the high costs comparing to the more conventional construction traditions. Utilizing sustainable systems such as active and passive systems, photovoltaic panels and etc. is essential in terms of energy management.

2.2. Water management (WM)

Water is probably the most important matter in environment and humankind's life cycle. Protecting clean water resources has a vital importance. Earth's surface consists around 71% of water, however liquid fresh water, which is in swamp water, groundwater, lakes and rivers, volume is about 10,633,450 km^3. This forms a sphere of 272.8 kilometres in diameter and represents 4% of Earth's overall water existence [12]. The 2% of the fresh water is polluted or deep in the ground or trapped in polar ice caps; which makes it only 1-2% of fresh water is available for humans [13]. Additionally the human population is ever-increasing and it makes clean water limited. In Turkey, 73% of the fresh water is consumed for agriculture, 11% for industrial production and 16% is consumed by households [14]. On the basis of this it can be said that sustainable water management represents crucially for its consumption levels. Sustainable water systems should be utilized by the constructors to save up fresh water. Rainwater collection, gray and black water recycling, waste water treatment systems, rainwater saving tanks, water saving sanitary ware and water reusage utilization must be essential for buildings.

2.3. Air quality management (AQM)

The concept of sustainability –which is not a new concept- has emerged as a response to the environmental degradation which is mainly caused by human activities. Today, the construction industry dominates the CO_2 emissions, negative environmental impacts and energy consumption. For this reason, environmental factors and energy efficiency should be considered when designing and constructing new buildings and improving existing buildings. 38% of the electricity consumption and 21% of the CO_2 emissions are from the buildings [15]. The commercial and residential building industry represents 39% of the CO_2 emissions in North America, which is more than any other sector and industry. Majority of the emissions caused by buildings come from combustion of fossil fuels to provide heating and generating power [16]. The construction sector can play a major role in reducing the carbon emission by converting the already built buildings and constructing the new ones to make them more energy-efficient and climate-friendly. A common LEED certified building consumes 32% less power and saves up to 350 metric tons of CO_2 emissions per year [16]. The air within the residential and commercial buildings atmosphere -including schools, hospitals and offices- could be approximately 2 - 5 times more polluted, even in certain situations it is 100 times more polluted than the air in the outdoors atmosphere [17]. Chemicals, furnishings, building materials, household and office products which can emit dozens of VOCs (Volatile Organic Compounds). Another crucial problem is moisture inside the building which can lead to mold growth in a short time. Particles and poor ventilation are another major reasons for low indoor air quality [18]. Material control and green design may be the best solution for indoor air pollutants. Using Greenguard certified materials and products for construction in order to utilize low chemical emission is a method to increase indoor air quality. Greenguard certified products are tested for approximately 10.000 chemicals to make sure that they are not a threat against the indoor air quality.

2.4. Material management (MM)

In simplest terms, a sustainable building; estates that do not pollute the environment during construction, operation and demolition and use water, energy, waste and material resources in the most appropriate way. Materials are the most fundamental and basic components of a building. One can find a great number of different materials, very diverse in terms of production techniques, purpose of usage and even where they are supplied in terms of distance. Sustainable buildings incorporates the concept of sustainable building materials. Sustainable building materials present convenient and functional benefits including; decreased maintenance costs during the building's life cycle, energy conservation, improving the resident's life quality and health and making to lower the costs and expenses. Construction industry consume approximately 3 billion tons of raw materials per year globally; in other words 40% of total global usage [11]. Employing sustainable building materials encourages conservation of decreasing non-renewable energy resources. Additionally, utilizing sustainable building materials into buildings can assist to decrease the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of the regular building industry materials.

Sustainable building materials are considered as responsible materials since the materials' impacts are evaluated over the life cycle of the material [19].

2.5. Financial Management (FM)

It is very crucial to construct a building at an optimal cost and make it financially well managed in terms of operating expenses. According to a survey back in 2008 which was towards to the real estate executives, majority portion declared that the initial costs are presenting a significant barrier, which can discourage the construction of sustainable buildings [20]. The additional costs of a sustainable building consist, the costs of obtaining a sustainable building certification (LEED etc.), higher construction expenses including materials, design and engineering, and the increased payback time. Almost all studies show that acting up early to get a sustainable building certification and emerging an integrated planning and design process decrease the initial costs [21].

3. Evaluation of Sustainable Business Management Criteria in OHQ and TCAHQ Buildings

3.1. Evaluation of OHQ Building in the context of sustainable business management criteria

The first case of this study is the Ostim Headquarters (OHQ) building, located in Ankara, Turkey. OHQ building is a structure of 3-storey and 2.700 m^2 floor area. Building is 450 meters away from OSTİM subway station. The images of the building is illustrated in Figure 1.

Figure 1. The satellite image and a view of OHQ Building [22, 23]

OHQ building was built according to the quadrilemma of the four conflicting elements; environment, public welfare, energy and economy. OHQ optimally satisfies these elements in its self-described high performance- sustainable building. The aim behind its design is to be a leading-edge model to illustrate and implement energy conservation, rational usage of energy resources in terms of both energy quality (exergy) and quantity. The building aimed the LEED platinum certification and is satisfying the ASHRAE High Performance Buildings overall criteria and guides. Within the scope of USGBC and ASHRAE guidance, 42 steps were set forth. These steps starts with the sustainability objectives and it covers; overall energy efficiency to exceeding 85% (according to the first law of thermodynamics), rational energy management efficiency to exceed 60% (according to the second law of thermodynamics), close to net-zero-carbon emissions, at least 50% contribution of alternative energy sources based on installed capacity (wind, solar, ground heat, waste heat, and other passive systems), at least 20% of shaving off the peak HVAC loads with optimum energy storage, being a low exergy building, compliance and exceeding ASHRAE Standards, hygienic and high indoor air quality, full building automation, reduced energy demand with hybrid air conditioning system, building with heavy insulation, net-zero-energy orientation with open-ended solutions, constant, preventive, and predictive maintenance and repair, minimum 30% of fuel savings in heating and power [24].

In Table 1, the systems used in OHQ Building in the context of sustainable business management criteria are presented.

Table 1 a) OHQ Building in the context of sustainable business management criteria

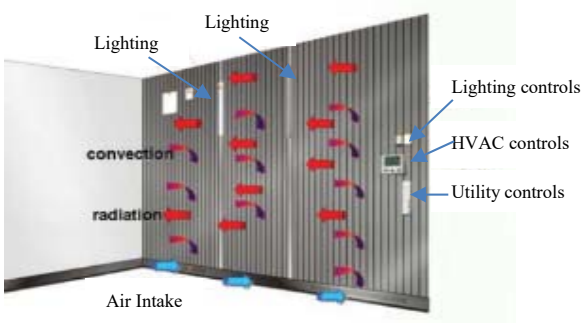
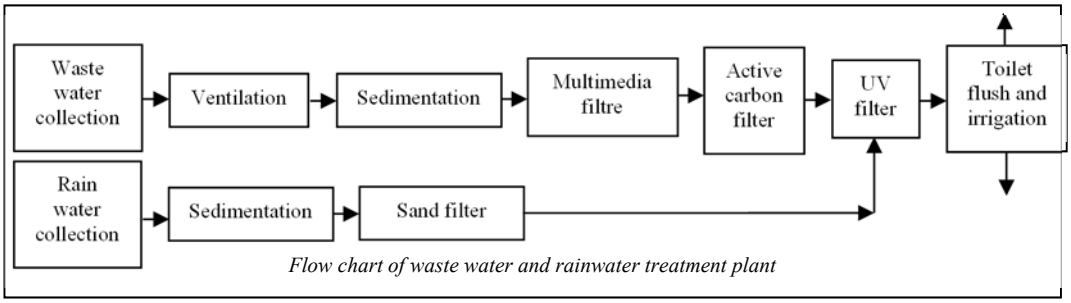
Systems Used in OHQ Building in the context of Sustainable Business Management Criteria [24, 25, 26]	
EM	  *ExergyWall (Hybrid Air-Conditioning Wall Panel):* Exergywall, merges the benefits of radiation and convection heat transfer into a single HVAC unit, reacts to optimum operative temperatures (60% radiation, 40% convection). It is a all day/year long system which meets all interior needs in all seasons.
	   *Trombe Wall:* In the winter session, part of the outdoor air that is preconditioned in the ground heat exchanger system is further heated in the greenhouse during the day and heated during the night by the stored heat in the trombe wall of OHQ building.
	Combi-Cycle Combined Heat and Power-CHP (Poly Generation): Natural gas is utilized in a high -energy and high-exergy efficient mini CHP tri-generation system in OHQ building. Combi-cycle with a steam bottoming cycle is a high efficiency co-generation system. Its specialties include electricity efficiency (up to 40%), first-law efficiency, minimizing carbon emissions, and constant part-load efficiency.
	Combi-Cycle Poly-Generation Coupled Ground-Source Heat Pump: The OHQ building's mechanical system is improved in terms of energy and exergy efficiency through utilizing a ground sourced heat pump, which is directly driven by the poly-generator.
WM	 *Flow chart of waste water and rainwater treatment plant* *Waste Water Treatment Plant*: The waste water treatment plant is designed as a sequential batch reactor in OHQ building. Reactor's working principle is based on the fact that microorganisms in the aeration tank removes pollutants by using them as nutrients than being filtered for the disinfection. The collected rainwater is included to the system after a pre-treatment and filtering. Gray and black water discharge from the building, may be properly utilized after being recycled in a biological treatment system. Waste waters which occur from the daily usage of the building and rainwater within the parcel are sent to the waste water treatment system where waste water get treated in accordance with standards used to irrigate toilets and gardens.
AQM	*HVAC System:* In main HVAC System of OHQ building, floor heating and floor cooling system operates with the central air-conditioning duct system in tandem, and the risk of surface condensation in cooling mode is eliminated by proper controls. Thermal comfort control is maintained by operative temperature controls, which factor in the radiant indoor surface temperatures into comfort calculations besides the indoor air temperature and relative humidity. Additional energy savings are being achieved by implementing hybrid wall HVAC system where there are additional measures that provide complete air hygiene.

Table 1. b) OHQ Building in the context of sustainable business management criteria

	Hybrid Wall HVAC System: With integrated HVAC arrangement in OHQ building, summer and winter COP values of the ground-source heat pump and the absorption chiller substantially increase. Additionally low-exergy HVAC system in the building requires energy at very moderate temperatures both in heating and cooling which also makes COP values to increase.
	CO_2 Emission: There is a small amount of CO_2 emission during biological treatment system where the OHQ building uses the system to manage waste water. With combi-cycle heat pump system, with nominal 100% 165 kW thermal power, there is 70% emission reduction, 72% thermal power 40% emission reduction. According to the calculations, the amount of CO_2 generated within the treatment and recycling unit is nearly 200 g/day. This amount is negligible comparing to the reduction in carbon emissions occurred from burning natural gas, which is to be replaced by biogas. Analysis has shown that annual carbon emission reduction potential of the building is over 500 tons.
MM	*Material Use Motto:* Use of (on a minimum level) environment-certified local and natural wood procuring from sustainable forests, procurement of all construction materials from local markets whenever possible, at least fifty percent reuse of construction waste which must be recyclable without polluting the environment, use of rapidly renewable materials that are convenient for reuse, prioritizing the local manufacture of all equipment, machinery, appliances, furniture, interior trim, and other construction systems in the immediate surroundings are essential and indispensable elements of OHQ building material concept.
	Material Use on Exergywall: A special paint was applied to the exergy wall's porous front panel surface that keeps the radiation at optimum level. When special conditions required, the optimal radiation-convection ratio can be changed on the porous surface of the radiant front panel through custom designed micro-nozzles. Besides, the condensation pane is anti-microbial based.
FM	Design and engineering approach of the building was very effective, the construction team adopted the integrated design process where the whole system approach applies, team members are involved in the whole process, most decisions are made by the team on a regular basis, life cycle costs and benefits are taken into account, systems are considered to be related to others, allowing full optimization, time, energy and most of the budget spent at the beginning of the planning period [27]. Additionally the OHQ did not get a LEED Platinum Certificate even it is qualified for it. Plus, the sustainable systems integrated within the building. All of these matters made the building financially more sustainable in terms of operating expenses.

3.2. Evaluation of TCAHQ Building in the context of sustainable business management criteria

The other sustainable building example in Turkey is Turkish Contractors Association Headquarters (TCAHQ) building in Ankara with LEED Platinum certification. Furthermore, TCAHQ building received the International Project of the Year Award in UK at Building Awards 2014 [28]. The building includes 7138 m^2 total construction area, 4817 m^2 enclosed area, 3915 m^2 useable area, and 910 m^2 labyrinth floor [29]. The images of the building are illustrated in Figure 2.

Figure 2. Satellite image and view of TCAHQ Building [30, 24]

TCAHQ building stands out in innovative use of energy efficiency, natural ventilation and air-conditioning utilizations, passive heating and cooling techniques. The building is comprised of 4.817 m^2 office space and 7.138 m^2 total construction area. The construction of TCAHQ building began on August 2012, and was completed in October 2013. TCAHQ building is located in Doğukent Boulevard, a developing zone in the Çankaya district which commands views of the valley stretching on the east

[31]. In Table 1, the systems used in OHQ Building in the context of sustainable business management criteria are presented.

Table 2 a) TCAHQ Building in the context of sustainable business management criteria

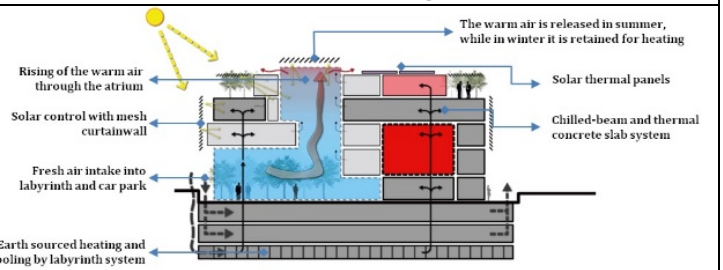
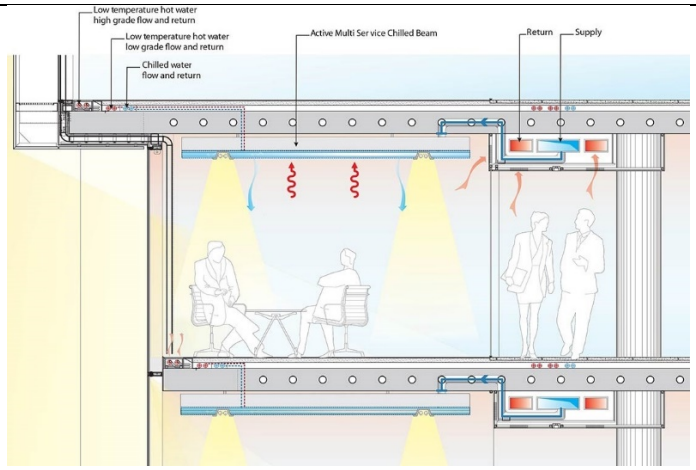
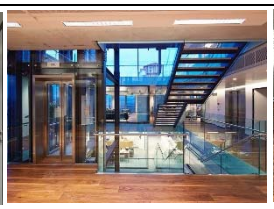
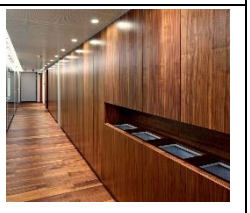
	Systems Used in TCAHQ Building in the context of Sustainable Business Management Criteria [32]
EM	  *Solar Energy:* 38 photovoltaic solar cells are installed on the roof of TCAHQ building in terms of emerging renewable solar energy through the building [33]. Moreover, solar-sourced excess heating, thus cooling energy needs have been minimized in TCAHQ building via the central atrium creating a chimney effect, getting use of the principle of hot air rising [31].
	 *Mesh Curtainwall:* Although TCAHQ building has a mainly transparent shell, after energy modelling and testing, majority of the surfaces of the building facade are shaded with a second layer of 900 m^2 stainless steel metal mesh. The solar heat gain and therefore cooling energy needs have been minimized by means of 3 varying densities of mesh designed to cope with 3 different solar orientations of the building [34].
	 *Labyrinth System:* Taking advantage of the variations between summer day time and night time temperatures in Ankara, a thermally massive concrete labyrinth of 910 m^2 was placed below the lowest level of the car parks to reduce and minimize the cooling energy demands of the building, while also providing a natural source of heating during winter time, gained from annual average ground temperature conditions. System provides around 40% reduction from heating and cooling costs [35].
	 *Thermal Concrete Slab Heating & Cooling System:* An important energy efficiency measure in the design of the TCAHQ building is the active 540 m long thermal floor slabs coupled with the active chilled beam systems. After the fresh air travels through the labyrinth and naturally tempered, it enters the *air handling units*. Secondary ductwork distributes to the individual floors via dedicated ventilation risers. The ductwork on each floor then distributes through a central distribution corridor and interfaces with the active thermal mass on the office floors coupled with the active chilled beams. Small bore ductwork cast in concrete slabs provide a surface to absorb internal gains and depending on the season either warm or cool the incoming air into the internal spaces, therefore reducing energy usage at the air handling unit and minimising the chilled beam cooling or heating requirement [36].

Table 2 b) TCAHQ Building in the context of sustainable business management criteria

	   *Chilled-Beam System:* Chilled-beams distribute the air coming from the *air handling units* to interior spaces, and utilize a 4 pipe system to control the thermal comfort conditions. The terminal 48 chilled beam units provides the final climate control adjustments to ensure thermal comfort within the occupied spaces [37, 38].
WM	    *Water saving sanitary ware* are utilized inside the TCAHQ building and *rainwater saving tanks* are placed. Besides, *gray water usage* is located in the foreground of the building. *Water efficient endemic plants* are preferred in accordance within the building's holistic design for landscaping [33, 39].
AQM	     *Ventilation System:* Ducts from the hollow walls terminate at vertical displacement ventilation units designed to operate at very low velocity and therefore minimize noise generation. Supplementary floor mounted units provide extra cooling or heating at the centre of the hall [40]. Moreover, automatic vent control systems located on the glass roof provide natural ventilation [31].
MM	     It is preferred to use local and sustainable building materials and local brands whilst construction of TCAHQ building [41]. The ceiling covering of the conference hall is made of 870 units of walnut veneered timber slats, each of which have been specially computer modelled [40]. Besides, the building consists of 980 m^2 glass+composite panel, 870 m^2 natural stone wall cladding, 2600 end-point building automation and 23500 m cabling [29].
FM	TCAHQ Building contains LEED Platinum level criteria within itself including sustainable land, water saving, green materials and sustainable systems criteria. Receiving LEED Platinum certificate and integrating sustainable systems brought additional costs to the building. The building has 354 TL/ m^2 of additional cost for its LEED Platinum level features. It also has 11,73 TL/ m^2 of savings thanks to its sustainable structure [2].

4. Conclusions

Despite their differences, it can be stated that both of the OHQ and TCAHQ buildings have a lot in common. Motives behind their constructions are very similar as both of the parties aimed to build something beneficial for the environment. The biggest problem towards constructing a sustainable building is the cost of construction. Additional costs are the main barrier against the sustainable buildings and in Turkey, cost is the number one matter for the construction industry players. Renewable system technologies, active systems and green materials cost more than the classic construction materials. It is observable that the increasing number of sustainable buildings causes the costs to decline thanks to the gained experience. The majority of the additional cost of building a sustainable building cause by Architecture and Engineering Design time (A&E), cost of modelling and time and effort spent to integrate sustainable systems into the building. These are the negative sides of a sustainable buildings. The positive sides are more dominant comparing to the negative sides. The advantages of a sustainable building include; energy, heat, water savings, reduced wastes, better indoor-air quality, reduced operating costs, lower maintenance costs and healthier building life cycle. Energy cost is the most crucial part since it has the major portion among the building's operating expenses. It can be reduced through energy efficiency and modern sustainable systems. Sustainable buildings consume 30% less energy comparing to the conventional buildings. A typical LEED certificated building is 30% more energy efficient, tend to generate renewable energy on site, tend to utilize grid power generated from renewable sources [42]. Energy savings are mostly due to the reduced electricity consumption and lower peak energy demand. Moreover, water savings, better indoor air quality, increased ventilation control, improved temperature control, and better lighting are strikingly correlated with better productivity and increased health conditions. OHQ and TCAHQ buildings utilized the LEED criteria in terms of energy, water, air quality, material and financial management aspects. It can be stated that both of the buildings managed to construct their designs successfully, and currently the buildings are operating very efficient. Of the current resources in Turkey, 28 % is met by the country's own resources, while 72 % is imported, and this rate is gradually increasing [43]. However, it is still a sceptical case about the future of sustainable buildings in Turkey. There are many roads to go in this area with a lot of barriers to overcome. With projects like OHQ and TCAHQ buildings, the Turkish construction industry gain valuable experience, and through this path it would not be wrong to say that in the near future sustainable buildings must become more common than the conventional buildings in Turkey.

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