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Hospital Landscape Sustainability: Case Study in Turkey

Abstract: Ecological awareness around the world is increasing due to increased signals of disruption to natural processes. To address these environmental concerns, the idea of environmental stewardship and sustainability has recently gained popularity throughout the developed world. For the building industry many sectors are beginning to advocate the use of "green" building practices including in healthcare facilities. LEED is one of the "green" rating systems which has been established through the measurement of sustainability performance. In Turkey, the Turkish Ministry of Health made the LEED certification compulsory in hospitals in 2013. Memorial Bahçelievler Hospital, Istanbul gained the world's first LEED platinum certificate as a full-fledged "green" hospital in 2018. In this study, we review the literature on sustainable architectural and landscape designs and design approaches in hospitals, with particular examination made in the case study of Memorial Bahçelievler Hospital.

Keywords: Sustainability, LEED, green hospitals, healthcare architecture, biophilic design, hospital landscape, Memorial Bahçelievler

1. Introduction

"Recognizing nature in the city, where our language itself has taught us to believe nature no longer exists, challenges our ability to see the world clearly – but to miss the city's relation to nature and the country is in fact to miss much of what the city is" [1]. Cities are contrast spaces that contain both natural resources, processes, and cycles, that is, nature, but also a series of practices that cause negative impacts on nature [2]. Although urban nature is seen as an opposing concept, the city is a building system established and spread in nature. Urbanization gained momentum, through the industrialization process and expanded with population growth and now creates increasing pressure on existing natural resources.

Ecological awareness of the severity of our cities' impacts on the natural world has risen parallel with increased signals in the ecosystem indicating that the balance is disturbed. This includes such factors as rising greenhouse gas emissions, global warming, climate change, flood and drought disasters, air pollution events, nuclear and chemical disasters, reduction in water resources,

environmental pollution, biodiversity and species extinction, and rapid depletion of natural resources [3].

To address these environmental concerns, the idea of environmental stewardship and sustainability has recently gained popularity throughout the developed world. Population growth and rising pollution are major catalysts for this movement. Water consumption is rising globally on average, while supplies remain relatively static. Accordingly, improving water conservation and efficiency standards have become a significant focus for various levels of governments throughout the developed world. The demands for higher standards and new technologies to improve the sustainability of our cities have found their way into legislation. As a result, many sectors of the building industry are beginning to advocate the use of "green" building practices [4]. The main target of green buildings is to develop eco-friendly construction practices for energy saving, reduction of emissions, and reuse and recycling of materials and resources.

A green building can be defined as a building that provides the specified building performance requirements while minimizing disturbance to and improving the functioning of local, regional, and global ecosystems both during and after its construction and specified service life. Buildings are essential parts of sustainable development with their environmental, economic, and social impacts. Green buildings aim to achieve a healthy and dynamic balance between these impacts and to significantly reduce any negative impact on the environment and the user. For this reason, green buildings are important elements for the sustainable development of cities [5].

Green or sustainable building is the practice of creating healthier and more resource-efficient models of construction, renovation, operation, maintenance, and demolition [6]. As stated by Heerwagen (2001) the real appeal of green buildings lies in their potential to create better building habits and to do so by incorporating design features that address health and well-being in an integrated manner [7].

A large number of "green" rating systems have been established to help mitigate the direct and indirect environmental impacts of development through the encouragement, measurement, and recognition of sustainability performance. The first initiative to assess and certify the environmental impact of these buildings, with the worldwide green building trend, was launched in 1990 under the name Building Research Establishment Environmental Assessment Method (BREEAM) in the UK [8]. This is followed by the US Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system in 1998 and by the German Sustainable Building Council's DGNB rating system in 2007 [9, 10]. Today, there are many certification systems around the world, some of

which are based on LEED and BREEAM [11]. For example, the most widely used certification system in Turkey is LEED.

Today, Turkey ranks 9th in the LEED-certified green buildings list of the world with 477 certified and registered projects. The increase in green building activities over the last ten years, following the initial LEED certification of Unilever's headquarters in Istanbul in 2009, is one of the most critical signs that Turkey has focused on increasing energy efficiency, in response to the increase in national demand for energy [12, 13].

The LEED certification and standards have undergone various revisions. They have remained flexible, changing with input from designers, builders, environmentalists, and others to incorporate new types of buildings and modify the existing standards to make them more geographically, economically, and functionally sensitive [14].

LEED certificate is divided into various categories and has separate guide documents for each group such as "New Construction", "Existing Buildings", "Residential", "Campus" and "Interiors". It has also started to differentiate according to different building typologies such as "Schools", "Core&Shell", "Warehouses and Distribution Centers", "Hospitality", "Data Centers", "Retail" and "Healthcare" [15].

2. Sustainability in Healthcare Architecture

We live in an era fraught with degraded natural resources, loss of biodiversity, and the reality of global climate change. Therefore, one of the major problems facing us is how to establish and maintain environments that support human health and, at the same time, are ecologically sustainable [16].

Hospitals are seen as a major management and service provider – a complex building-type serving a wide range of functions from medical applications to functional programs. They are dense buildings housing various users, and are continuously evolving and changing where technological medical equipment is used [17, 18].

Throughout the world, hospitals and other healthcare facilities are dedicated to providing innovative and compassionate patient care that cost-effectively meets high standards of quality. However, in fulfilling this important mission to care for patients, healthcare facilities have an impact on the natural environment. It is known that energy and water consumption in hospitals is high, the amount of chemical and non-chemical waste is enormous, the output of potentially hazardous materials is high, the purchase of materials are various, and so on [19, 20].

Over the past few years, regulatory agencies and local communities have pushed for greater environmental controls within the healthcare setting. From energy conservation to the proper disposal of medical waste, healthcare facilities are discovering that the adage "do no harm" is applicable not only to their patients but to the natural environment and communities around them. Healthcare facilities across the globe are rising to this challenge by identifying and reducing the negative environmental impact of their operations [19].

The concept of "green" has emerged in hospitals due to limited resources, insufficient waste storage and disposal areas, and limited training of personnel on the use and disposal of hazardous materials and low incentives for the use of renewable energy resources. With this concept, it is aimed to produce alternatives to the use of resources, to encourage the use of energy, water and materials more effectively and efficiently, and to design environmentally friendly and sustainable hospital buildings [20].

Guenther and Vittori mentioned that the way of design, construction, and operation of the buildings has a profound impact on human health and the health of the environment. In order to have a positive impact on human and environmental health, we need to change the way we build. At this point, green buildings become prominent, consuming fewer resources, generating less waste, and dramatically curbing emissions. Meeting patient needs is a hospital's top priority. Several studies have shown that elements of green building design can positively influence patient health, leading to faster healing times, reduced duration of hospital stays and patients can be discharged approximately 2.5 days earlier [21, 22].

As more hospitals demonstrate that sustainable architecture benefits patient healing, a general acceptance of new hospital design that shows significant efforts at minimizing and mitigating the adverse environmental and human health impacts of modern development has started to be followed. These efforts have resulted in the growth of the sustainable or green design movement, dramatically illustrated by the extraordinary rise of the US Green Building Council's LEED certification and rating system [18, 23].

3. Biophilic Design in "Green" Hospitals

In its simplest representation, the solution to architectural sustainability is to work with, not against, nature; to understand, sensitively exploit and simultaneously avoid damaging the natural systems [16].

There is a recently rediscovered body of evidence that supports the view that nature generally, and everyday living environments, in particular, can have a

profound effect on health and well-being. Contact with nature is an effective "upstream health promotion" tool for whole populations [24]. This relationship between nature and health has been studied by many researchers for years. These studies have shown that both active and passive interactions with natural environments, even if they are artificial, increase recovery rate and provide social, psychological, and physiological benefits [25–33]. The belief that plants and gardens are beneficial for patients in healthcare environments is more than one thousand years old [34].

Additionally, nature, with its perceived healing properties, is seen progressively as a useful means in addressing medical needs. As a result, architects have been employing the concepts of nature as a healer to landscape designs in hospitals since the 18th century. The natural environment is considered one of the most important sources of healing [35].

People's physical and mental well-being remains highly contingent on contact with the natural environment, which is a necessity rather than a luxury for achieving fitness and satisfaction even in our modern urban society [23].

The emergence of a new design trend "biophilic" in architecture has increased in popularity in recent years. The core of the biophilic design is to bridge the gap between human beings and nature, by taking evolutionary biology, ecology, and environmental psychology as the basis for the design. Nature's therapeutic value should be considered the most important factor to take into account in biophilic design [36]. Biophilic design is the expression of the inherent human need to affiliate with nature in the design of the built environment. The basic premise of biophilic design is that the positive experience of natural systems and processes in our buildings and constructed landscapes remains critical to human performance and well-being [23].

It is important to distinguish "biophilic" design from "green" design, or even from eco-conscious design. Buildings that have green or sustainable designs are not necessarily biophilic, or vice versa. It is necessary to fully explore the possibilities inherent in each concept [37]. The traditional architecture can be covered by plants to become a green building but does not necessarily represent biophilic architecture, where the architecture must interpret such a sizeable strategic form and possession of many objective and subjective parameters. Consequently, a green building is a complex expression of biophilic architecture. Despite the name, current "green" architecture pays exclusive attention to being environmentally friendly rather than being biophilic as well. Green building is a construction, which can be shaped by means of renovation process. At the same time, biophilic architecture struggles with the adverse effects of urban heat island in the local microclimate scale. It improves human physical comfort to

create a healthy human life. Biophilic architecture is part of an innovative view in architecture, where nature, life, and architectural conjecture merge to create a lively habitable edifice fit to satisfy the demands, restrictions, and respect for both people and the environment [16, 36].

The primary deficiency of current sustainable design is a narrow focus on avoiding harmful environmental impacts, or what we call low environmental impact design. Low environmental impact design, while fundamental and essential, fails to address the equally critical needs of diminishing human separation from nature, enhancing positive contact with environmental processes, and building within a culturally and ecologically relevant context, all basic to human health, productivity, and well-being. These latter objectives are the essence of biophilic design. Real and lasting sustainability must combine both low environmental impact and biophilic design [23]. Biophilic design can be organized into three categories [38]:

Nature in the space addresses the direct, physical, and ephemeral presence of nature in a space or place. This includes plant life, water and animals, as well as breezes, sounds, scents, and other natural elements. Nature in space encompasses seven biophilic design patterns:

- Visual connection with nature
- Non-visual connection with nature
- Non-rhythmic sensory stimuli
- Thermal and airflow variability
- Presence of water
- Dynamic and diffuse light
- Connection with natural systems

Natural analogues address organic, non-living, and indirect evocations of nature. Objects, materials, colours, shapes, sequences, and patterns found in nature manifest as artwork, ornamentation, furniture, décor, and textiles in the built environment. Natural analogues encompass three patterns of biophilic design:

- Biomorphic forms and patterns
- Material connection with nature
- Complexity and order

Nature of the space addresses spatial configurations in nature. This includes our innate and learned desire to be able to see beyond our immediate surroundings, our fascination with the slightly dangerous or unknown; obscured views and revelatory moments, and sometimes even phobia inducing properties when

they include a trusted element of safety. Nature of the space encompasses four biophilic design patterns:

- Prospect
- Refuge
- Mystery
- Risk/peril

Biophilic design is a "cognitive sustainable" design and can be applied at all levels of scale, creating interior and exterior revolutionary forms, private and public buildings, landscapes, and whole cities [36].

4. Landscape Design in Hospitals

Research on hospitals and healthcare environments is not a new area of research, but it is a growing area of concern. Recently, landscaping and gardens at hospitals have increasingly come to be considered as an integral part of a healthcare environment, which are reserved for patient treatment and have traditionally been prioritized [39–41].

This attention on the physical and psychological healing effects of landscaping at hospitals has provided us with new opportunities and challenges. Thus, how to plan the outdoor environment that people in hospitals value and enjoy is an appropriate topic for the humanitarian practice of quality healthcare. From the perspective of hospital management, constructing a quality landscape also implicates a significant investment and, therefore, hospital administration and landscape architecture expect people to benefit from the environment through constant use [41]. On the other hand, land costs and pressure from insurance companies to minimize hospital stays have largely worked against the provision of gardens in new or refurbished medical complexes. "Landscaping" is often seen as a cosmetic extra and rarely viewed as a significant adjunct to patient healing or as a setting for stress reduction for staff and visitors [39].

Hospital outdoor spaces can be classified into 12 groups and according to the site, building and landscape design featuring different types of outdoor spaces can be observed in hospitals (Tab. 1). Healing gardens and meditation gardens are identified as separate categories within the garden typology. In general, meditation gardens could be considered a subset of healing gardens [42].

Tab. 1: Typology of outdoor spaces in hospitals [42]

Outdoor Spaces		Advantages	Disadvantages
Landscaped Grounds	A landscaped area that forms an outdoor area between buildings.	▪ Can tie together a variety of buildings – by function, style, or age – into a campus-like setting ▪ Can serve a variety of users and activities	▪ Maintenance may be costly
Landscaped Setback	A landscaped setback is an area in front of the main entrance to a medical center, usually comprising lawns and trees.	▪ May evoke a familiar, comforting image at a hospital entrance ▪ Provides offices or rooms at the front of building with some privacy	▪ While not usually intended for use, if this is the only outdoor space, its lack of seating, pathways, etc. may be frustrating for staff or visitors who want to use it
The Front Porch	These might include an overhang or porch roof, a turnaround for vehicle pickup and drop-off, seats, directional signs, a post box, phone, bus stop, and so on.	▪ Provides visual cue to main entrance ▪ Overhang may scale down size of building ▪ Sensitively located seating provides amenity for those waiting to be picked up or waiting for bus	▪ May be overused if it is only outdoor seating area provided ▪ May be under-used if main access to hospital is via parking under building
Entry Garden	This is a landscaped area close to a hospital entrance that, unlike a "front porch," is a green space with a garden image and, unlike a "landscaped setback," is designed and detailed for use.	▪ Visible and accessible ▪ Makes positive use of part of site that might otherwise have been paved for parking ▪ Provides a pleasing image on entering hospital environment ▪ Allows use by ambulatory patients who want to see a little "action" near the main entrance	▪ Without sensitive planting, may be too exposed to nearby parking and entry road

Continue of Table 1. Typology of outdoor spaces in hospitals [42].

Outdoor Spaces		Advantages	Disadvantages
Courtyard	This is a space that forms the "core" of a building complex like the hole in a doughnut. Trees for shade, flowers for colour, a water feature for pleasing auditory relief, and movable seating are "basics" for such a space.	▪ Semi-private and secure; surrounded by hospital buildings ▪ Depending on location, may be easily viewed and accessed ▪ Shielded from wind; buildings likely to provide shade ▪ Likely to be of human scale	▪ Depending on its size and location, may create a "fishbowl" experience for those using it ▪ If too small to include adequate buffer planting, adjacent rooms may need to keep blinds drawn for privacy
Plaza	Plaza spaces in hospitals are outdoor areas, furnished for use, and predominantly hard-surfaced. They may include trees, shrubs, or flowers in planters, though the overall image is not of a green space, but of a paved urban plaza.	▪ Low plant maintenance and irrigation costs ▪ A small place can be designed for relatively heavy use ▪ Patients using wheelchairs, walkers, or crutches may be able to move easily in this space.	▪ May have few of the qualities that people perceive as therapeutic in outdoor spaces – an overall green and/or colourful setting, a garden or oasis image ▪ May evoke the image of a shopping mall or corporate office plaza rather than a space for peaceful, stress-reducing, passive enjoyment
Roof Terrace	A roof terrace is an accessible outdoor area that is bounded on one side by a building and often forms a long narrow "balcony" to that building. The basics of such a space are plantings; a choice of seating types; a choice of seating locations	▪ Captures space that might otherwise go unused ▪ Potential for expansive views	▪ Depending on location, may be too windy, too hot, or too shaded

(*continued on next page*)

Continue of Table 1. Typology of outdoor spaces in hospitals [42].

Outdoor Spaces		Advantages	Disadvantages
	with regard to privacy and sun/shade; and accessibility/ visibility to potential users.		
Roof Garden	This is an area on top of a hospital building that is designed and landscaped for use by patients, staff, and visitors, and – in some cases – for viewing from offices and hospital units.	▪ Captures space that might otherwise be unused ▪ Private – unlikely that public would use it ▪ Potential for expansive views	▪ Exposed to elements: may be more windy than ground level, or enclosed courtyard. ▪ Depending on the growth and height of adjacent buildings, temperatures may be uncomfortable (too hot or too cold)
Healing Garden	This is a category that includes outdoor or indoor garden spaces in hospitals that are specifically designated as healing gardens by the administration and/or the designer.	▪ Users can expect that some thought has been given to creating an environment that is therapeutic ▪ Possibly disruptive activities, such as children playing or groups eating and laughing, will probably not be found in the space	▪ Depending on its size, location, and visibility, some people might feel self-conscious using such a garden ▪ If not designated as such, users may be confused as to its function
Meditation Garden	This is a small, very quiet, enclosed space specifically labelled with a plaque as a meditation garden	▪ Provides a space for those in a hospital setting who want to be very quiet and contemplative	▪ If it is visible from indoor spaces, one might feel self-conscious, in a fishbowl. It is quite
	by the administration and/or the designer.	▪ By its name, precludes other, possibly distracting, activities (eating, smoking, etc.)	probable that only one person at a time might use such a space, depending on its size

Continue of Table 1. Typology of outdoor spaces in hospitals [42].

Outdoor Spaces		Advantages	Disadvantages
			▪ Given its designation, one might feel self-conscious about using it for other legitimate quiet activities that are not meditation (reading, writing)
Viewing Garden	With space and budget limitations, some hospitals incorporate a small garden that cannot be entered but can be viewed from inside the building.	▪ Green space in a small area ▪ Can be viewed from comfortable indoor seating area – sheltered from rain; heated/ air-conditioned ▪ Low maintenance costs	▪ Greenery, flowers, etc. cannot be viewed up close or their fragrances enjoyed ▪ Fountain, birds – if present – cannot be heard ▪ Cannot walk, stroll, or sit in garden ▪ May be frustrating for some – "Look, but don't touch"
The Viewing/ Walk-In Garden	This is a variation of the viewing garden in which a space that is predominantly (in terms of spatial extent and use) a garden to look out at from inside the hospital can also be entered and sat in by a very limited number of people. Such a space is usually viewed or entered from a waiting area or corridor.	▪ Provides a soothing green outlook for people waiting or passing by ▪ Provides a very quiet sitting place since few people are present ▪ The relative lack of use ensures that users of any adjacent offices or patient rooms will not feel that their privacy has been unduly intruded upon	▪ People sitting in the space may feel that they are in a "fishbowl," being stared at

5. LEED Healthcare

The first "green" hospital to be certified was the Boulder Community Foothills Hospital in the US state of Colorado, achieving LEED Silver in 2003. The USGBC recognized the need for a rating system to make certification more accessible for the criteria of healthcare projects. In 2004, a committee was formed out of the need for healthcare-specific metrics. In 2010, USGBC prepared and presented the guidance document of LEED for Healthcare, which started as a pilot program, in collaboration with the Green Guide for Healthcare [15, 43].

LEED Healthcare has four levels. The credits are distributed across seven categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation in Design, and Regional Priority. In the evaluation process, a hospital needs to take 40–49 out of 110 points to be certified, 50–59 for a silver certificate, 60–79 for a gold certificate, and 80 and above for platinum certificate, from these categories. Today, there are 28 certified, 43 silver, 39 gold, and five platinum-certified healthcare facilities worldwide [44]. In Turkey, there is one silver, six gold, one platinum-certified hospital, and 13 hospitals are in the certification processes. This number is expected to increase with the Ministry of Health making LEED certification compulsory in public hospitals with a capacity of 200 beds or more in 2013.

"LEED Platinum" has been received among fully-fledged hospitals around the globe as well as Turkey for the first time by the Memorial Bahçelievler Hospital on January 11th, 2018. Dell's Children's Medical Center (USA), Chang Gung Proton Therapy Centre (Taiwan), KP San Diego Central Hospital (USA), and Hospital Fraternidad-Muprespa Habana (Spain) are the other platinum LEED certified health facilities in the world [44].

6. World's First LEED Platinum Certificated Full-Fledged Hospital: Memorial Bahçelievler, Istanbul

The construction of Memorial Bahçelievler Hospital, which has a land area of 14000 m^2 in İstanbul-Bahçelievler district, started in 2015 and was completed in 2018 and put into service. The hospital serves a total of 72000 m^2 of the area and has a bed capacity of 340. The interior and exterior spaces of the Memorial Bahçelievler Hospital, which has been built with an environmentally conscious approach, were designed by taking into consideration the positive effects of green spaces on human health and psychology [45].

One of the most important criteria taken into account during the construction process of Memorial Bahçelievler Hospital was the creation of a structure that would not break the connection between nature and humans. The building was completed with a layered design by retreating a little further from one of the main highways. The hospital has a green area of 8000 m^2 [46]. The fact that 44 % of the land area is preserved as open space and approximately 30% of this area is vegetated represents a significant value considering the total 1% green area rate of the district where the hospital was established [47].

The goal of the project is to have a design which complies with new technologies and aids in the reduction of stress levels for the patients, relatives, and employees. The architectural project combines all design data with a holistic approach that support the patient's recovery process and positively affects the experience in the hospital. In this process, where patient experience is a fundamental design prerequisite, it is also aimed to create an efficient working environment for the employees. Sustainability, energy efficiency, and an eco-friendly approach were the priority of the design group [46].

The hospital was awarded a LEED platinum certificate with a score of 83 out of 110. The hospital got 13 points out of 18 from Sustainable Sites, 8 points out of 9 from Water Efficiency, 29 points out of 39 from Energy and Atmosphere, 8 points out of 16 from Materials and Resources, 15 points out of 26 from Indoor Environmental Quality, 6 full points from Innovation in Design, and 4 full points from Regional Priority categories [44].

The architectural mass is shaped according to land data, climate, daylight, heat effect, wind, access to landscape, and transportation schemes. However, one of the most striking design features of the hospital is the combination of nature and architectural structures, both with landscape design and art elements used in interior design. Indeed, the "biophilic design" approach is used as important components of the architectural design of the hospital.

7. Landscape Design of Memorial Bahçelievler Hospital

There are four different types of outdoor spaces observed in Memorial Bahçelievler Hospital. These spaces are characterized as "Landscape Setback", "The Front Porch", "Roof terraces", and "Viewing gardens" (Fig. 1).

Ground floor: Outdoor spaces on the first floor can be defined as "Landscape Setback" and "The Front Porch". There are three entrances on the ground floor. The main entrance of the hospital is located in the southern part of the hospital (Fig. 2a), secondary access located in the northern (Fig. 2b), and the emergency

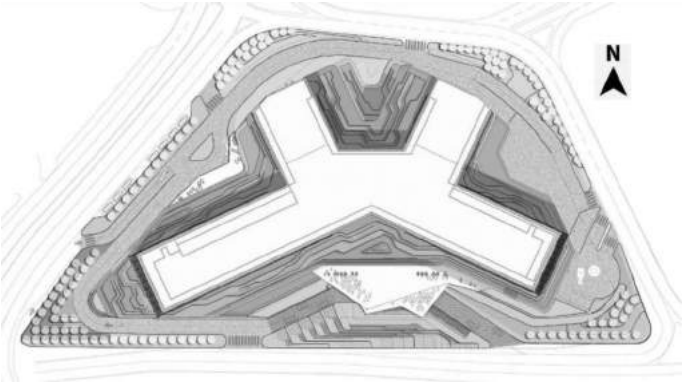

Fig. 1: Memorial Bahçelievler Hospital's landscape plan [48]

entrance is located in the south-eastern part of the hospital. Soft landscape area is approximately 1900 m^2. In the main entrance zone, a "visual feast" has been created by planting. The reflecting pool at the front porch (Fig. 2c) and the plantings made with evergreen bush groups are in harmony. Some of the plants used in this area have been selected from seasonal shrubs with aromatic scents that will emphasize the main entrance. Intensive care units are located in this area within the hospital to provide more daylight for patients. In this area, plantings with short shrub varieties are designed so as not to interfere with sunlight. There is a children's playground of ~ 70 m^2 in connection with the children's polyclinic on the northern part. Decorative flowerpots compatible with children's playground styles are used for landscaping (Fig. 2d). Underground parking garage entrance is located in the western part of the hospital (Fig. 3).

First floor: This floor, where the polyclinics are located, only has 100 m^2 of a "viewing garden" designed with *Aspidistra elatior*, *Cotoneaster horizontalis,* and *Cotoneaster salicifolia.*

Second Floor: On this floor where the polyclinics are located, the outdoor spaces have the character of "roof terraces". The roof terraces surrounding this floor have an area of 410 m^2 and are created to reflect visually positive emotions to patients coming to polyclinics. On the second floor, they use the benefits of the therapeutic effect of nature on the patients. There is no access to the outdoor spaces within the polyclinics directly. The terraces on this floor are not suitable for walking, resting, etc. as the areas are not big enough. Only one part of this roof terrace is used by the cafe visitors (Fig. 4).



Fig. 2: Ground floor landscape design details



Fig. 3: Underground parking entrance

Third Floor: The roof terraces of this floor, with an area of 845 m^2, are designed as a therapy garden. This floor is a reserved area and might be used by physiotherapy and rehabilitation patients in the future. Landscaped areas bordered by wooden walkways are present. The benches are designed for seating and as relaxation areas (Fig. 5). With an ecological approach, the plant design is used to create a habitat for birds in the region. Access to outdoors is restricted due to reduced use and maintenance costs, or because staff use is not close enough to monitor.



Fig. 4: Roof terraces of the second floor



Fig. 5: Roof terraces of the third floor

Fourth floor: This polyclinic floor only has a roof terrace located in the northern part of the hospital. This terrace has an area of approximately 250 m^2, is closed to access, and has a character of a "viewing garden" for the patients (Fig. 6).

List of the plants used on each floor of this project is shown in Tab. 2. Some of the plant characteristics, which are essential for the use in hospital landscape and



Fig. 6: Roof terraces-viewing gardens of the fourth floor

LEED Water Efficiency, such as toxicity, drought tolerance, moisture use, and whether they are native, are stated in this table [49, 50]. Since there is no direct information about the characteristics of some plants (mainly cultivated subspecies and herbaceous plants) in the project area, relevant properties were added to the list by looking at their synonyms [51].

Abies sp., *Magnolia grandiflora, Laurus nobilis, Nerium oleander, Viburnum tinus, Hedera helix, Cerastium sp., Lavandula stoechas, Rosmarinus officinalis* "Prostratus", and *Thymus* sp. that were used in the planting design have been identified as native plants in the Turkish Plant Data Service [49]. The non-native species on the list are well-adapted plants to Istanbul's climate. Nearly half of the plant species in the project have high and medium drought tolerance and need low and medium moisture levels. A drip irrigation system was preferred in the whole project, for not allowing evaporation to wasted water.

Nerium oleander "Salmonera Nana" used on the ground floor and third floor's roof terraces contains very toxic cardiac glycosides (oleandrin, digitoxigenin, neriin, folinerin and rosagenin) that exert a digitoxin-like effect (cardiotoxic potential) [52]. It does not cause any problems as it located in places that cannot be reached on the roof terraces, but it may be dangerous for the humans on the ground floor in case of eating. *Nandina domestica* berries are considered toxic to pets and grazing animals as they contain cyanide and other alkaloids that produce highly toxic hydrogen cyanide (HCN) [53]. *Hedera helix* has a medical use, but its stems, leaves, and berries are poisonous when ingested in large quantities, and severe skin irritation may occur when skin comes in contact with the sap [54]. These plants can be replaced with other species so not to cause harm to humans and animals.

Tab. 2: List of the plants used on each floor in Memorial Bahçelievler Hospital

	Scientific name	Native	Toxicity	Drought tolerance	Moisture use	Floor			
						0 and 1	2	3	4
Trees	*Abies sp.*	✓	None	Low	Medium	X			
	Liquidambar sytraciflua	X	None	Low	High	X			
	Magnolia grandiflora	✓	None	Low	High	X			
	Laurus nobilis (Pyramidal)	✓	-	Medium	Medium	X			
	Ligustrum japonicum	X	Slight	Medium	Low	X		x	x
	Ligustrum texanum	X	Slight	Medium	Low	X	x		
	Nerium oleander	✓	High	High	Low		x	x	
	Photinia fraserii "Red Robin"	X	None	Medium	Medium	X			
	Photinia fraserii	X	None	Medium	Medium	X			
Shrubs	*Abelia grandiflora*	X	None	Medium	Medium	X		x	
	Cotoneaster dammeri	X	-	-	-				x
	Cotoneaster horizontalis	X	None	Medium	Medium	X			
	Cotoneaster salicifolia	X	None	Medium	Medium	X			
	Eriobotrya "Coppertone"	X	-	-	-	X			
	Escallonia bifida	X	None	High	-	X			
	Gaura lindherimeri	X	-	-	-	X		x	
	Hebe salicifolia	X	-	Low	High	X			
	Juniperus horizontalis	X	None	Low	High		x		
	Lonicera nitida	X	-	Medium	High	X			

Continue of Table 2: List of the plants used on each floor in Memorial Bahçelievler Hospital

	Scientific name	Native	Toxicity	Drought tolerance	Moisture use	Floor			
						0 and 1	2	3	4
Shrubs	*Nandina domestica*	X	Fruit	Low	High	X	x	x	x
	Nerium oleander "Salmonera Nana"	X	Moderate	High	Low	X		x	
	Photinia fraserii	X	None	Medium	Medium	X			
	Phyllostachys aurea	X	None	Low	Low	X			
	Pinus mugo "Mughus"	X	None	Low	Low	X			
	Pittosporum tobira "Nana"	X	None	High	Medium	X	x	x	
	Rhaphiolepis indica	X	-	-	-			x	
	Viburnum lucidum	X	-	-	-	X			
	Viburnum tinus	✓	-	-	High		x		
Herbaceous Plants	*Hedera helix*	✓	High	Low	Medium	X			
	Rhyncospermum jasminoides	X	-	-	-	X		x	
	Agapanthus africanus	X	None	Low	High		x	x	
	Aspidistra sp.	X	-	High	-	X			
	Carex oshimensis "Evergold"	X	-	-	-			x	
	Cerastium sp.	✓	-	-	-			x	
	Coreopsis grandiflora	X	-	-	-			x	
	Lavandula stoechas	✓	None	High	Medium	X			
	Rosmarinus officinalis "Prostratus"	✓	None	High	Low	X	x	x	
	Stipa tenuissima	X	-	-	-	X	x	x	x
	Thymus sp.	✓	Moderate	High	Medium			x	

8. Conclusion

In big cities such as Istanbul, where intense effects of urbanization and global climate change are observed, there is a heightened interest in sustainable healthcare, and how sustainable, green hospital design can help alleviate these negative impacts on the environment. In Turkey, the Ministry of Health decided in 2013 to make sustainable public hospitals compulsory. With that, architectural and landscape designs with low environmental impacts have come to the fore in both public and private hospitals. Becoming LEED-certified means extra cost; however, the immediate and measurable return in investment of LEED can be listed as a decrease in operating costs, increase in building values, improvement in return on investment, increase in occupancy, rent increase, and increased productivity [22].

To be truly effective, green building programs must go beyond approving architectural products; they must also include landscape-related goals. Site-intensive and site-only projects (landscapes) cannot achieve LEED-certification because they emphasize structure-specific goals [55]. Currently, landscape-based decisions and interventions account for up to 27 LEED credits, which exceed the minimum for basic certification (26 credits) and represents nearly 40% of total possible credits. It does illustrate the prominent role that the site plays in the overall design process. If a goal of LEED is to increase environmental performance, then it must ultimately evolve to account for the biophysical character and landscape of a site from the beginning of a project. This early understanding of the ecological context deeply informs the conceptual strategy for the entire design. It allows for a holistic, integrated approach to the design process, directly affecting decisions such as the form, materiality, and composition of a building, the siting and arrangement of structures, water management strategies, vehicular and pedestrian circulation patterns, plant selection and composition, and programming [56]. Landscape-related credits are under the categories of Sustainable Sites, Water Efficiency, and Materials and Resources.

As the world's first LEED platinum-certificated fully-fledged hospital, Memorial Bahçelievler is one of the best samples with its landscape design for bringing nature closer to a hospital environment, restoring habitat, and maximizing open space in an urban area. The hospital reserved 44 % of its open spaces as vegetated open space, and by roof terraces and viewing gardens they increase this rate to 56%. By roof terraces, the hospital also reduces the heat island effect. In Istanbul, only hospitals established in the early 1900s have direct access to the natural areas, but today, unfortunately, this opportunity cannot be provided in urban hospitals as a direct connection. Under present market

conditions, the price of land is continuously rising, and cities are being shaped accordingly. Because of this, there is an overall reduction of open green spaces available in urban areas [57].

Reuse of wastewater cannot be used for irrigation in hospital landscaped areas because wastewater in hospitals is potentially infectious and includes some important chemicals, mercury, excessive nutrients and nitrates, pharmaceuticals, radioactive wastes, and infectious agents (bacteria, viruses, and parasites) [58]. Stormwater is not harvested for irrigation in Memorial Bahçelievler Hospital, but some water needs of the plants in roof terraces are met by the rain. In general, the drip irrigation system was used to reduce the use of potable water and the hospital did not get credits from water-efficient landscaping. Xeriscape is a way to earn credits from water-efficient landscaping but in Turkey, due to aesthetic concerns in landscape designs, this approach is not used very often.

The Project team tried to create a healing environment in the hospital not only with landscape design but also using a biophilic approach in architecture. In line with this approach for triggering physical recovery of the patients, colour selections inspired by nature, wooden materials, acoustic arrangements, art exhibitions, digital art installation, and a concert area were used in hospital interiors.

Minimizing the inputs of non-renewable resources and energy, maximizing the levels of internal recycling, and improving the environmental quality of all outputs in hospitals that have to obtain a LEED certification can be possible also with sustainable landscape design. Natural solutions that have emerged with landscape architecture studies will provide not only physical, psychological, and social benefits but also long-term economic benefits to these projects. Insisting only on the visual and aesthetic quality of landscapes cannot provide these benefits.

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