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GREEN MUSEUMS: AN INTRODUCTION AND A POSSIBLE IMPLEMENTATION IN ANKARA

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GREEN MUSEUMS: AN INTRODUCTION AND A POSSIBLE IMPLEMENTATION IN ANKARA

A Master's Thesis

by
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To my father

GREEN MUSEUMS: AN INTRODUCTION AND A POSSIBLE IMPLEMENTATION IN ANKARA

The Graduate School of Economics and Social Sciences
of
İhsan Doğramacı Bilkent University

by

DEFNE DEDEOĞLU

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ABSTRACT

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This thesis explores study the concept of green museums, reviews informational resources on this topic, evaluates the possibility of a green museum in Ankara as a case study and makes suggestions about its implementation. Recently, the severity of the threat of climate change has highlighted the concepts of "green" and "sustainability". Green building and museum practices emerged to bring these concepts to life. The thesis includes a discussion as well as a timeline on the history of green buildings and green museums. Many international and local green building certification systems have been developed and started to be used for the environmentally friendly construction and implementation of buildings and museums. In this thesis, the criteria of LEED, which is the most known and widely used of these systems, are consulted. Then, the principles required to become a green building, hence a green museum are examined. Some of these are sustainable material selection, efficient use of water and energy, renewable energy sources and waste management. In addition to these green practices common to any green construction, a green museum should also use green exhibition techniques and provide education for a sustainable world. Green museums following these principles exist mainly in the

USA. The only example in Turkey is the Konya Tropical Butterfly Garden. A survey was carried out with museum officials in and around Ankara about their awareness and knowledge of the concept of green museums. According to the survey, the subject of green museums is not known much in Ankara. However, the possibility of a green museum in Ankara is very favorable as I demonstrate in my case study. The existence of environmentally conscious consulting firms, eco-friendly material producers, local and natural building materials, and sufficient examples of green buildings are the factors that would facilitate the opening of a green museum in Ankara while a new museum building could be built, many old buildings could be renovated and turned into green museums as well. It has become a necessity, not an option, for museums in Turkey and Ankara to practice green principles because of the increasing environmental problems at present. This thesis is expected to contribute to the creation of awareness of green museums and to serve as an introduction to resources for realizing them.

Keywords: Ankara, Green Buildings, Green Museums, LEED Certification System, Sustainability.

ÖZET

YEŞİL MÜZELER: GİRİŞ VE ANKARA'DA OLASI BİR UYGULAMA

Dedeoğlu, Defne

Yüksek Lisans, Arkeoloji Bölümü

Tez Danışmanı: Prof. Dr. Dominique Kassab Tezgör

Haziran 2020

Bu tez, yeşil müze kavramını tanıtmak ve incelemek, bu konu ile ilgili kaynakları gözden geçirmek, bir vaka incelemesi olarak Ankara'da bir yeşil müze olasılığını değerlendirmek ve bunun uygulanmasında önerilerde bulunmak amacıyla yazılmıştır. Son zamanlarda, iklim değişikliği tehdidinin ciddiyeti "yeşil" ve "sürdürebilirlik" kavramlarını öne çıkarmıştır. Yeşil bina ve müze uygulamaları bu kavramları hayata geçirmek üzere oluşmuştur. Tezde yeşil bina ve yeşil müze tarihi tartışılmakta ve bunların zaman çizelgesi sunulmaktadır. Binaların ve müzelerin, çevre dostu inşaları ve uygulamaları için birçok uluslararası ve yerel yeşil bina sertifikasyon sistemleri geliştirilmiş ve kullanılmaya başlanmıştır. Bu tezde, bu sistemlerden en bilinen ve yaygın olarak kullanılan LEED'in kriterlerine başvurulmuştur. Ardından, yeşil bir müze olabilmek için gereken koşullar incelenmiştir. Bunlardan bazıları, suyun ve enerjinin verimli kullanımı, yenilenebilir enerji kaynakları, sürdürülebilir malzeme seçimi ve atık yönetimidir. Bu çevre dostu uygulamaların yanında, yeşil bir müze ayrıca sürdürebilir bir dünya için eğitim vermeli ve yeşil teknikleri sergilerinde de kullanmalıdır. Bu ilkelere uyan yeşil müzeler ağırlıklı olarak ABD'de bulunmaktadır. Türkiye'deki tek örnek ise Konya Tropikal Kelebek Bahçesidir. Ankara ve çevresindeki müze yetkilileri ile yeşil müze kavramıyla ilgili bilgileri ve farkındalıkları konusunda bir saha çalışması yapılmıştır. Saha çalışmasının sonuçları

göstermiştir ki, yeşil müze konusu Ankara'da fazla bilinmemektedir. Aslında, vaka çalışmasına göre Ankara'da bir yeşil müze açılması olasılığı oldukça fazladır. Yeşil binalarla ilgili danışmanlık firmaları, çevre dostu malzeme üreticileri, yerel ve doğal yapı malzemesi ve yeterli miktarda örnek bulunması, Ankara'da bir yeşil müze açılmasını kolaylaştırıcı etkenlerdir. Ankara'da yeni bir müze inşaat edilebileceği gibi birçok eski yapı da yeşil müzelere dönüştürülebilir. Çevre sorunlarının giderek çoğaldığı günümüzde Türkiye'de ve Ankara'da müzelerin yeşil ilkeler uygulaması artık bir seçenek değil, zorunluluk haline gelmiştir. Bu tezin, yeşil müzeler ile ilgili farkındalık yaratması ve yaşama geçirebilecek kaynakları tanıtması beklenmektedir.

Anahtar kelimeler: Ankara, LEED Sertifikasyon Sistemi, Sürdürülebilirlik, Yeşil Binalar, Yeşil Müzeler.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES[1]

[1] Unless stated otherwise, photographs were taken by the author.

CHAPTER 1

INTRODUCTION

1.1 Background

Today, climate change is the biggest threat that our planet is facing. It is the direct result of the disrespect of nature by humanity, over time. With rapidly increasing population, urbanization, irresponsible industrialization and a lifestyle of consumption, the burning of fossil fuels is releasing billions of tons of carbon dioxide and methane into the atmosphere. These two gases are contributing to the greenhouse effect, raising the temperature of the earth. In turn, the climate is changing with devastating effects on the ecosystem. The consequences are natural disasters like storms, floods, hurricanes, extreme temperatures, droughts, extinction of many animals and plants, forest fires and the appearance of new illnesses. Furthermore, ice in polar regions and glaciers on the mountains are rapidly melting, reducing the reservoir of fresh water and raising the level of the sea. All cities on the seafront are under the threat of upsurge, which could cause many millions of refugees.[2]

It is obvious that urgent actions need to be taken against these catastrophes. Individuals as well as states should take responsibility to decrease their carbon dioxide footprints[3]. One way to achieve this goal is to change the way humans construct and use their buildings. Buildings consume a considerable amount of energy, water and other natural resources, and can have a negative impact on their environment. Museums can exhaust even more resources in order to ensure proper

[2] Details on the effects of climate change can be found at: https://www.wwf.org.uk/learn/effects-of/climate-change.

[3] Carbon footprint represents a particular amount of gaseous emissions which contribute to climate change and are consequences of human activities (Wiedmann & Minx, 2008:55).

care for and preservation of their collections. To overcome these problems and minimize their impact on the climate, green buildings and museums play a significant role to increase awareness and help to create a green environment. In addition to being eco-friendly buildings, green museums have a mission to educate and inform the public about their environment. Green museums also provide a healthy environment for their staff and visitors and are financially economical in the long run.

1.2 Statement of the Problem and Objectives

This thesis examines a developing field in museum studies. Its goal is to present the concept of green museums and, as a case study, to evaluate the possibilities offered in Ankara and its surroundings to implement green concepts.

Many museums in the world today are aware of the threat of the climate change and are trying various applications and strategies to incorporate green into their design and programming, either in the original plans or later with the help of modification projects. Nevertheless, the situation in Turkey is a little disappointing because although green building constructions is widespread, not many studies and projects exist about green museums. However, environmental sustainability for museums is gaining wider acceptance, and this thesis is expected to increase it. That is why the goals of this thesis are to collect and present literature about the subject, to assess the awareness of museum officials about the green concept, to examine the possibility of a green museum in Ankara as a case study and to make recommendations to this end. Thus, two main research questions of the thesis are;

1- What are the awareness of museum officials about green concept?
2- Is implementation of a green museum in Ankara is possible?

It is hoped that this thesis may contribute to the implementation of a green museum in Ankara or other locations in Turkey.

1.3 Methodology

Different strategies have been used to reach a better understanding of the concept of sustainability and green construction and to explore the possibility of an implementation in Ankara. In order to gain knowledge of the green concept on buildings and museums, the author attended a course offered by LEED through ECOBUILD company on green buildings, then sat an examination and was awarded a certificate. In addition, the author consulted various professionals about green building concept and conducted a detailed literature review as summarized in the following section about previous studies.

This thesis mainly uses a qualitative research design. Apart from a comprehensive examination of resources, a semi-structured questionnaire was used to assess the knowledge of museum officials. The answers to the questionnaire and on-site observations on green features of the museums were evaluated and presented.

One of the goals of this thesis it to examine possibilities for a green museum in Ankara. In Ankara, a survey was conducted in order to assess the knowledge of museum officials about green museums. Three survey questions were prepared beforehand and a face-to-face interview was carried out with museum officials. At the same time, the museums were observed for green practices that are implemented in their institution. After the survey, a short introduction to green museums was provided by the author to those interviewed.

In order to find inspiration, two exemplary museums were studied in detail, California Academy Sciences (CAS) because of its excellence and Konya Tropical Butterfly Garden (KTBG) because it's the first and only green museum in Turkey and was rewarded by LEED. KTBG was personally visited two times and the coordinator of the museum was interviewed. It is thought by the author that KTBG could be a good example for future green museums in Turkey.

1.4 Previous Studies

Although the green museum concept is a relatively recent topic in the museum field, it is earning a great amount of attention among professionals. A noteworthy academic literature already exists, consisting of books, dissertations, articles and online sources. The literature listed below was selected from among many for their value in the development of this thesis.

1.4.1 Books

The subject of green museums was firstly developed and introduced by Sarah S. Brophy and Elizabeth Wylie in 2008 with a comprehensive book, *The Green Museum: A Primer on Environmental Practice*. This book is an explanatory guide on how to make a museum green. Authors discussed many environmental topics including energy saving, water efficiency, waste management, air quality, and also educational missions of green museums. This book is the key source because of its innovative approach to museums. The authors revised the first edition and published a second edition in 2013 with new standards, techniques, and new case studies.

Another important book about green museums is *Sustainable Museums: Strategies for the 21st Century* by Rachel Madan published in 2011. Rachel Madan is an expert in museum sustainability. This book provides information and offers strategies about environmental sustainability in museums with many international case studies.

Another recent source for this thesis is Sarah Sutton[4]'s *Environmental Sustainability at Historic Sites and Museums,* published in 2015. Sutton highlights different aspects and provides new and updated details of green museums when compared with previous sources. She is a consultant in environmentally sustainable practices in

[4] Previously Sarah S. Brophy, co-author of *The Green Museum: A Primer on Environmental Practice.*

museums and regularly makes presentations on these subjects in museums, conferences and other nonprofit gatherings.

1.4.2 Articles

Among many specific articles about environmental sustainability and its relation to museums, the article, *"Museums and the Future of a Healthy World: "Just, Verdant and Peaceful*", by Sarah Sutton, Elizabeth Wylie, Beka Economopoulos, Carter O'Brien, Stephanie Shapiro and Shengyin Xu (2017) was the most useful of all. The authors are all members of the American Alliance of Museums' professional network on environmental sustainability. This article is about the vital role of museums in highlighting the effects of climate change. The article contributed especially to the green education section of this thesis.

Another distinguished article is Christer Gustafsson and Akram Ijla's *"Museums: An incubator for sustainable social development and environmental protection"* (2016). It illustrates the important impact of museums on regional development, both social and environmental. It also includes extensive review and analysis of major papers, books and reports about this topic.

1.4.3 Dissertations

The present study is the first thesis about green museums in Turkey; however there are many dissertations written on this topic in the USA and other countries. Some of them are: *Green Museums & Green Exhibits: Communicating Sustainability through Content & Design* by Rachel Byers in 2008 (University of Oregon), *Eco-Exhibiting: A Study to Reduce the Carbon Footprint of Museums and Galleries through Environmentally Sustainable Practices and Procedures* by Jasmine Fenn in 2012 (Carleton University) and *The Evolving Museum: Going Green in Collections Management Practice and Policy* by Ashley Marie Reclite in 2016 (San Francisco State University). These selected studies were very useful for this research in investigating different perceptions and aspects of green museums such as green exhibitions or green policies.

1.4.4 Online Resources

In addition to published books, articles and dissertations, there are also very informative online sources about green museums. Related websites were frequently referred to in this thesis because the subject of green museums is still developing, and many museums and organizations do not have any published books or booklets. Information provided by the LEED official website and these individual museum websites is valuable since it could not be found elsewhere. In addition, because green museums incorporate green building principles, this thesis has also benefited from the green building council websites (LEED, BREEAM, etc.), which do not have an equivalent in a publication.

One of the most important online sources for this thesis is Sarah Sutton's informative blog[5]. This website provides expert advice for museums and cultural centers about environmental sustainability and climate change. In addition, the website call attention to many recent articles, events, and strategies related to climate change.

Most green museums in the world have very explanatory data about their greenness only in their websites. For example, the California Academy of Sciences' website has a separate section, which illustrates their environmentally sustainable practices with photographs (Green Building & Operations, n.d.). Apart from individual museum sources, many non-profit museum organizations[6], such as the American Alliance of Museums (AAM), and California Alliance of Museums (CAM) provide guidance for environmental friendly museums. For example, AAM was involved in creating a practice guide for museums entitled *Small(er) and Green(er) Sustainability on a Limited Budget*[7]. This document has served as a groundbreaking resource for the green shift in museum practices. It is free and also downloadable as pdf.

[5] The website can be accessed in here: https://sustainablemuseums.net/
[6] See page 38.
[7] See report in: https://www.aam-us.org/wp-content/uploads/2018/01/smaller-and-greener-sustainability-on-a-limited-budget.pdf.

One of the most useful websites for the green building concept is the World Green Building Council's[8] (WorldGBC) website. This is a very useful resource for comprehending the green building concept. The site includes many green building councils around the world. One of them, the most important one for this study, is the website of the U.S. Green Building Council[9] (USGBC). The Council provides principles for green buildings according to their rating system, LEED, as well as supplying all LEED projects' data with explanatory information. Detailed information provided in Table 1 of this thesis was collected from the USGBC's website.

These published studies and online information, the museum survey, and observations by the author have been the main resources of this thesis.

1.4.5 Examination of Resources

As seen above, this thesis required the use of many and varied resources. Most of these are websites which provide scientific information or details about specific green museums. However, while there is satisfactory information in most of the official websites of green museums about their green practices, some do not give any details at all.

Publications about green museums are limited because it is a recently developing subject. Because of the novelty of the green museum concept, the information provided in websites is not yet sufficiently established and confirmed to be included in books.

Lack of focus on this topic in Turkish academia is noteworthy. While there are some resources about green buildings, there are no books or websites on green museums. There is one thesis written about spatial design and the use of daylight in sustainable

[8] See page 22.
[9] See page 24.

museums (Sapchi, 2016) and only a few about ecological architecture (Motor, 2017; Tarım, 2016) but nothing specifically about green museums. Therefore, this thesis will cover new ground and be a comprehensive source on green museums, thus helping to fill in this gap.

1.5 Outline of the Thesis

The present study is divided into six chapters. Contents, aim of the thesis, methodology and previous studies are presented in this introduction, which is the first chapter.

The second chapter analyzes the concepts of "green" and "sustainability". Before going into a detailed discussion on green museums, it is essential to gain a better understanding of the meaning of sustainability and green approaches. The definition of green is often confused with the definition of sustainability; however, these concepts are different even if they are complementary. They are explained according to the descriptions of professionals and institutions, and the differences between them are discussed.

The following chapter, chapter three, covers the history of sustainability, green buildings and museums. The emergence of green buildings and museums in history is closely bound with the rise of the concept of sustainability. Oil crisis of 1970's prompted considerations about alternative energy sources and energy conservation. The concept of a green movement in buildings started in mid to late 1980's and was rapidly followed and further developed by the emergence of organizations which guided and assessed sustainability in buildings. Many countries have their own green building organization and rating system. The most recognized rating systems are the LEED certification system from the USA and the Building Research Establishment's Environmental Assessment Method (BREEAM) certification system from the UK. Green building rating system from Germany, German Sustainable Building Council (DGNB) and Passivhaus standard are also introduced and discussed. Apart from Passivhaus, all systems use specific criteria for their evaluation. Green buildings,

including green museums, get credits for each of these criteria and are awarded with different certificates. This study followed the LEED rating system and principles because it is one of the most widely used rating system in the world. Reasons for selecting the LEED system from among others are justified in Chapter 3.

While the first part of the third chapter is devoted to the history of green buildings, the second part examines the chronological framework and the evolution of green museums. The green museum movement was initiated mainly with children's and science museums because of their topic, children's museums to create a healthy environment for young visitors and science museums to increase the awareness about environmental problems and natural conservation. Zoos, aquariums, and botanical gardens followed these examples. Today, every type of museum can become green. Most of the green museums worldwide are included in the LEED certification system. The majority are situated in the U.S. In Turkey there is one valuable example, the Konya Tropical Butterfly Garden which will be discussed in the fourth chapter as an example.

The fourth chapter focuses on the general principles of green buildings and green museums. The first part of the chapter includes details of green policy and planning, as well as the basic requirements to be considered for a building to be green according to the LEED principles. The most important requirements are a sustainable site for construction, green transportation, the production and conservation of green energy, management and conservation of water, quality of the indoor environment, management and minimization of waste, provision of green materials from sustainable sources, and implementation of green roofs and walls. Besides, to reinforce their social impact green museums should create a green team, organize green educational programs and green exhibitions. Two examples are given in this chapter to illustrate green museum features in more detail: the California Academy of Sciences and the Konya Tropical Butterfly Garden.

The fifth chapter includes a survey which was undertaken in museums in and around Ankara. The survey aims to present the current level of awareness among museum officials about green museums. Green principles practiced in the museums were also observed during the survey. The survey results have guided the proposals about the possibility of a green museum in Ankara, comprising the main section of this chapter. Potentials of Ankara in terms of resources, available museum sites, and the existence of related government ministries were also considered, together with current initiatives for a green environment, possibilities and obstacles to a green museum.

The sixth chapter of the thesis is the conclusion. This chapter provides an overview of the whole thesis and the results of the research. It includes the role of green museums, the potential of a green museum in Ankara, the author's observations, proposals and thoughts for the future. The results of the survey revealed that the green museum concept is not well-known in Ankara. However, some museums had already implemented many green features but because of lack of knowledge about the concept, they had not pursued a certificate. The interviews performed and the information about green museums provided by the author are tangible contributors of this thesis to raising awareness. When the available locations, green construction materials, natural resources, and initiatives are considered, a green museum in Ankara is highly possible.

CHAPTER 2

CONCEPTUAL FRAMEWORK

For the purposes of this thesis, the concepts of "sustainability" and "green" need to be explained to understand the movement of green museums. These terms are frequently used in environmental resources. The term "sustainability" is often confused with "green" or is used interchangeably despite the fact that they are two distinct concepts. The following sections will describe each of them separately. In conclusion, their meaning accepted for this study, their use throughout the thesis and the reasons the "green" concept has been chosen for the title are stated.

2.1 "Sustainability"

The concept of sustainability has a very wide meaning that cannot be completely explained by one definition only. This is due to the fact that, it is influenced by current conditions and needs of the world at different times and is being constantly redefined. It is important to have a solid understanding of sustainability in order to apply it to museums (Byers, 2008: 32). The following definitions are used by worldwide institutions, recognized organizations and some professionals. Among a great number of definitions, these were selected because of their wide acceptance by professionals as well as their suitability to the aim of this thesis.

2.1.1 Definition

The definition of sustainability was first described by the United Nations Brundtland Commission[10] in 1987. The Brundtland Commission was convened to discuss the degradation of the human and natural environment (Byers, 2008: 32). In its report, *Our Common Future*[11], sustainability is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987: 54). This definition shows that the concept of sustainability is a long term commitment to development, and it aims to leave a habitable world to future generations. After the publication of the Brundtland Report, "sustainable development" became the leading concept of the environmental movement, and the literature about sustainability grew exponentially (Purvis et al., 2019: 684).

John Elkington is an advisor, entrepreneur and author and co-author of nineteen books on corporate responsibility and sustainable development. A pioneer and an authority of the sustainability movement in the world, he describes sustainability as "… the principle of ensuring that our actions today do not limit the range of economic, social, and environmental options open to future generations" (Elkington, 1997: 20). It shows that activities of current development should take their influences for the future into consideration.

According to the U.S. Environmental Protection Agency (EPA), "sustainability creates and maintains the conditions under which humans and nature can exist in a productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations" (EPA Learn about Sustainability, n.d.).

[10] Between 1984 and 1987, United Nations formed a Commission on Environment and Development (WCED), named after its chair Gro Harlem Brundtland (https://www.britannica.com/topic/Brundtland-Report).
[11] Full text can be found: https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

For the U.S. Green Building Council (USGBC), sustainability "means creating places that are environmentally responsible, healthful, just, equitable, and profitable" (Knox, 2015).

According to Sarah S. Brophy and Elizabeth Wylie, sustainable refers to "practices that rely on renewable materials and processes that enable continued use and practice into the future" (2013: 18).

It is obvious that all definitions are related to social, economic and environmental concerns. They all recommend responsible development, and there are few minor differences between the definitions. While the definition of the United Nations is rather general, John Elkington's, EPA's, USGBC's, and Brophy and Wylie's are more specific to their own perception about environmental conservation. All definitions of sustainability share a common characteristic: they consider the needs of future generations with minor additions depending on the author's purpose. However, sustainability has three basic dimensions which should be considered when making a definition, it's environmental, social, and economical aspects. In addition, a special dimension, mission should be included for green museums.

2.1.2 Triple Bottom Line (TBL)

The Brundtland Commission also puts forward the idea that sustainability could be achieved when three components are balanced. These are environment (planet), social (people), and economy (finance) (Elkington, 1997: 70). Environment includes natural resources, biodiversity, waste reduction, low emissions, water and air quality, energy conservation and land use. The social component contains human rights, education, health, equity and quality of life. The economic component consists of profitable growth, management and long term viability. These three mechanisms of sustainability are known as the triple bottom line[12]. Figure 1 is one of the more common graphics used to describe sustainability within academic literature, business

[12] The term, *triple bottom line*, was first coined by John Elkington in 1994.

literature and online sources. As shown in Figure 1, they are linked with each other. The figure shows how all three factors can influence each other to create a healthy global ecosystem (Elkington, 1997: 72).

The triple bottom line is not static: each of its components may change according to social, political, economic and environmental pressures, cycles and conflicts (Elkington, 1997: 73). For instance, during a political crisis one component can gain prominence whereas during an environmental disaster another will come forth. Figure 1 points out that for development to become truly sustainable, it is essential to equally achieve environmental sustainability, social sustainability, and economic sustainability together.

2.1.3 Quadruple Bottom Line (QBL)

According to Brophy and Wylie, there is a fourth factor which is exclusive to museums to achieve sustainability. This fourth line is the "program" or "mission" (Brophy & Wylie, 2013: 19). "In museums, much of the decision making about any proposed project is based on its support of institutional mission, and the sustainability decision making process should also be based on mission" (Brophy & Wylie, 2013: 19). The factors represented in Figure 1 are also commonly used as the three pillars presented in Figure 2. However, I have added the factor mission to represent the foundation of the structure rather than a fourth line as proposed by Brophy and Wylie. As seen in Figure 2, mission forms a sound basis for sustainability because in many institutions, including museums, many of the decisions taken are based on their mission. It is the mission that determines how environment, society and economy will be incorporated into the museum's principles and put into action. The triple bottom lines in museums can only be successful if there is a mission. Taken all together, museums founded on the principles of QBL should have positive effects for people, their environment, their finances and their mission (Brophy & Wylie, 2013: 20).

The advantages of a sustainable museum are many. The beneficial effects of a sustainable museum on the planet (i.e. environment) include reduction of negative environmental impacts such as pollution, resource depletion, greenhouse gas production and loss of biodiversity (Sutton, 2015: 4). When the second pillar in Figure 2 is considered, public outreach, education of the society (i.e. staff and visitors) about a sustainable environment and their benefit from healthy, pleasant and comfortable conditions could be mentioned. As to the third pillar for finances, sustainable museums will save costs if they reuse materials, economize water use and implement energy efficiency and alternative choices of energy. Financial savings will then be able to support other green activities of the museum. Museums should program and evaluate all their environmental, social, and economic activities under the umbrella of their mission.

2.2 Concept of "Green"

Because of the threat of climate change, green concept is getting more significant. This section is rather short because, unlike sustainability, there are not many different definitions of green. The term "green" is basically used for environmentally friendly practices such as clean energy, responsible design and construction using harmless building materials, and green roofs and walls. Energy and water conservation; waste management; local, non-toxic and renewable materials; eco exhibits; and educational programs are examples of some green practices which will be described in Chapter 4.

According to Yanarella, Levine and Lancester, green is "easy to do because it connotes quick and inexpensive steps to make the world more sustainable by deployment of tactics that reduce the environmental impact of human activity, agricultural and industrial production, and our built environment" (Yanarella et al., 2009: 297). Creation of a more habitable planet is feasible by limiting human activities that could harm the environment. While green has a limited meaning, it has a significant and effective impact on the environment.

2.3 Difference between the Terms "Sustainability" and "Green"

The major difference between green and sustainability stems from the scale and scope of these two concepts. Green is defined by products, practices and services, comprising the environmental pillar of QBL. Green is pragmatic: it is about making as very small changes as possible to achieve best environmental results. On the other hand, sustainability comprises the whole system, including mission, environmental, social, and economical dimensions. Hence, green is a vital part of the all-encompassing concept of sustainability.

The difference between green and sustainability has also been discussed by many authors. For example, according to Brophy and Wylie, green is similar to "do not harm" and sustainable is comparable to "do not harm and keep the patient alive" in medical practice (2013: 49). Appendix A further demonstrates the differences between the characteristics of these two terms. As can be observed, while green rests on only one leg of the triple bottom line (environment), sustainability relies on all three legs (environment, economy and society).

2.4 Use of "Sustainability" and "Green" in this Thesis

In this thesis, sustainability is mainly used for its environmental component because of the scope of the study and its emphasis on the impact of museums' environment. In this capacity sustainability aims to improve and preserve the ecosystem, and to leave a healthy planet to future generations of people, animals and plants. Climate change is currently the most urgent aspect of sustainability (Gustafsson & Ijla, 2016: 460) even to the extent that the environment is determining economic and social aspects of sustainability. Therefore, the economic and social components are also considered in this thesis, but not in as much detail as the environment.

Although a healthy ecosystem today is vital, economic factors predominate today's world. Businesses often focus on financial gain, leaving social and environmental considerations as an afterthought. Although this approach is now being challenged

by significant portions of the world's population, the achievements are slow, while the temperature of the atmosphere continues to rise to disastrous levels.

The place of environment in the QBL was described in preceding sections. The thesis follows this framework. It focuses specifically on the environmental pillar, museum practices and particularly "green" practices and does not engage in the complex system of sustainability.

As explained above, while sustainability is a much wider concept than green, in this thesis "sustainability" is mostly used in its green context. Therefore, the title of the thesis includes "green" instead of "sustainable" because it has a narrower meaning and is easier to comprehend. Moreover, "green museum" is a very common and accepted term widely used in scientific and popular literature. In consequence, "green" in this thesis means environmentally-friendly practices.

CHAPTER 3

GREEN BUILDINGS AND MUSEUMS

FROM A HISTORICAL PERSPECTIVE

The emergence of green buildings and museums in history is closely bound with the rise of the concept of sustainability. The first part of this chapter is devoted to explaining the starting points of green buildings and the main green building councils with their rating systems. The second part is focused specifically on the history of green museums and their development. A timeline of milestones in the history of sustainability, green buildings and museums is provided in the Appendix B.

3.1 The Emergence of the Sustainability Movement

The concept of sustainability has been around for as long as humans have existed because; they depended on a healthy environment for their survival. However, the modern perception of environmental sustainability emerged with the recognition of the effects of industrialization, in the late 19th century. After the Industrial Revolution, mass production, transportation, consumption of resources, and waste deposition had rapidly increased and became hazardous. As one new technology led to the other, economic growth increased exponentially for a hundred and fifty years. Transportation became more efficient, buildings became higher, and cities grew larger (Maeda, 2011: 25). As a result of this overwhelming growth, the environment began to suffer and its sustainability became an issue.

Two significant publications in the 20th century established the importance of environmental sustainability. The first one is Rachel Carson's *Silent Spring*,

published in 1962, in which she discussed her environmental concerns. She mainly mentioned the negative effects of humans on the natural world. According to Carson, human actions upon nature always have consequences, often resulting in an effect much larger than expected (Carson, 1962: 16). The second publication is Garrit Hardin's *The Tragedy of the Commons*, published in 1968, which discussed the need for better resource management. Hardin argued that overpopulation is depleting the earth's resources (1968: 1248). Both of these works called attention to the concept of sustainability and, as a consequence, the idea of an environmental movement. These two publications with their warning messages helped to launch the announcement of Earth Day in 1970, which is celebrated on April 22 in 184 countries annually to draw attention to environmental issues.

On a related note, the United Nations has held many international conferences in different countries. The first one in 1972 was held in Stockholm to coordinate global efforts to promote sustainability and protection of the natural environment (United Nations Conference on the Human Environment, n.d.). In 1987, the Brundtland Commision, formed by the UN, published it's influential report *"Our Common Future"* on sustainability, mentioned in the previous chapter. At the 1992 UN Earth Summit in Rio, countries adopted Agenda 21[13] and discussed how they can reduce poverty, advance social equity and ensure environmental protection. In 1997 the United Nations Kyoto Protocol[14] was signed. It is an international agreement which establishes target goals for emission reductions on an international scale. Unfortunately, in 2001 the U.S had retreated from the Kyoto protocol. While previous meetings had addressed sustainability and environmental concerns, the UN World Summit on Sustainable Development in 2002, Johannesburg, focused on the integration of sustainable practices into daily life. These practices included managing and reducing water and energy use (World Summit on Sustainable Development, n.d.).

[13] Agenda 21, referring to 21st century, is a comprehensive action plan to be taken globally, nationally, and locally by organizations of the United Nations system, governments, and major groups. Agenda 21 was adapted by 178 governments (Agenda 21, n.d.).
[14] Kyoto Protocol is the world's first greenhouse gas emissions reduction treaty.

All these landmarks were important steps towards sustainability of the ailing planet. With the new perception of sustainability, the public was more conscious about climate change and resource management. Many other international meetings were held later. Among them, the 2012 Rio UN Conference, which focused on green economy policies, is worth mentioning. However, the most important one is the Paris Agreement in 2015. The Paris Agreement's main goal is to strengthen the global response to the threat of climate change by keeping the global temperature rise below 2^{o} C by 2030 (UNFCC Climate, Get the Big Picture, n.d.). For the first time, the agreement brought all nations together for a common aim to undertake efforts to control climate change and adapt to its effects. Developing countries agreed to provide financial and technical support to poorer countries for this effort (UNFCC Climate, Get the Big Picture, n.d.). While the agreement is still in effect, the U.S has not accepted its terms. This would have a big impact on the environment because U.S is responsible from much of the carbon dioxide emissions.

The United Nations reports, agreement and meetings about climate change, and the warnings by scientists have received great attention from the public. These international meetings affected many sectors, including the building industry, motivating them to reduce their carbon dioxide footprint. In fact, the building industry is considered to be the major contributor[15] to environmental damage and change due to its consumption of a large proportion of natural resources, water and energy (Doan et al., 2017: 244). When these hazardous effects of buildings were considered, the appearance of environmentally-friendly buildings, also known as green buildings, was inevitable.

3.2 The Emergence of Green Movement in Buildings

Although green buildings are a recently phenomenon, the roots of sustainable practices in buildings can be traced as far back as the Antiquity. Sustainable design

[15] Buildings are responsible for major energy and resource consumption, accounting for more than 40% of all energy usage (Doan et al., 2017: 244) and responsible for more than a third of global resource consumption(Rode et al., 2011: 336). In addition, the building sector generates 30% of the world's greenhouse gases and 40% - 50% of water pollution to the environment (Doan et al., 2017: 244).

methods, such as building with local materials or harnessing natural energy, started before technological advancements in construction. Ancient Greeks and Romans, for example, used some green building practices. To benefit from the sun's warmth, the Greeks positioned their dwellings in a way to absorb the sunlight (Maeda, 2011: 24). In 400 BC, Socrates advised that in houses oriented towards the south, warming sunlight enters deep into the house in winter, while in summer the solar orbit is so high that the portico casts the house interior in cool shade (Barber, 2012: 5). Romans were doing the same for their bathhouses (Maeda, 2011: 24). Also, ancient Greeks and Romans created sustainable water techniques by building water structures that were adapted to the environment and fitted in with their natural surroundings. Both used sustainable water management systems to control water consumption such as condensation caves, stone arrangements for rainfall, dew harvesting, underground dams, and preventing leaks (Mays, 2010: 229). Very different from today's understanding, ancient people knew how to respect nature and how to use their resources like water consciously because they were limited. Many of these techniques now have become the basic principles of modern green buildings (Maeda, 2011: 24).

Contrary to these early productive and beneficial examples, however, humans have also overhunted, destroyed forests, polluted nature and consumed natural resources without limit and control. Thus, environmental damage and change were unavoidable results. The construction and operation of green buildings are actions taken against these threats and ways to raise awareness of the public.

There is not a single event designating the beginning of green buildings; it has been a continuing process instead. The oil crises of 1970's led to a search for alternative sources of energy (Riberio & Lomardo, 2016: 598). In addition, with the increasing level of environmental awareness, the green building industry began to attract more attention in the mid to late 1980's (Abdelkader et al., 2015: 7). Definitions of a green building began to emerge, such as "a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment" (WORLDGBC About Green Building,

n.d.). In 1990 the first attempt to create a green building was initiated with a Passivhaus[16] Building in Darmstadt, Germany (Feist, 2014: 1), but later that year green architecture gained wider acceptance with more complex and larger programs. Today, the green building industry is one of the fastest growing building and design initiatives compared to other architectural movements. As a result, many organizations with international acclaim have appeared worldwide.

3.2.1 Green Building Councils and Rating Tools

WorldGBC, the world's largest international organization in the green building sector, is leading a revolution of the built environment to make it sustainable and healthy. WorldGBC's mission is to "create green buildings for everyone and everywhere to build a better future" (WORLDGBC About us, n.d.). Since its formation in 2002, WorldGBC has grown into a global network of around 70 Green Building Councils around the world. WorldGBC works closely with national councils to promote local green building actions and address global issues such as climate change (WORLDGBC About us, n.d.).

The organization of WorldGBC is given in Figure 3. Many National Green Building Councils have created their own assessment systems (rating tools). Green building rating tools, also identified as certification systems, are used to evaluate and accredit buildings which fulfill specific green requirements and standards (WORLDGBC Rating tools, n.d.). For the purposes of this thesis, only the LEED, BREEAM and DNGB systems are mentioned (Table 1); however, there are many other recognized rating systems such as CASBEE, GBI, or GreenMark, being used by only a few countries.

[16] See page 27 about the Passivhaus concept.

Table 1. Comparison table of different green building certification systems

	LEED	**BREEAM**	**DGNB**
Founders	USGBC	BRE	DGNB
Country of Origin	USA	UK	Germany
Launch Date	1998	1990	2007
Criteria	• Location & Transportation • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Innovation • Regional Priority	• Energy • Health and Wellbeing • Innovation • Land Use • Materials • Management • Pollution • Transportation • Waste • Water	• Environmental Quality • Economic Quality • Sociocultural and Functional Quality • Technical Quality • Process Quality • Site Quality
Award Levels	Platinum Gold Silver Certified	Gold Silver Bronze	Outstanding Excellent Very Good Good Pass

3.2.1.1 LEED rating system

LEED is one of the most widely used and important rating systems, and was developed by the U.S. Green Building Council (USGBC), one of the members of WorldGBC. USGBC was founded in 1993 by Rick Fedrizzi, David Gottfired and Mike Italiano, and it is now the leading organization in the world. In 1998, the USGBC launched a rating tool to measure a building's performance: Leadership in Energy and Environmental Design (LEED) (LEED rating system, n.d.).

The seven goals of the LEED certification program include the following (Cottrell, 2014: 37):

• To reduce and even reverse negative impact on global climate change,

• To enhance individual human health and well-being,

• To protect and restore water resources,

• To protect, enhance and restore biodiversity and ecosystem,

• To promote sustainable and regenerative material resources cycles,

• To build a greener economy,

• To enhance social equity, environmental justice, community health and quality of life.

LEED has also released five guidelines on its website, which change according to the project and the building type. These are (LEED rating system, n.d.):

- Building Design and Construction (BD+C),
- Interior Design and Construction (ID+C),
- Building Operation and Maintenance (O+M),
- Neighborhood Development (ND),
- Homes Design and Construction.

Under each of these main titles, detailed criteria are provided for different building types such as hospitals, retail, schools, etc. All these building types can either be new or existing. For new ones BD+C guidelines and for existing ones O+M guidelines are applied. When planning a building, project teams select one of these reference guides above, provided by LEED's website which is best suited for their projects (Cottrell, 2014: 38). According to the guideline selected, LEED assesses the project for six specific criteria:

- Location & Transportation,
- Sustainable sites,
- Water efficiency,
- Energy & atmosphere,
- Materials & resources,
- Indoor environmental quality.

In addition to the criteria above, bonus points are given for innovation and regional priority. All these criteria will be examined in detail in Chapter 4, which is dedicated to the basic principles of green museums. Under each of these criteria, there is a collection of mandatory and optional strategies. Mandatory prerequisites set the minimum requirements that all buildings need to meet in order to achieve LEED certification; simply fulfilling the minimum requirements of prerequisites will not earn points. Optional strategies are the ones that earn points or "credits" and can be selected according to the specific type of project (Cottrell, 2014: 43). To earn a certification, projects must prove that they have comply with all prerequisites and receive at least 40 credits out of the maximum 100.

Based on the number of points achieved, a building project then earns one of four LEED rating levels: Certified, Silver, Gold or Platinum (Kubba, 2017: 34). LEED certified O+M projects need recertification on a regular basis to maintain, improve and document ongoing sustainable performance. Every project has to enter 12 month data to keep the certification active and this recertification will be valid for three years.

The LEED rating system is one of the most accepted and widely used green building program across the world including the U.S. and 150 other countries such as Canada, China, the United Arab Emirates, Italy, Israel, and India (Kubba, 2017: 35). Turkey is included in the list of 150 LEED practicing countries.

3.2.1.2 BREEAM Rating System

The earliest rating system, Building Research Establishment's Environmental Assessment Method (BREEAM) (What is BREEAM, n.d.), was founded in 1990 in the United Kingdom to assess the sustainability of buildings (Maeda, 2011: 29). This system is used mostly by England, Netherlands, and Sweden. It uses a number of criteria[17] which are similar with LEED's system (Gauzin-Müller, 2002: 20) but some of the headings are different, as follows: Energy, Health and Wellbeing, Innovation, Land Use, Materials, Management, Pollution, Transportation, Waste, Water (Kubba, 2017: 106).

Credits are given to each for these criteria and are rated on a scale of "Pass", "Good", "Very Good", "Excellent" or "Outstanding" (How BREEAM Certification Works, n.d.)(Table 1).

3.2.1.3 DGNB Rating System

The German Sustainable Building Council (Deutsche Gesellschaft für Nachhaltiges Bauen - DGNB) was founded in 2007 by 16 initiators from various disciplines to encourage green buildings (The DGNB, n.d.). This system is used currently in Germany, Bulgaria, Denmark, Austria, Switzerland and Thailand. There are six thematic criteria[18], each sub-divided into various groups of topic for the evaluation of buildings: environmental quality, economic quality, sociocultural and functional quality, technical quality, process quality and site quality (Kubba, 2017: 97). Buildings can get awards in the categories "Bronze", "Silver", and "Gold" (Table 1).

[17] The details of the criteria used by BREEAM can be seen from here: https://www.breeam.com/discover/how-breeam-certification-works/.
[18] The details of the criteria used by DGNB can be seen on here: https://www.dgnb-system.de/en/buildings/new-construction/criteria/index.php.

3.2.1.4 Passivhaus

Apart from the rating systems mentioned above, the green building industry also uses another important standard developed in Germany called the Passivhaus (Passive[19] House). Passivhaus is a guideline for buildings aiming to achieve extremely low energy consumption. The Passivhaus standard started from a discussion in May 1988 between Bo Adamson of Lund University (Sweden), and Wolfgang Feist of the Institute for Housing and the Environment (Germany), both of whom specialized in low-energy building designs (International Passive House Association, 2018: 4).

The dialogue between the two experts moved to practical application and the first Passivhaus building was completed in 1990 in Darmstadt (Feist, 2014: 1). In 1996, the Passivhaus Institut was founded in Darmstadt to promote and control Passive House standards. After 1996 the Passivhaus certification system became valid.

The standard' main aim is to drastically reduce the energy required to heat and cool buildings while maintaining comfortable temperatures and high indoor air quality (International Passive House Association, 2018: 1). The standards can be applied to any type of building, not just houses. In order for a building to achieve Passivhaus certification, it must achieve specific performance criteria. Passivhaus is limited, focusing on energy consumption only; however, Passivhaus projects also provide high quality construction, indoor comfort, and well-being. The vast majority of Passivhaus buildings are situated in Europe, including Turkey.

3.2.2 Analysis of Different Rating Systems

There are some differences and similarities among the rating systems mentioned in this chapter. These green building rating systems were developed by specific countries at different times with particular priorities and criteria as seen in Table 1.

[19] The standard is called "passive" because the design needs to focus on "passive" influences in a building such as sunshine, shading or ventilation rather than active heating and cooling systems such as air conditioning.

Points to be gained to get a certain level of certificate are different in LEED, BREEAM and DGNB. LEED, BREEAM, and DGNB rating systems are based on specific criteria such as site selection, energy and water efficiency, material selection or indoor environment quality while Passivhaus is based on energy performance only. Contrary to other systems, Passivhaus does not include other aspects of sustainability such as building site management, efficient use of water green materials or waste reduction.

When the criteria of LEED, BREEAM and DGNB are studied, it can be seen that these systems have common topics like energy, water, materials location or waste management. However, when the contents of DGNB is examined in detail, its criteria shows that it is the only system which covers all three dimensions (environmental, social, and economic) of sustainability equally. DGNB even has a criteria about safety and security under the heading of sociocultural and functional quality. On the other hand, LEED and BREEAM are mainly focused on environmental aspect of sustainability. LEED and DGNB were developed by their national green building councils; while BREEAM and Passivhaus were developed by independent research institutes. Nevertheless, in spite of their differences, all of the rating systems have a similar common goal: to create a livable and sustainable environment by building green.

LEED and BREEAM are the most widespread globally and more commonly used when compared to other systems (Doan et. al, 2017: 257). However, in this thesis, LEED system is taken as a reference for the following chapters because it is the preferred rating system in Turkey (ÇEDBİK, n.d.). The other reason is that the LEED system is very well organized in terms of its website, educational programs and publications. Moreover, the author is much more familiar with the LEED system having joined a LEED training course, sat an examination, and granted a Green Associate certificate from LEED.

3.2.3 Green Building Implementations in Turkey

In Turkey, green and sustainable building design and construction is a very recent phenomenon when compared with other countries. However, today there is a great amount of interest in green buildings.

Turkey also has its own green building council under the WorldGBC, called ÇEDBİK (Çevre Dostu Yeşil Binalar Derneği) which was established in 2007 by environmentally conscious construction companies. In 2018, ÇEDBİK developed a rating system, B.E.S.T[20], which is only used for new residential projects (B.E.S.T Residential Certificate, n.d.). Although mostly the LEED rating system is practiced in Turkey, the BREEAM system is also used frequently. Currently, 388 LEED (ÇEDBİK, n.d.), 100 BREEAM and 1 DGNB project[21] exist in Turkey. Turkey's first LEED certified building is the Unilever Central Office[22] in Istanbul. The building received the Silver Certification in 2009.

Because the number of green buildings rapidly increased after 2009, many green building consulting firms have appeared such as ECOBUILD in Ankara and ERKE and ALTENSIS in Istanbul. These consulting companies act as a green guide for building firms. They manage phases of design and construction of buildings according to LEED and BREEAM certification references, as well as meet the demands of their clients. In addition to LEED and BREEAM certified buildings, Turkey also has two Passivhaus buildings both located in Gaziantep, indicating the awareness of the Gaziantep Mayor, Fatma Şahin.

The green building concept is also widely applied in the capital of Turkey, Ankara which is chosen as a case study in this thesis. Ankara has 56 green building

[20] B.E.S.T certificate guide: https://cedbik.org/static/media/page/12/attachments/b-e-s-t-konut-sertifika-kilavuzu-2019-agustos-v-2-0.pdf?v=100919110112 .
[21] To see the project: https://www.dgnb-system.de/en/projects/index.php?filter_Freitextsuche=&filter_Land=T%C3%BCrkei&filter_Bundesland=&filter_Standort=&filter_Jahr=&filter_Zertifizierungsart=&filter_Nutzungsprofil=&filter_Zertifiziert_von_1=&filter_Verliehenes_Guetesiegel=&filter_Architekt=
[22] To see the details of the project: https://www.altensis.com/en/project/unilever-turkiye-merkez-ofisi-turkiyenin-ilk-leed-sertifikali-projesi/.

projects[23], most of which are completed. Two examples were selected from Ankara because of their illustrative nature at different scales: Eser Green Building and Bilkent University.

3.2.3.1 Eser Green Building

Eser Green Building, Ankara's first LEED certified green building, is situated in the Yıldız District, and is designed, constructed and operated professionally with an ecological approach. Eser Holding is an energy, construction and engineering firm in Ankara and works in the Middle East, Central Asia, Eastern Europe, and Africa. Eser Holding's office building was completed and opened in 2010, and was named the "Eser Green Building" (Figure 4). In February 2011, the building, which was realized under the guidance of consulting company ALTENSIS, received a LEED Platinum certificate, the highest level of the LEED rating system. The historical significance of this building is that it is Turkey's first LEED Platinum building (Figure 5).

Different from other conventional building construction, green goals were already established during the design stage of the construction process. In line with this decision, the design collectively engaged civil, electrical and mechanical engineers and architects, and became an integrated, interdisciplinary process. The building earned 90 points out of 100. The building intends to use water and energy with utmost efficiency and to minimize the negative impacts of the building on occupants and the natural environment.

Eser Green Building is not just a functional building. It also provides an excellent opportunity for visitors to experience the features of green buildings. A small park was built next to the building to illustrate green techniques for primary school students. In addition, the staff of the building welcomes academicians as well as students to present the building's advanced green technologies. The team is very

[23] The LEED projects in Ankara can be seen here in detail: (https://www.usgbc.org/projects?Search+Library=%22ankara%22).

supportive and informative about green approaches, fulfilling an important educational mission.

3.2.3.2. Bilkent University

Not only buildings but some university campuses are also part of this green trend. Among them, Bilkent University has intentions to become green. As stated by the Director of Construction and Technical Works at Bilkent University, Mevlüt Kahraman, (Personal communication, December 24, 2019), many Passivhaus techniques are already being used in the new dormitory construction at the campus. In addition to its efficient energy design as required by Passivhaus standards, water systems, lighting, insulation and acoustics of the building are also carefully designed based on green techniques. In addition, irrigation water of the campus is supplied from a lake within in the boundaries of university. In the future, the whole campus area will be rearranged with a green perspective.

As an example to Bilkent University's green initiative a recent attained environmental accomplishment should be mentioned. On April 2020, Bilkent became the first university in Turkey to qualify for the certification of "Zero Waste[24]", which it received from the Ankara Provincial Directorate for the Environment and Urbanization[25].

3.3 History of Green Implementations in the Museum Field

The first handbook on environmental topics applied to museums was published by the American Association of Museums (AAM) in 1971 (Keogh & Möers, 2015: 82). It detailed a survey of U.S. museums on the role of educating the public about the science of ecology and major environmental issues, and suggested exhibition and programming ideas. The report contains a brief introduction to the science of ecology. Many museums responded favorably to these proposals (American Alliance

[24] For Zero Waste Project see page 81.
[25] The information was retrieved from: http://bilnews.bilkent.edu.tr/bilkent-achieves-zero-waste-milestone/.

of Museums, 2013: 56). After this initiative, ICOM held two conferences, first in 1972[26] and then in 1990 in France about Museology and Environment (American Alliance of Museums, 2013: 56). In 1974, Coyote Point Museum (now CuriOdyssey) was created in California as a museum dedicated to environmental education (American Alliance of Museums, 2013: 56). These efforts can be considered as the first attempts to introduce green museums. However, main implementations of green museums first started in the 2000's when green buildings were widely used and put into practice.

Children's and science museums were the first to adopt green principles (Brophy, 2011: 1). The Association of Children's Museums (ACM), a professional service organization in the field of children's museums, describes these as "places where all families are welcome and learn together through play and hands-on activity" (Association of Children's Museums, 2015: 11). These museums were pioneers in green principles because they were especially concerned about the health of the visiting children, who come in close contact with exhibition materials and should have a healthy indoor environment. These museums aim to have an educational impact on the whole family about environmental issues. Science museums were interested in climate, environment and giving people information about daily green practices (Sutton, 2011: 1). In fact, both types of museums serve similar clientele.

Following children's and science museums, zoos, aquariums, and botanical gardens began to adapt sustainable design and construction. They were motivated by the opportunity to take an active role in the conservation of wildlife and their habitats (Chitima, 2015: 227).

Today, sustainable movement in museums, in general, is rapidly growing and developing. Every type of museum, whether art, archaeology or any other field, can find some reason to become green. There is even a green football museum in Dortmund, Germany. Not only children's museums, but all museums play a crucial

[26] To see the report of the conference: https://unesdoc.unesco.org/ark:/48223/pf0000127361.

role in the growing trend of environmental sustainability. According to Brophy and Wylie, environmental sustainability will become a professional expectation for all museums in the future (2008: 2).

A newer effort in 2013 by the American Alliance of Museums was the gathering in Baltimore of more than 100 museum professionals from all museum types in the U.S with the intention of setting sustainable standards for museums. The participants published a report titled "*Museums, Environmental Sustainability and Our Future*"[27]. The museums chose to comply with LEED standards at present rather than create a new rating tool specific to museums.

In presenting the history of green museums, only those included in one of the rating systems were considered. There is no information about the opening dates of other green museums which are not registered. The following section will mainly focus on the LEED system because this study follows the standards of LEED, the most commonly used system among museums. However, other certification systems such as BREEAM, DGNB and Passive House will also be mentioned subsequently.

3.3.1 Green Museums in the LEED rating system

There are conflicting dates about the first LEED certificate museum. However, it can be stated that the Mark Twain Historic House Museum (Silver LEED certificate) (Figure 6) and ECHO (Ecology, Culture, History, and Opportunities) (Certified LEED certificate) Leahy Center for Lake Champlain, Vermont are the earliest examples of LEED certified museums, dating back to the beginning of 2000's.

Following these first examples, the Children's Discovery Museum in Normal, Illinois USA, received a Silver Certification in 2005. Next, because of their contributions to the green movement, the Pittsburgh Children's Museum's (Figure 7)

[27] To see the report: http://ww2.aam-us.org/docs/default-source/professional-networks/picgreenwhitepaperfinal.pdf.

new expansion was awarded with a Silver certification in 2006 and the Boston Children's Museum with a Gold certification in 2007, leading the movement of green museums. The Pittsburgh Children's Museum uses %100 renewable energy for its electricity, and it has a green roof (Pittsburgh Green Museum, n.d.). On the other hand, the Boston Children's Museum has embarked on a large-scale renovation project which focused on green features with educational activities and programs (Boston Children's Museum, n.d.).

Another early adopter of green practices, California Academy of Sciences[28] incorporating several museums on science, natural history etc., was opened in 2008 and received LEED Platinum award. The institution utilized many innovative, and exemplary green techniques. The Fort Worth Museum of Science and History decided to start from scratch in 2009. The original building was demolished, and then recycled to construct a new building incorporating sustainable elements (Reclite, 2016:14). The Natural History Museum of Utah is another green museum worth mentioning; recipient of a LEED Gold award in 2013, it is a successful example of adaptation with its environment. It has the largest solar panel installation in the state (National History Museum of Utah Sustainability, n.d.).

Art museums also started to participate in this green movement. The world's first LEED certified art museum complex, the Grand Rapids Art Museum in Michigan, U.S., opened in 2008 and received a LEED Gold certificate.

[28] This museum will be examined in detail in the following chapter.

Table 2. Distribution of LEED certified museums.

Year	USA	China	Canada	Philipinnes	Greece	Turkey	South Korea	Palestine	Total
2003	1								1
2004	1								1
2005	1								1
2006	4								4
2007									-
2008	3								3
2009	2								2
2010	7	2							9
2011	11								11
2012	8		1	1					10
2013	14						1		15
2014	9		1		1				11
2015	12	2				1			15
2016	12								12
2017	6		1	1				1	9
2018	6		1						7
2019	9	1							10
2020	6								6
Total	112	5	4	2	1	1	1	1	127

Only green museums that are especially significant have been mentioned in the previous paragraphs. In fact, there are 127 green museums with LEED certification worldwide at the time of writing (June, 2020) (Table 2[29]). Almost all are in the U.S., where the first LEED certified museums opened, as Table 1 shows. Museum opening in other countries began only after 2010. There are five in China, four in Canada, two in Philippines and ten in various other countries (South Korea, Palestine, Greece) and only one in Turkey, the Konya Tropical Butterfly Garden (see below). Starting in 2010, there has been a rapid increase in new green museums in all countries, mostly in U.S. The peak was reached in 2013-2015 with fifteen new green museums on each date.

[29] The table was structured by the author using the information provided in: (https://www.usgbc.org/projects?Search+Library=%22museum%22).

3.3.2. Green Museums in the BREEAM system

Some other green museums are certified by the BREEAM system. The first museum recipient is not known, because the BREEAM website does not include all the dates and the websites of the individual museums do not either. Of the total sixteen museums, eight are in United Kingdom and eight are in Netherlands (Table 3[30])

Table 3. Distribution of BREEAM certified museums and their awards.

BREEAM Green Museums	Point / Awards	Country, Dates
Ulster Folk Museum	Pass	United Kingdom
Stranmillis Museum	Pass	United Kingdom
Museum of Science and Industry	Good	United Kingdom, 2010
National Army Museum	Very Good	United Kingdom, 2017
National Horse Racing Museum	Very Good	United Kingdom, 2015
National Maritime Museum	Very Good	United Kingdom, 2011
Victoria and Albert Museum	Excellent	United Kingdom, 2013
Road and Rail Museum	Pass	United Kingdom
Eye Film Museum	Very Good	Netherlands, 2017
Amsterdam Museum	Good	Netherlands, 2017
Het Scheepvaartmuseum	Very Good	Netherlands, 2017
Van Gogh Museum	Very Good	Netherlands, 2019
Joods Historish Museum	Good	Netherlands, 2017
Nemo Science Museum	Very Good	Netherlands, 2018
Rijksmuseum	Very Good	Netherlands, 2017
Stedelijk Museum	Very Good	Netherlands, 2017

3.3.3. Green Museums in the DGNB

There are two museums included in DGNB's system: the DFB Football Museum, 2013, and the Ravensburg Art Museum, 2013 (Table 4[31]).

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[30] The table was structured by the author using the information provided in: (https://tools.breeam.com/projects/explore/buildings.jsp?sectionid=0&projectType=&rating=&certNo=&buildingName=museum&client=&developer=&certBody=&assessor=&location=&countryID=0&partid=10023&Submit=Search).

[31] The table was structured by the author using the information provided in: (https://www.dgnb-system.de/en/projects/index.php?filter_Freitextsuche=museum&filter_Land=&filter_Bundesland=&filter_Standort=&filter_Jahr=&filter_Zertifizierungsart=&filter_Nutzungsprofil=&filter_Zertifiziert_von_1=&filter_Verliehenes_Guetesiegel=&filter_Architekt=).

Table 4. Distribution of DGNB certified museums and their awards

DGNB	Points	Country, Dates
DFB Football Museum Dortmund	67% Silver	Germany, 2013
Ravensburg Art Museum	71% Gold	Germany, 2013

3.3.4 Passivhaus Museums

Four museums[32] around the world have used the standards of Passive House: Ravensburg Art Museum, 2012; Niedersulz Museum, 2012; Gaobeidian Technology Museum 2017; and Fivewin Science and Technology Museum, 2019. The fact that Passivhaus standards cover only energy performance makes this rating system less preferable.

3.3.5. Green Museums in Turkey

Although green buildings have existed in Turkey since 2000, the concept of green museums has lagged behind. Turkey has only one completed LEED-certified museum, the Konya Tropical Butterfly Garden, which received a Silver Certificate in 2015 as a museum. A detailed examination of the Konya Tropical Butterfly Garden will be given in Chapter 4.

Apart from Konya, another attempt at a green museum has started in Istanbul, Arter Koç Contemporary Art Museum. The museum was opened in September 2019 in an originally designed building. The museum has applied for a LEED BD+C: New Construction Certificate.

The idea of green museums is getting more attention every year in Turkey. For instance, in 2012, a green museum in İznik was planned by the Ministry of Culture and Tourism. The museum, designed by UED Architectural Firm[33] comprises a green roof, gray water system, natural lighting and ventilation, and solar panel

[32] The information was obtained from: https://passivehouse-database.org/index.php?lang=en#k_museum.
[33] Personal communication with architect Demirci E. (December 28, 2019).

implementation. However, because of economic concerns, the construction of the museum was cancelled.

In 2018, the Ministry of Culture and Tourism inaugurated the museum of Troy. It was originally planned by Aksan Inşaat Construction Firm[34] as a completely green museum. Unfortunately only a green roof could be realized. These valuable efforts can be seen as first attempts in the establishment of future green museums in Turkey. The involvement of the ministry is particularly significant.

3.3.6 Consulting Organizations and Tools for Green Museums

In addition to green building rating tools, many international and local organizations are also active in informing, encouraging and giving consultations to museums about environmental sustainability.

One of the most influential ones is International Council of Museums (ICOM). ICOM is an international non-governmental organization. It sets professional and ethical standards for museums. A green museum should also comply with the ethical principles put forward by the ICOM. Preserving, interpreting and promoting the natural and cultural inheritance of humanity is the first of these principles.

ICOM has established a working group on achieving the goals of the Paris Agreement. The working group has examined the use of natural resources in museums and their potential roles in sustainability initiatives through their collections, as information resources, as communicators, as educators, as facilitators, as activists and advocates (ICOM Working group on Sustainability, n.d.).

Another influential organization is the independent Network of European Museum Organizations (NEMO) which was founded in 1992 by member states of the Council

[34] Personal communication with architect Önen E.B. (December 27, 2019).

of Europe (NEMO Who we are, n.d.). This important institution, like ICOM, aims to achieve the goals of Paris Agreement and is involved with two movements with similar goals, Climate Heritage Network[35] and Museums for Future[36].

More specifically defined groups include the Museums Association (MA) in the UK (MA About, n.d.). The MA was first established in 1889 and is the oldest non-profit museum association in the world. One of the MA's influential function is to get museums to think about economic, social and environmental sustainability. In 2008, MA held workshops about sustainability in museums throughout the UK and published a discussion paper[37].

Another active association concerned with sustainability is the American Alliance of Museums (AAM), an alliance formed by museums in 1906 in the U.S. It is a non-profit association directed by a board, which helps museums to develop their standards and practices (About AAM, n.d.). Under AAM, a Professional Interest Committee called "PIC-Green" was established in 2007. PIC-Green's aim is to develop a network of people who want to advance, consult, learn from, and highlight museum greening projects around the country (PIC Green Network, n.d.).

The California Association of Museums (CAM) is another very active organization involved with environmental sustainability in museums. CAM developed a program named Green Museum Initiative (GMI) in 2006. Its mission is to inspire California museums to develop eco-friendly facility management, green practices, and sustainable programming (Green Museums Initiative, n.d.). In 2013, CAM and AAM teamed up to expand this green museum movement in the entire U.S, exerting a great effort to make museums and communities green.

[35] See: http://climateheritage.org/
[36] See: https://museumsforfuture.org/about/
[37] To see the report: https://www.museumsassociation.org/download?id=17944.

In addition to these universal and local organizations, some museums in the U.S. have developed their own green exhibition rating tools, which will be discussed in detail in the following chapter. One of the most important ones is part of the Oregon Museum of Science and Industry (OMSI). OMSI created a *Green Exhibit Certification* guide to rate exhibitions in museums in 2008 (Willcox, 2009: 14). OMSI's Green Exhibit Checklist[38] rates an exhibit in terms of its environmental impact. In the web site, there is a sustainability decision-making tool, a green exhibit checklist, and a materials guide (Sutton, 2015: 153). The most helpful of these tools is the green exhibit checklist which is an innovative document that provides museums to measure the environmental sustainability of an exhibition. As seen in Appendix C, the checklist covers five basic categories. The guide was inspired by the LEED rating system and criteria. According to the points which are gained from specific criteria, the exhibition can be given Bronze, Silver, Gold, or Platinum award, with Platinum being the highest. The checklist is used by many institutions across the U.S. It is a very interesting fact that OMSI is not a LEED certified museum itself. OMSI's goal is to help other museums worldwide to plan their exhibits with environmental considerations in mind. OMSI is currently working to gain acceptance of the *Green Exhibit Certification* within the whole museum field (Willcox, 2009: 16).

Another significant tool to help create green exhibitions is again an online source, greenexhibits.org. The website is designed, developed, and maintained by Madison Children's Museum. This site provides a resource for designing and building exhibits that support healthy and sustainable places for children. Different than OMSI's structure, this source is especially for children's museums because of the potential of children as actors of change in the future. Rather than a rating system, this website's aim is to just provide information and inspire children's museums about environmental sustainability (Greenexhibitis.org and how to use it, n.d.).

[38] The checklist of the certification can be seen here: http://www.sustainablepractice.org/wp-content/uploads/2012/12/grnexhibcheck_v1_0.pdf.

There are also various programs for technical assistance, training and advocacy in the private sector to help museums become green. Some of them are the Rocky Mountain Institute, the Natural Step Network, and Clean-Air Cool Planet (Brophy & Wylie, 2013: 16). These institutions provide all kinds of information about subjects such as green communication, exhibits and interpretation. With the help of these programs, consultants, and online sources and tools, museums can enlarge their knowledge of sustainability.

3.4. Conclusion

Today, with growing awareness of environmental concerns, the green building movement is growing rapidly in the U.S. and many other countries around the world (Brophy & Wylie, 2006: 39) including Turkey. This movement is crucial since the effects of climate change are being felt more strongly every day. Many professionals agree that wide use of green building councils' rating tools will make a huge contribution to environmental improvement. Out of many, only the most appropriate rating systems for the purposes of this thesis were examined: LEED, BREEAM and DGNB. In the following chapters, environmental practices of museums will be assessed by utilizing the criteria of LEED rating system.

When the green building phenomenon first emerged, many museums thought that integrating green and sustainable practices did not exactly fit their mission and vision. However, today both international and local organizations have tried to inform museums about environmental sustainability and persuade them to take action. Due to their efforts and the motivation given by the green building certification systems, more and more certified museums have opened which incorporate sustainability and green concepts into their buildings. "Today, there are dozens of science museums, art museums, natural history museums, children museums, botanical gardens and conservation centers going green" (Brophy & Wylie 2006: 43). With the ongoing threat of climate change, all types of museums will have to be re-born or become green in the future. Green museums mentioned in this chapter are only those that were certified by green building rating systems. However, it is not compulsory to get an institutional certificate for a museum to be green.

Although having a certificate has many advantages, any museum can implement green practices and be sustainable without any need for an official certificate.

CHAPTER 4

GENERAL PRINCIPLES OF GREEN MUSEUMS

Museums are important institutions in terms of their contributions to culture, art, history, archaeology and science. However, to function effectively museums occupy large areas, use water and materials and thus have a high environmental impact. They consume energy more than twice as much as other conventional office buildings (Brophy & Wylie, 2006: 39). Therefore, museums have a significant role, not only in preserving the past but also in being green for the present and helping to construct a sustainable environment for the future. This chapter describes many ways that a building, in particular museums, can originally be green or become green. The principles that are given below are some of the most important ones; however, with the rapid changes in technology, they are likely to be developed further in the future. The strategies given below can be implemented for both new and existing buildings. As mentioned before, this study follows the LEED rating system; thus LEED criteria and principles are examined when discussing site selection, transportation, energy, water, material use and indoor air quality. As mentioned before LEED system is selected because it is one of the most accepted system worldwide, it has the biggest collection of certified green museums and the author was trained in LEED. However, other green building rating systems could have been used as well since their criteria are similar.

Apart from basic green building principles which are also applied to museum buildings, specific tools for green museums are also mentioned, such as green policy and planning, green team, green education and green exhibition, which are not included in the principles of LEED. The subjects are ordered according to their design stages.

4.1 Green Policies and Planning

With the increasing awareness of climate change and global warming, every activity or institution should consider a green approach. Hence, every museum needs to have a green policy and plan. Developing a policy is very critical for success because it guides all the decisions made for the institution (Brophy & Wylie, 2008:121). Policies of museums shape their behavior by providing vision and frameworks, defining process, identifying goals and evaluation methods, and determining participation of staff in management (Brophy & Wylie, 2013:245). Each green museum has its own necessities, environment, priorities and goals to consider. For this reason, there is no exact format to be copied for each museum's project (Sutton, 2015:173). Policy of a green museum on environmental sustainability should include the following components, the fundamentals of which were mentioned in Brophy and Wylie's book and then further developed by the author (Brophy and Wylie, 2013: 245):

- The mission of environmental sustainability should determine all activities of the museum.
- Goals and priorities should be clearly stated.
- Methods for evaluation of goals and activities should be identified.
- Explanation of the line of authority and the decision making mechanisms need to be clarified and staff should participate in the policy development and implementation.
- Staff of the museum should be trained before opening and all through its operation.
- Methods for supervising of the staff should be determined.
- Amount of money allocated to different expenditure items of the museum should be specified.

This basic policy structure serves as a starting point for museums that are in the beginning stages of practicing green practices (Reclite, 2016: 21).

The plan provides information on how the actions, which are structured by the policy, will be carried out. Green planning is focused on how to achieve museums' sustainable goals. It answers how, when, where and with what the policy decisions

will be carried out. For this, objectives and procedures are clarified, an action plan is formed, rules are set, the program is scheduled, methods are identified, the budget is detailed and management is planned. After establishing the policies and designing the plan, implementation should be carried out according to the principles mentioned below.

4.2 Basic Green Building Principles

For a museum to be certified as "Green", the main practices to be implemented in the process of construction, operation and maintenance of the building are listed below. The information about these principles has been gathered from LEED documents, sustainable architecture sources, the author's observations, LEED training and meetings with specialists. These principles are valid both for new museum buildings or renovated ones.

4.2.1 Landscaping and Maintenance

This topic is divided according to location of the building, transportation choices and sustainability of the building site. All these components are closely bound with and affected by each other.

4.2.1.1 Location

The location of the building is an extremely important aspect of a green design especially if it is a new construction, because where a project is situated and how it is developed can have multiple effects on the ecosystem. The site location can influence a building's energy performance by its positioning. Site of the building affects decisions about heating and cooling choices and also humidity issues (Sutton, 2015: 16).

Location and orientation influence the relationship of the building with the sun as recognized by the Greek and Romans. Façades facing north will consistently be cooler, while façades facing south will be warmer. Similarly, façades facing east will have early morning sun and west will have sun later in the day. The wind corridors,

the relationship with the topography and vegetation can create a microclimate and change energy needs and response. The orientation of the building as to natural light has an impact on energy conservation. All of these need to be carefully analyzed before the design starts so that the structure can maximize the amount of energy it can use from natural sources and minimize artificial heating and cooling.

As with many other decisions while working on a green building project, the triple bottom line[39] values need to be applied to achieve a successful site selection. A museum should not bring any harm to its locality but should improve it. From an *environmental* perspective, the selection of the site should avoid destruction of wildlife habitats. From an *economic* point of view, the museum can contribute to the economic development of the area. From a *social* viewpoint, an attractive environment can be enjoyed and witnessed by future generations. According to LEED principles, rather than destroying the existing natural habitat, renovating an existing building is a more suitable strategy for site selection (Cottrell, 2014: 69). However, in some cases, while renovation is beneficial for preserving natural land, it might also cause some harm because it might need more resources than usual to mold an existing building to something it was not originally built to be.

4.2.1.2. Transportation Choices

Building location is also closely related with transportation, which is another important component of sustainability, because vehicle emissions have a dramatic impact on climate change, smog and acid rain. The building needs to be located on an accessible site to visitors and staff (Brophy & Wylie, 2008: 162). Easy access to the museum also means more visitors and publicity.

In the case of a newly constructed museum, choosing a site which is accessible by public transportation is one strategy to reduce negative transportation impacts. As expected, the main goals of easy access are to reduce the need for transportation and encourage more sustainable modes of transportation, such as bicycles. Today, many

[39] See page 11.

green museums encourage their visitors to come to their buildings by walking or bicycle. A renovated building in a remote location could provide a shuttle.

The triple bottom line should be considered here as well. The *environmental* benefits of green transportation include reduction of pollution (Cottrell, 2014: 71). The *economic* benefits include the reduction of the need to build and maintain roads (Cottrell, 2014:71). From a *social* perspective, reducing transportation needs results in more visitors and improvement of their health.

4.2.1.3 Sustainability of the Site

After the selection of the site and construction, the museum should continue to consider its environmental approach. The strategies to achieve a sustainable museum site need to be further elaborated.

In order to provide a sustainable site, native or adaptive plants[40](Cottrell, 2014: 82) need to be used for landscaping. These plants necessitate less water and maintanence; they also avoid rain water run off[41]. Protecting species and habitat by working with local ecologists and nonprofit organizations creates awareness of the environment both for the museum and visitors. Another strategy is the prevention of light pollution. For this, a suitable angle should be given to outdoor lights at night and their level should be kept to a minimum (Cottrell, 2014: 87).

Another critical issue concerning the sustainability of the site is the heat island effect[42] (Cottrell, 2014: 90). Strategies to reduce the heat island effect include the using reflective roof materials, reducing the area of paved surfaces exposed to sunlight, and extending green areas. The placement of a green roof or a green wall,

[40] Native plants refer to native vegetation that occurs naturally in an area. Adaptive plants are not natural but can adapt to their environment.
[41] The water from a rain event that does not immediately absorb into the ground but runs off in quantity.
[42] The buildup of heat, in urban or built areas, as the sun's heat is absorbed in dark roofs and pavement (Brophy & Wylie, 2008: 180).

which will be explained in a separate section, will also help to reduce the heat island effect.

4.2.2 Water Management and Efficiency

Water use of buildings is another vital factor which affect the sustainability of a museum. Water is a precious and fundamental resource (Carson, 1962: 50), which is getting more and more polluted in recent times while decreasing rapidly in quantity. Efficiency is the first aim when designing water a conservation strategy, including specification of efficient fixtures, equipment, and appliances that require less water. There are six water types that are used in buildings:

- **Potable water:** Drinkable water from the faucets, supplied by the municipality.
- **Reclaimed water:** Undrinkable water supplied by the recycling systems or municipality.
- **Gray water:** Waste water from sinks, not contaminated but non potable, often reused to flush toilets (Brophy & Wylie, 2013: 280).
- **Black water:** Used water from dish washer, kitchen sink, toilets and power plant cooling towers, which cannot be reused.
- **Rain water:** Collected and stored water coming from rain.
- **Irrigation water:** Water used for watering plants. Rain water, gray water and reclaimed water could be used for this purpose.

In these days of climate change, where water shortages and drought are imminent threats, water conservation is critical. Water use should be reduced and water should be re-used both inside and outside of the building.

Indoor water consumption includes drinking, toilets, sinks, cooling, and cleaning. A strategy for the conservation of water for these purposes is recycling and reusing water. For example, non-potable water captured from rainwater, gray water, and municipal reclaimed water can be used for irrigation of landscape and flushing toilets (Cottrell, 2014: 101). Installing efficient plumbing fixtures is another strategy to

reduce indoor water consumption (Cottrell, 2014: 101). Lastly, installing sub-meters to track consumption is a beneficial method for indoor water use.

Outdoor water usage is primarily related with irrigation of the landscape. The strategies for reducing outside water use are again planting of native and adaptive plants, high efficiency irrigation systems, and the use of reclaimed, gray water or rain water.

In fact, water efficiency has two advantages, leading to both water and energy conservation. By reducing water use, energy to treat, heat, cool or distribute water is also saved, reducing costs. (Cottrell, 2014: 97).

4.2.3 Energy Production and Efficiency

In buildings, energy is used to create comfortable, safe, healthy and productive environments. Energy consumption in buildings includes space heating; generating hot water; humidity, lighting, ventilation, air conditioning; and electrical equipment; and electrical services such as escalators. Unlike conventional buildings for habitation or offices, museums have very high energy use because of heating and cooling, lighting of exhibitions and ventilation of large areas. Some of these systems have to be operated for 24 hours to conserve the collections. Therefore, energy consumption is very critical for museums. The first thing to do is carry out an energy audit[43] in order to design baseline data for energy consumption. The audit should, take into consideration "the current uses, effectiveness of the current systems, the quality and the extent of insulation, and the locations of air infiltration" (Sutton, 2015: 42). Apart from its use, the source of energy is also very significant. The next section will present possible energy choices.

[43] Energy audit is a review of energy used by the institutions themselves. It includes rates, amounts, types, fixtures, and demand levels to create benchmarks and locate areas for energy conservation or system changes (Brophy & Wylie, 2013: 279).

4.2.3.1. Energy Choices

The source of the energy needs to be renewable and not harmful to the environment in order to be green (Sutton, 2015: 47). Renewable energy, also referred to as 'green energy', is the energy generated from a natural source that is not depleted when used, in contrast to petroleum, coal and natural gas. According to the LEED system, the main renewable energy sources include solar, wind, biomass, geothermal power and hydro power, which are briefly described below. These sources can be easily designed for new construction but can also be adapted for existing buildings.

• **Solar Energy:** This abundant and powerful source of energy from the sun is a sustainable form of renewable energy, which can be used to generate heat and electricity. There are two types of solar heating, active and passive (Curley, 2012: 3). In active heating, provision of hot water or space heating in buildings are achieved by mechanical means to store, collect and distribute the solar energy. Unlike active solar heating systems, passive heating is simple and does not involve substantial use of mechanical and electrical devices (Curley, 2012: 2). It relies on architectural design to maximize the heating and lighting effect of the sun by means of the building's site, orientation, structure, and materials.

To generate electricity, solar energy is collected by photovoltaic cells. They absorb light and convert it directly to electricity. A group of photovoltaic cells is known as a solar panel, which can be placed on the roof, windows, walls or garden of the building.

•**Wind Energy:** The kinetic energy of the wind can be converted into mechanical or electrical energy through the use of turbines (Curley, 2012: 17). Wind turns the blades of a turbine that generates electricity. A number of wind turbines are grouped together to form a wind farm on or off shore, providing a larger source of energy (Curley, 2012: 17).

• **Bio-Energy:** Bio-energy is an energy produced from biofuel, which is any fuel derived from plant material or animal waste called biomass. Since such biological material can be replenished easily, biofuel is considered to be a source of renewable energy, unlike fossil fuels (Curley, 2012: 67).

• **Geothermal Energy:** Geothermal energy is the power obtained by using hot ground water, heated by the core of the Earth. This hot water steam is brought to the surface by deep wells and is used directly to heat buildings or to turn turbines which generate electricity. Another use of geothermal heat is through heat pumps which can be used for heating and cooling buildings (Curley, 2012: 52).

• **Hydroelectric Energy:** Hydroelectric power is the electricity produced from generators driven by water turbines. Water turbines are used to turn electric generators at hydroelectric dams through the action of falling water (Curley, 2012: 29).

Another type of hydro power is wave energy, which is the generation of electricity through the harnessing of the up and down motion of ocean waves or tides (Curley, 2012: 34).

Ecological, climatic and geographic conditions determine the type of renewable energy to be used in buildings. For instance, buildings or museums near an ocean can use tidal and wave energy; a windy area is suitable for wind power. Regions without much sun light or without wind must choose other energy sources. Even if these energy types are very useful in buildings, they all have some disadvantages that should always be considered. For example, solar panels occupy big spaces of land, sometimes agricultural lands. Fish species are greatly affected by hydro power because dams prevent them from reaching their breeding ground. Submergence of land and existing settlements for dam construction leads to economic and ecological loss. In addition, the lifetime of dams is limited because they fill up with soil within

an average of 50 years (Wieland, 2010: 35). As for wind energy, wind turbines produce a level of noise from the whirring of the blades that affect animals. They also disturb migrating birds.

In summary, “there are pros and cons, the building must weigh them against mission and institutional goals” (Sutton, 2015: 51). However, despite these disadvantages of various sources of green energy, their advantages dominate when considering their low impact on the environment, especially because green energy is non-pollutant and renewable (Sutton, 2015: 51).

4.2.3.2 Energy Efficiency

Energy used for heating, cooling, lighting and ventilation should also be conserved and used efficiently. This can be accomplished by several techniques and strategies.

Passive designs, as used in solar energy, should be preferred to active processes. Appropriately positioned buildings and windows, glass roofs and open courtyards are used for passive heating, natural ventilation and day lighting.

To reduce electricity use, green museums can install smart lighting systems in synchronized with available day lighting. In that case, electric lights are not needed during daylight hours, and also this natural lighting provides some benefit to the health of personnel and visitors. Motion sensors can be used to reduce lighting time, too (Brophy & Wylie, 2008: 94). Certain kinds of lamps and fixtures can also reduce energy use; replacing incandescent light bulbs with efficient ones such as LED will consequently conserve energy. In fact, even most non green museums are presently using LED, thus practicing perhaps unintentionally an important green principle. Not only lighting of the building but also of the exhibitions must be energy efficient, to be detailed later.

Effective insulation is another way to conserve energy. Good insulation of the roof and walls keeps the inside temperature warm in winter or cool in summer. Green roofs and walls can also be used for this purpose.

Harnessing the natural potentials of a site by orientating properly for natural light, wind, topography and vegetation can reduce energy conservation considerably. A line of trees, for instance, can be a powerful isolator.

In addition to these fundamental measures, the use of energy efficient electrical equipment and devices[44], whether they be computers, office machines, air conditioners, or kitchen equipment, must be considered.

4.2.4 Green Materials and Product Sourcing

As buildings are a huge consumer of resources, there are a number of strategies to minimize the environmental impact of building materials and their sources. Similar to the energy, an audit for materials and waste needs to be completed before implementing the strategies. This part is divided in to two sections: selection and conservation of materials and waste management.

4.2.4.1 Selection and Conservation of Construction and Operation Materials

Specifications are necessary for the selection of materials in museum buildings. Materials for construction and operation are not only expected to support the local economy, but they must be sustainably grown and harvested. They should be free of toxins, long lasting, reusable and made in factories that support human health and workers' rights (Cottrell, 2014: 136). Today, there are special companies that provide eco-friendly and green materials for buildings. Many of them use recycled products such as insulation material that is made from old newspapers or used denim. There are also many institutions that award green certificates to outdoor and indoor

[44] Energy Star is an international standard for consumer products that are energy efficient.

materials. One of these commonly used in Turkey is Environmental Product Declaration (EDP) which is based on ISO 14025 and is the only materials registration system in Turkey (https://epdturkey.org/).

- **Material Selection:** The LEED system points out that materials which reproduce themselves within ten years at the most should be preferred by buildings also museums (Cottrell, 2014: 137). Bamboo, cotton and other organic materials which regrow are examples of such materials. However, choices vary, depending on the location and region of the building, because different geographies have different circumstances and natural resources. Non-toxic, non-cancerogenic and non-allergic materials for paints and furniture should be selected. Materials containing heavy metals, formaldehyde, aliphatic hydrocarbons and PVC should be avoided. In addition, materials should be durable.

- **Production of Materials:** The extraction method and source of the raw material are also very important for LEED, which expects the providing companies to be sensitive and respectful to nature. For example, quarry companies should use environmentally friendly methods during extraction. Thus for LEED, not only materials but also the extraction technique and source of materials need to be eco-friendly.

- **Conservation of Materials:** The aim of materials conservation is "to eliminate the need for new materials as much as possible, by focusing on reuse, the highest form of conservation" (Cottrell, 2014: 132). According to LEED principles, strategies include the renovation of existing buildings, the design of smaller buildings and reuse of salvaged materials.

4.2.4.2 Waste Management

Another vital issue connected with buildings' materials is waste management, which needs to be implemented both during the construction of the building and later during operation.

- **Construction:** During the construction of museums, environmental impacts from debris and waste must be minimized. In the process of construction, museums must develop a construction waste management policy, and establish a tracking system (Cottrell, 2014: 143). Waste should be separated on-site into individually labeled waste containers. In demolition, construction or renovation of a building, waste such as concrete, wood, metal, bricks, glass, plastics and building components like sinks, windows and doors is generated. This waste can be sold, recycled or salvaged and reused. For example, wood from old buildings can be used to create new furniture and buildings.

- **Operation:** Educating staff is one of the main methods to reduce waste throughout the museum's operation. Waste can be reduced, recycled, composted or reused.

  - Reducing waste is the most efficient way to help the environment. An example is reducing paper consumption (Brophy & Wylie, 2008: 74).
  - One of the easiest ways for people to reduce their excessive use of natural resources is recycling. Certain types of paper, metal, plastic, and glass are easily and frequently recycled. "Managers can educate staff so they can recycle appropriately by sorting materials carefully and correctly, and provide consistent encouragement and support to keep recycling an important part of regular duties" (Brophy & Wylie, 2008: 77).

  - Composting is a process in which waste and organic material is transformed into fertilizer through the application of suitable soil and climate conditions. Composting combines both reducing and recycling. It reduces landfill waste by recycling organic material. For instance, organic waste can be composted and used as a fertilizer in the garden (Brophy & Wylie, 2008: 69).

  - Reused materials are different from recycled materials in a way that they have not been re-processed and made into a new product, but they can be

used in their original form for another purpose. Reusable materials include discarded materials that can be salvaged and used in a new way.

4.2.5 Indoor Environmental Quality

According to the LEED system, "occupants of green buildings are typically exposed to far lower levels of indoor pollutants and have significantly greater satisfaction with air quality and lighting than occupants of conventional buildings" (Cottrell, 2014: 151). The indoor environmental quality affects the health of visitors and staff through the quality of its air, temperature and lighting (Brophy &Wylie, 2008: 88).

4.2.5.1 Air Quality

As stated by Cottrell, studies have showed that poor indoor air quality can cause some health problems such as allergies, asthma and sick building syndrome, and can therefore impact the performance and productivity of staff (2014: 153). Circulation of air needs to be provided and the quality of air should be monitored at all times. Methods for complete elimination of cigarettes within and nearby the building should be put in use. The following strategies could be considered as well: outside air intake should be prevented, the ventilation system should be adequate, and the building should be kept clean (Cottrell, 2014: 153- 154).

4.2.5.2 Lighting

Quality of lighting depends on several factors. For example, lighting must be homogenous and apart from focusing on specific exhibition objects, should not be done with direct spot lights. Natural lighting should be used as much as possible, at the same time considering its harmful effects on some specific exhibited objects. Especially for some museums clerestory roof is a good way to achieve natural lighting. It provides both visitor satisfaction because of aesthetics and comfort, as well as economical gain because of reducing artificial lighting consumption. The current trend of dark spaces with focused artificial light should be minimized. Museum management

should conduct occupant surveys from time to time to measure visitor and personnel satisfaction.

Every building and museum should give importance to principles of indoor environmental quality. In museums, visitors will be more energetic, and they may choose to stay longer and even come back if the indoor environmental quality is favorable. In fact, in addition to its environmental benefits for the world, being green is a powerful marketing strategy.

4.2.6 Green Roofs and Walls

Green roofs and walls are separately discussed here because they combine many green principles, such as reduction of the heat island effect, building insulation, rain water management, purification of gray water and carbon dioxide reduction. They also aestheticize the building.

A green roof consists of a waterproof membrane covered over partially or completely with plants. It may also include additional layers such as a barrier to prevent over growth of roots and layers for drainage and irrigation systems (Brophy & Wylie, 2013: 152). Green roofs offer ecological, economic and aesthetic advantages to the buildings.

From an *ecological* standpoint, a major benefit of a green roof is that it creates a natural habitat in a city and also provides a new home to many insect, butterfly and bird species. Another benefit is that a green roof slows and avoids rain water runoff by providing a pervious, vegetated surface (Weiler & Scholz-Bart, 2009: 11). A green roof can also help to clean the air in the city. The plants filter dust particles from the air, absorb carbon dioxide and produce oxygen (Owen, 2009: 30). Green roofs can improve energy efficiency inside the building depending upon the climate but their biggest value is rain water management. The *economic* advantage is the reduction in energy use by insulating the building. From an *aesthetic* standpoint, “a primary application of a green roof is to provide a visually motivating vegetation

layer of diverse texture and seasonal color, in contrast to an ordinary surface of a classical roof" (Weiler & Scholz-Bart, 2009: 10).

Another important component worth mentioning is the green wall. A green wall is a planted vertical surface. It can be situated indoor or outside, and it can be attached to the air system or the water system or neither (Brophy & Wylie, 2008: 110). If the wall is connected to a building's air system, the air passes through the plant-attachment material and the plant roots clean the air (Brophy & Wylie, 2008: 110). If the wall is attached to a water system using gray water from sinks, the water travels though the plant-attachment material; the roots of the plants filter the water, converting it to recycled water to be used in irrigation or flush toilets (Brophy & Wylie, 2013: 154). Another benefit of green walls in interior places is that they provide acoustic protection and reduce noise through sound absorption. The aesthetic feel and visual appearance of green walls are other benefits. Like a green roof, a green wall brings plants and nature into cities and buildings.

The main differences between green museums and green buildings are their educating role and the existence of exhibitions inside green museums. For this reason, the following discussion is especially related to museums.

4.3 The Green Team

The most productive way of implementing sustainability in a building or museum is through the formation of a green team. A successful green team is composed of motivated employees who volunteer to learn, research, promote, and actively involve the rest of their organization in green practices (Brophy & Wylie, 2008: 62). The green team should master the subject of green policies and plans of their museum. They are responsible for fulfilling the requirements for sustainability, informing visitors, and developing and communicating green practices among the staff (Byers, 2008: 51). While the motivating role of green team is of utmost importance, implementing the green plan is not the job of the green team only, but rather the responsibility of every staff member and department of the museum. Therefore, for

success, it is essential to educate museum staff, making them feel included in the process and enabling them to further the progression of sustainability in museums. According to Madan, a museum can only make a real difference if the people within its walls decide to be green (2011: 49).

4.4 Green Education

The lack of accurate information about the future risks of climate change causes confusion in the minds of people on how to respond to this crisis (Hulme, 2015: 14). This is where museums can play a distinctive role. Museums are the "places of the muses" (Worts, 2011: 119). They are not only buildings with collections with different fields, but they also have a mission to, inspire, research and educate the public. Thus, a green museum is a building with green practices, but it has a considerable impact on the attitude of environmental sustainability of the society as well. Museums have unique communicative and influential social qualities, and they promote learning outside the classroom (Cameron et. al, 2013: 9; Cole et. al, 2020: 2).

According to Sarah Sutton *et al.*, museums are perceived to be one of the most trustworthy sources of information and education by society (2017: 153). For this reason, especially in time of climate crisis, a green museum has power to influence its visitors about environmental issues. The impact will mostly be created by educational programs. A green museum is well placed to inform about climate change and green practices, and it can do it by using the museum building itself.

Not only the young generation but also adults, local citizens and tourists are the targets of museum education, since a museum is a gathering place where people can meet, discuss and be inspired by others through its activities (Byers, 2008: 41). In fact, as said by Sutton *et al.*, inspiration is not enough; green museums are also drivers of change and make communities better places to live in (2017: 153). Especially children should be prioritized in developing a green consciousness in order to preserve nature and the environment. Children can be inspired about environmental sustainability

through instructive stories. It is a significant function of green museums to equip future generations with skills to shape the world that they will inherit.

Green museums can attract attention of their visitors by presenting current results of climate change and sharing climate change actions in a way to connect them to the daily lives of people (Sutton et al., 2017: 157). Here, children and their families can learn how to conserve energy, water and resources in their daily lives. They can also have a chance for a real understanding of how much they can do to conserve resources. Although it is difficult for people to change their behavior, they can be motivated by museums' green activities and exhibitions which may achieve at least a small change. A green educational program, planned by a green team, should be integrated into every action of the museum. However, many green museums only focus on energy and water efficiency and waste management but miss out on educating the public. Moreover, green museums can expand their activities to carry out research, build knowledge and develop skills of environmental sustainability.

In reality, today not only green museums, but all museums have a responsibility towards a sustainable world. When the positive influence of museums on behavior of visitors is considered, raising consciousness about climate change seems to be a duty of all museums.

4.5 Green Exhibitions

Green exhibitions also known as "eco- exhibiting" are another method to create green awareness (Fenn, 2012: 4). The exhibition is a very fundamental feature of all museums since it is the reason people visit museums. Different from the past, today visitors are not passive spectators anymore, but rather active participants (Byers, 2008: 53). Exhibitions use multimedia and technology to give an active role to visitors and to involve them. They aim to address feelings and values as well as introduce information and facts by using photographs, illustrations and graphics. Color, the use of space, and the design of texts and labels are some features that can transfer emotions to visitors. Thus, exhibitions have a great part in making an impact on the thoughts of

visitors and creating experience for visitors (Sutter, 2008:188; Byers, 2008: 54). Therefore a green museum needs to concentrate on green exhibitions in order to influence visitors but also to conserve energy and materials that museum exhibitions consume in great quantity.

According to Byers, there are two types of green exhibits, "green theme exhibits" and "green design exhibits" (2008: 56). Green theme exhibits consist of a topic related to sustainability and environmental conservation. These exhibits focus on subjects related to nature, conservation and the ways humans use nature (Byers, 2008: 56).

Green design exhibits incorporate green design into their construction, use and disposal. This type can be used in any exhibition; they are not limited to environmental issues (Byers, 2008: 59). All basic features of exhibitions, such as materials or resources, need to be conserved and environmentally friendly. Apart from various green material selection principles such as using nontoxic, reusable, recyclable materials and durable materials, some additional principles specific to exhibitions are multiple purpose design, energy efficiency and reduced amount of materials (Byers, 2008: 60).

Another important feature of the green design exhibit is the conservation of resources, energy and water (Byers, 2008: 66). There is noteworthy relationship between the exhibitions and energy conservation (Brophy & Wylie, 2013: 130). For example, efficient use of exhibit lights can help to reduce the amount of a museum's electricity. LED's and light sensors are other ways to conserve energy consumption. "Then, museums can use occupancy sensors that detect motion to trigger exhibit lights only when a person enters the room" (Byers, 2008: 66). By this method, both the museum collection is protected from the effects of the sun and the use of resources is reduced.

As already mentioned in the Chapter 3, one of the best resources to support museums for their exhibitions is the ExhibitSEED website[45], a project of the Oregon Museum of Science and Industry (OMSI). Another one is an online source of Madison Children's Museum, green exhibits website[46]. Both resources provide valuable information about green exhibitions.

To sum up, there are many different ways for green museums to make a green exhibition. In fact, green museums themselves are green exhibitions. Apart from the actual exhibitions, the museum building, its operation and its environmentally friendly choices set a good example for visitors. Technological developments and innovations make virtual museums more possible and appealing. It would take years to build a green museum while creating virtual green museum presenting green principles with animations, green exhibitions and informative videos would be both affordable and practical. It would be the first stage of introducing a tangible green museum in a region.

4.6 Selected Examples for Application of Green Principles in Museums

In order to understand the implementation of the general principles of green museums, two different examples have been selected. The first one is the California Academy of Science (CAS) which is considered to be the greenest museum in the world[47], having received two Platinum LEED Certificate. The second one is the Konya Tropical Butterfly Garden which is the only green museum example in Turkey. These specific museums have been selected because of their illustrative nature, CAS for the world and Konya Tropical Butterfly Garden for Turkey. CAS have set standards on environmental sustainability worldwide, and a new green museum in Turkey should aim to surpass Konya Tropical Butterfly Garden. Konya Tropical Butterfly Garden needs attention in that it is a solid example of successfully operating green museum in Turkey.

[45] To see the website: http://www.exhibitseed.org/.
[46] To see the website: https://www.greenexhibits.org/.
[47] The information is gathered from: https://www.calacademy.org/press/releases/new-california-academy-of-sciences-receives-highest-possible-rating-from-us-green.

4.6.1 California Academy of Sciences

CAS, an outstanding scientific and educational institution, was founded in San Francisco in 1853. CAS conducts a great deal of research and operates a museum that educates visitors about the natural world (CAS Our History, n.d.). For CAS, its museum building plays a vital role at a time of increasing attention on climate change and conservation.

Its new museum was built on the site of the old one. Opened in 2008, it became a masterpiece of green architecture (Figure 8). The museum is situated in the Golden Gate Park in San Francisco. The architect of the museum building is Renzo Piano, who is very famous for buildings which are environmentally sustainable (An Architect's Vision, n.d.).

The California Academy of Sciences museum building has earned a unique LEED rating with a double LEED Platinum Certificate. CAS, first earned a LEED Platinum certification in the New Construction category (BD+C)[48] in 2008. After that, in 2011, CAS received a second Platinum certification in the Existing Building category (O+M). The second one was awarded for keeping day to day green operations and practices. The museum's exhibitions are both "green theme exhibits" and "green design exhibits".

The museum complex includes sections from different disciplines of science: an aquarium, a rainforest, a natural history museum, a planetarium, and a research center with certain animal species and changing exhibits and events (Brophy & Wylie, 2013: 91) (Figure 9).

According to CAS Executive Director Dr. Gregory Farrington, their goal "was to create a new facility that would not only hold powerful exhibits but serve as one itself, inspiring visitors to conserve natural resources and help sustain the diversity of life on

[48] See page 24.

Earth " (A study in innovation, 2010: 4). This museum is an exceptional example because of its perspective on sustainability and its innovative green applications. Some of the distinctive green features of CAS are mentioned below.

- **Green Roof**

CAS considers the roof as the core of the museum. According to the architect, Renzo Piano, the goal was to "lift up a piece of the park and put a building under" (Purpose Built, n.d: 8). As can be seen from Figure 1, the roof features a field and seven rolling hills to mimic San Francisco's landscape. CAS's living roof is planted with native Californian plants[49] (Figure 10), creating a habitat for wildlife. Many regional insect, butterfly and bird species live there. Besides its ecological benefit, this enormous green roof provides a thermal insulating layer for the building, reducing energy need for air-conditioning and saving costs. The green roof captures 100% of rain water which drains into an underground chamber and percolates back into the water table (Efficient Daily Operations, n.d.). The roof is bordered by a glass canopy containing nearly 60,000 photovoltaic cells, which produce up to 10% of the museum's annual energy needs (Efficient Daily Operations, n.d.). "By using solar power, the release of 405,000 pounds of greenhouse gas emission into the air is avoided" (Project: California Academy of Sciences, n.d.). In addition to all these benefits, the roof includes an observation deck, allowing visitors to observe the roof and learn about the benefits of it. The roof is used for weekly public programs and research studies by high school and university students (Figure 11). This activity shows that CAS uses its museum building as a three-dimensional model of architecture as well as an exhibition and educational tool (Cole et. al, 2020: 11).

The green features mentioned below were mainly taken from Brophy & Wylie's book (2013: 93) and CAS's official website (Efficient Daily Operations, n.d.):

- **Ventilation and Lighting:**

[49] The planted area measures 2.5 acres and approximately 1.7 million plants blanket the green roof. (https://www.calacademy.org/press/releases/new-california-academy-of-sciences-receives-highest-possible-rating-from-us-green).

- Skylights, providing natural light to the rainforest, situated in the right of the entrance are designed to open and close automatically to ventilate the building in response to the measurements of the meteorological station situated on the roof (Figure 11).
- The undulating roofline draws cool air inside, into the central square, which is covered with glass that can be opened as required, naturally ventilating the building (Figure 10) (Purpose Built, n.d.: 6).
- In order to allow clean air into the building, motorized windows automatically open and shut. Operable windows are also employed in the top floor staff offices (https://www.calacademy.org/press/releases/new-california-academy-of-sciences-receives-highest-possible-rating-from-us-green).
- 90% of the office spaces have natural light and ventilation, preventing heat caused by lighting and reducing energy use.

- **Materials:**
  - 90% of all demolished materials such as glass, wood and concrete, from the old buildings on the site were recycled and reused for this project.
  - 95% of all steel came from companies supplying recycled steel and was used for the building structure.
  - At least 50% of the wood in the museum building was sustainably harvested and certified by the Forest Stewardship Council (FSC[50]).
  - The insulation in the building's wall is made from recycled blue jeans.

- **Transportation:**
  - The CAS provides bicycle parking at the front and back entrances, as well as an electric car recharging station, which is open to visitors.

- **Water Conservation:**
  - Low-flow fixtures have reduced overall potable water use by %40.

[50] FSC is a global, non-profit organization dedicated to the promotion of responsible forest management worldwide (https://www.fsc-uk.org/en-uk/about-fsc/who-is-fsc).

These are just the major and more exceptional green features of the museum; however, there are many more. Apart from these technical features, CAS also welcomes visitors with environmentally friendly practices such as (Brophy & Wylie, 2013: 93):

- The museum has a café with local and organic food.
- Visitors are saving 3 dollars off their ticket when they arrive by foot, bicycle or public transportation.

These sustainable practices make this museum a perfect example of a green museum. Here, visitors are also treated to a unique journey into the past, present, and future of the world through different sections of the museum. One of the key features of CAS is that it continues to examine its impact on environment and comes with innovative ways of incorporating green practices (Styx, 2019). The strategies and technologies of CAS can become a replicable model for other green museums.

4.6.2 Konya Tropical Butterfly Garden

The Konya Tropical Butterfly Garden (Konya Tropikal Kelebek Bahçesi) is the first butterfly park in Turkey and the biggest one in Europe (Burkut, 2018: 213). The Konya Tropical Butterfly Garden is actually a museum which includes live butterflies, plants and insects, similar to zoos and botanical gardens. As seen in Figure 12, it is situated in a park. The museum is a large, glass covered building, which is designed in the shape of a butterfly (Figure 12). The terms *garden* and *museum* are utilized interchangeably throughout this section.

The main reason this museum is chosen to illustrate the principles of green museums is because it is the only green museum example in Turkey. The establishment was certified as a "Butterfly Garden and Insect Museum" by LEED in 2015 by a Silver award. The Konya Tropical Butterfly Garden demonstrates how a green museum can function in Turkey. That is the reason this museum is investigated in more detail when compared to CAS.

The information about the Konya Tropical Butterfly Garden was obtained from interviews with museum officials, related articles and observations of the author

during two visits at the museum. This section includes general information and a description of the sections of the building, as well as a detailed examination of the museum according to LEED standards.

4.6.2.1 General Information

The Konya Tropical Butterfly Garden is situated at the periphery of the city, about 9 km from the center. The construction started in 2013 and was completed in 2015 by the Selçuklu Municipality of Konya. The Selçuklu Municipality worked with a London-based multinational architecture and engineering company named ARUP; it provided architectural design and engineering services for the construction of the museum. In the process of LEED certification, the Turkish Firm ECOBUILD has provided consultancy services. The museum building received a LEED Silver award in 2015 (Figure 13). Some numeric data about the museum:

- Original construction expenses reached TL 21,000,000. TL 4,500,000 are spent on the museum every year.
- Last year, 450,000 visitors were hosted in the museum and 65,000 of them were from foreign countries.
- The museum has 33 personnel from different disciplines such as botany, different specialties of biology and engineering. The security of the museum is provided by employees of the Municipality of Konya.

4.6.2.2 Vision of the Museum

The museum has aimed to create a building complex that is environmentally friendly, contributing to the fight against climate change. According to coordinator of the museum, Selvi Y. (Personal communication, June 24, 2019), KTGB inspires visitors about nature and its conservation. Visitors have many visual and tangible experiences in the museum, enabling them to remember it in the future. Children who visit the Konya Tropical Butterfly Garden will certainly remember the plants and butterflies they will see here but will not encounter in their daily lives. Leaving a

legacy of respect for the plants and animals around us is one of the main goals of the museum.

4.6.2.3 Sections of the Konya Tropical Butterfly Garden

The Konya Tropical Butterfly Garden building covers 3,500 m^2. The building has 3 different sections, all under one roof with the shape of a butterfly (Figure 14). These sections are listed as follows:

- As shown in Figure 14, Number 1 represents the section of the butterfly garden. The tropical butterfly garden section covers an area of 2,100 m^2. In this area, butterflies are observed in their natural habitat with artificial rocks and ponds. The garden is landscaped with different plant species and there is a pedestrian path going all around the garden (Figure 15). Throughout the garden along the path, there are many showcases positioned where visitors can observe the cocoon formations of butterflies.

- Number 2 from Figure 14 is the insect museum which has an area of 550 m^2. The first part of this section is devoted to butterfly species (Figure 17) and their characteristics. The second part consists of show cases which include lifeless samples of different insects and give visual information about their life-cycles, eggs and their products such as honey and silk. Each class of insects is presented in a different window case shaped in the form of insects' eggs (Figure 16).

- Number 3 in Figure 14 corresponds to other sections which cover an area of 800 m^2 and include a movie theater, which shows films about the life cycle of butterflies and insects. There are also classrooms used for education. A gift shop, which includes a cafeteria, has an area of 164 m^2.

4.6.2.4 Butterflies and Plants of the Garden

The museum gives the chance to visitors to observe butterfly and plants in their natural habitat (Figure 18). The museum team has created a very successful environment that includes 15 butterfly species and 98 plant species. There are 200,000 plants in the garden. The butterflies have been brought from tropical zone countries such as Philippines, Kenya and Costa Rica.

Surprisingly, not the butterflies but the plants are the most essential component of the garden (Figure 19) because they have an incredible bond with butterflies. This bond is formed by three types of plants. First, the plants which produce the nectar that the butterflies eat constitute the majority (70%). The second type consist of the host plants where the butterflies lay their eggs (20%). Thirdly, there are ornamental plants which provide an aesthetic atmosphere to the garden (10%). Each plant is selected, according to the kind of butterfly which will be exhibited in the museum. The plant which will provide nectar or a host for the butterfly is brought from the same country and is grown before the butterfly pupas are purchased. The plants are given great care because their growth takes a lot of time and effort.

Every factor for the good of the butterflies and plants has been considered. The climate conditions for the butterflies and plants have been researched in detail and recreated successfully. The goal is to enable plants and butterflies to live in their sustainable natural environment.

4.6.2.5. Examination of the Tropical Butterfly Garden in Terms of LEED Standards

The following part answers the question of what makes this museum green according to the criteria of LEED. For each criterion, the main requirements are mentioned and explained. This section also includes a table published by the official LEED website to illustrate the points gained by the museum for each criterion in order to receive a Silver Award (Appendix D).

- **Sustainable Site:** Since the site where the building is built is not fertile agricultural land, it created a more environmental friendly area by greening an unproductive one. All construction pollution such as land clearing, demolition and dust pollution had to be prevented during the building process of the museum.

  The garden is situated within the public transportation network, such as a bus and minibus line, to reduce the use of motor vehicles. A proper number of parking spaces and a bicycle parking lot have been created.

  With the shape of a butterfly, the building is lighted by 1000 LED lights at nights (Figure 20), which is the reason it did not receive any credit for prevention of light pollution in the LEED evaluation.

  The building, which contains most of the principles of a sustainable site, received 22 credits out of 26.

- **Water Efficiency:** Rain and snow water collected by drains from the facade of the building is stored in tanks and later used for the irrigation of the surrounding park. The building, as a result, consumes 47% less water than buildings that do not have water-efficient equipment (Yanar, 2017: 85). Efficient systems and equipment are used in the toilets in order to conserve the water but the water is not recycled.

  The museum received 10 points out of 10 from LEED for the criterion of water efficiency (Table 1).

- **Energy and Atmosphere:** The building, which does not use renewable and green energy, did not receive any credit for these criteria. The building consumes a great deal of energy to stabilize the temperature and humidity to accommodate the sensitive butterflies. In the cooling, heating and ventilation systems of the building, harmless techniques are utilized.

  As a whole, it received 4 points out of 35 for the energy and atmosphere criteria.

- **Materials and Resources:** During construction, 65% of the materials in the building were locally supplied (Yanar, 2017: 87). The building was mainly built of glass and steel, which were locally produced. However, films, which cover the glass from inside and outside to allow UV light to get in, were imported from abroad. Additionally, equipment used for providing 80% humidity was brought from abroad. In accordance with the waste management plan for the construction, recyclable materials were collected: 79,52% of the construction wastes were reusable (Yanar, 2017: 87).

  In operation, the management avoids buying non-recyclable materials for use in workshops and offices, as a principle. Recyclable paper and cardboard from the office; glass, plastic and metal waste from the workshop and garbage are collected in separate containers and handed over to the municipality.

  The museum gained 6 points out of 14 for this criterion (Appendix D).

- **Indoor Environmental Quality:** The air temperature of the area for butterflies is adjusted to 28 degrees Celsius and the rate of humidity to 80% to enable the butterflies to adapt to Konya. The high temperature and humidity of the garden does not bother the visitors because the duration of the visit is arranged to be less than 30 minutes. The visitors pass on to the museum section before they have a chance to feel uncomfortable. The indoor air of the building is regularly renewed and its quality is continuously monitored by the building operating system.

The paint, coating and insulation materials used in interior spaces do not contain VOCs (Volatile Organic Compounds). However, flooring, composite wood and agrifiber products could not be selected from harmless materials. The building received a total of 5 out of 23 credits for indoor environmental quality criteria (APPENDIX D).

4.6.2.6. Education in the Museum

The museum places great importance on education. Every day schools visit the museum and learn new information about butterflies and insects, and the number of students is increasing every year. The museum provides education to young people, ranging-in age from 4 year old children to university students. These young visitors come from 42 provinces all around Turkey. The museum includes three classrooms fully equipped with educational materials and has experienced museum educators. Interactive education also takes place while visitors tour the museum.

4.6.2.7 Outcomes

At the time of writing, the Butterfly Garden and Insect Museums has become a center of interest and is considered as a symbol of Konya. The museum building has also received awards such as "Sign of the City Award" in 2018 and “Plant Awards” in 2017 and 2018. Managers of the Butterfly Garden have some future plans. For example, a unit for live insects is planned to be added to the insect section. In addition, the municipality wants to open related museums such as a natural history museum, and create a cultural zone in the same park. The Butterfly Garden management also wants to add solar panels to decrease energy consumption and produce renewable energy.

The effort of the museum is not limited to only becoming sustainable; their enthusiasm to educate the public is also very admirable. The museum is very well managed by a competent staff. The author hopes that this museum will become an

example for other similar institutions, both as a green construction and as a perception of museology.

Konya is a very supportive city for this kind of sustainable and green projects. Apart from the Butterfly Museum, Konya Science Center, Konya Sports and Convention Center, and Unilever Taş Konya Ice Cream Factory have also been awarded with LEED certificates.

4.7. Conclusion

To conclude, with huge degree of impact, green design, construction and operations in museums can have positive global consequences (Brophy&Wylie, 2008: 39). Going green lowers operating expenses, increases the value of museum, protects environments and allows more resources to be used in achieving goals of the museum. A green museum presents a higher quality of life for its staff, visitors, and the community, it contributes to environmental sustainability (American Allience of Museums, 2013).

Similar to the LEED rating system, there are many other helpful systems and applications which provide information and guidance in buildings and museums. Thanks to the increasing interest for green buildings, today there are many companies, suppliers and choices available and reachable. Sustainable operations and practices are fast becoming the new standard (Brophy & Wylie, 2013: 196). “Every day more products, new equipment, and groundbreaking ideas surface that are energy efficient, use recycled materials, rely on less natural resources and are more affordable” (Sutton, 2015: 196). Museums do not need to apply LEED or other green building rating system but they can follow their basic green principles and implement the most appropriate for them. It should be stressed that a museum does not necessarily have to have a certified award from any rating system if it effectively practices environmentally-friendly principles.

CHAPTER 5

SURVEY RESULTS AND POSSIBILITIES OF A GREEN MUSEUM IN ANKARA

In the previous chapter, the impact of museums on a sustainable environment and increase of awareness was presented. Rapid changes in the climate make a substantial change in the museum paradigm more urgent than ever. Furthermore, the green museum concept is recently gaining recognition in Turkey. For any effort to open a green museum, presence of consciousness among responsible authorities is needed first. To assess the level of this consciousness a survey was carried out among museum officials, one of the research questions of this thesis. Ankara was chosen as the study site of the survey because its location as the capital of Turkey means that there is a wide presence of government ministries, like the ministry of culture and a significant concentration of state and private museums. In the second part of the chapter, results of the survey were considered to discuss the potential of opening a green museum in Ankara.

5.1 Survey Results of Museums in and Around Ankara

This section describes the process and results of the survey undertaken in a total of seven museums out of which six are located in Ankara city and one in a nearby town, Kaman, Kırşehir. It objective was to gauge the sensitivity and knowledge about the concept of green museums. The chapter aims to present the current awareness of green museums. The interview technique was used as the survey tool. The interviews were carried out with museum authorities and staff.

5.1.1 Selected Museums

The museums in and around Ankara were selected based on the nature of their collections, buildings or their potential to become green:

- Anatolian Civilizations Museum, Ankara:

The Anatolian Civilizations Museum is a state museum. It was selected because the museum complex consists of two historical buildings, situated in the Citadel which can potentially be renovated as a green museum, and also because it is the most prestigious and the oldest museum in Ankara. The museum was officially established in 1943. In 2014, the buildings were restored and renovated (Figure 21). Today, the museum, one of the most important ones in Turkey, includes archaeological artifacts found in Anatolia from Paleolithic to Classical ages.

- Erimtan Archaeology and Arts Museum, Ankara:

The Erimtan Archaeology and Arts Museum is a private museum that mainly exhibiting the collection of Yüksel Erimtan's archaeological artifacts from Anatolia. The museum was chosen for its contemporary architecture and design. It is also a cultural center of arts, organizing temporary exhibitions, concerts, workshops and seminars. The collection is mostly from the Roman period but it also includes Byzantine artifacts. The museum was opened in 2005 and is located near the entrance of the Ankara Castle. The museum in traditional style from the remains of three old buildings from the site (Figure 22).

- Rahmi M. Koç Museum, Ankara:

The Rahmi M. Koç Museum, which is a part of the Rahmi M. Koç Museology and Cultural Foundation, is a private institution dedicated to the exhibiting of industrial and engineering objects and documents mainly from Turkey but also other countries, encompassing different periods of time. The Rahmi M. Koç Museum is Ankara's first industrial and transport museum and was opened in 2005. It is one of the largest museums in Ankara and is managed by an environmentally conscious director. The museum is situated in two historic caravanserais, Çengelhan and Safranhan, opposite the Ankara Citadel Gate (Figure 23).

- Industry and Technology Museum, Ankara:

The building of the Industry and Technology Museum was constructed at the end of the 19th century to be used for production of guns and ammunition. It was completely burned down in 1922, and rebuilt and converted into a museum in 2013 (Figure 24). It is a state museum attached to Makina ve Kimya Endüstrisi (MKE), an institution of the Ministry of Industry and Technology. It contains samples of machinery reflecting the industrial history of Turkey. A museum on technology was expected to use or be aware of green techniques.

- Feza Gürsoy Science Center, Ankara:

The Feza Gürsoy Science Center is the first science center in Turkey and was opened in 1993 (Figure 25). Affiliated with the Ankara metropolitan municipality, it was named after a world famous physicist. The museum presents scientific demonstrations, experiments to illustrate basic chemical and physical principles, science workshops, films and videos about science, and educational games. These activities are mainly oriented towards school children. This feature is the main reason why this center was selected.

- Kaman - Kalehöyük Archeology Museum, Kırşehir:

The Kaman Kalehöyük Archaeology Museum is situated near a village called Çağlayan, Kaman, close to Kırşehir and 120 km from Ankara. The museum was planned and constructed by the Japanese government and then handed over to the Turkish Ministry of Culture. The museum is a creation of Ishimoto Architectural & Engineering Firm. A Japanese team is also carrying out the excavations of the Kalehöyük mound and other locations nearby. Japanese Institute of Anatolian Archaeology (JIAA) is also situated near the museum building. The museum was opened in 2010 and presents the artifacts which were founded in the excavation sites. The design of the building replicates the Kalehöyük mound site (Figure 26) and the building gives an opportunity for visitors to experience excavation activities and methods. Every step of the excavations is displayed in a series of photographs, some taken by drones. Although, it is not a LEED certified museum,

it received a "Green Good Design Award[51]" in 2010 because it creates a green and sustainable area in a steppe landscape.

- MTA Energy Park, Ankara:

The MTA Energy Park is a museum specifically about energy sources, water use, natural resources and waste reduction (Figure 27). It was constructed in 2004 to educate school children by demonstrating efficient uses of energy and water. It also contains an exhibition about minerals and natural resources of Turkey. MTA is an institution attached to the Ministry of Energy and Natural Resources, which is involved with examining and searching for minerals. Because of its name and subject, this museum was expected to be informed about green museums.

5.1.2 Survey Questions

The following questions were asked in order to understand the knowledge of museum authorities about the green concept. As the directors were not always available, sometimes the questions were answered by the highest positioned museum staff available. These questions were originated by the author because there are no appropriate examples of questions related to this topic.

1- Have you ever heard of the green museum concept?

2- Which sustainable building principles are practiced in your museum (energy conservation, water use, lighting, material use, etc.)?

3- Do you think your museum can be made green?

5.1.3 Results of the Survey

The answers given by the officials follow in the same order of the questions listed. Only noteworthy results which are useful for the case study have been considered here.

Out of seven museums, only one institution, Rahmi M. Koç Museum is fully aware of the green museum concept. While MTA Energy Park had fragmented information,

[51] This award is given by The Chicago Athenaeum Museum of Architecture and Design and Metropolitan Arts Press Ltd.

other museums had only a limited notion of green museums. In these cases, the author informed the officials about the green concept in museums.

The answers to the second question revealed that many museums in Ankara are not aware of sustainable building principles; however, it was observed during visits that some were actually using green museum features. All museums are using LED light bulbs for their exhibition sections; some use natural lighting through windows; and the clerestory roofs and Rahmi M. Koç Museum has automation systems to control temperature, humidity and lighting. The Rahmi M. Koç Museum is located in two renovated historical buildings, and Erimtan was constructed by reusing the building materials of three torn down old buildings. By using non-toxic materials, the Erimtan Archaeology and Arts Museums have increased indoor air quality. The Kaman Kalehöyük Archaeology Museum has natural ventilation provided through grills in the walls. In addition, they used local stone in inside and outside of the building. This museum was built under a mound and the mound was covered with grass. The mound is actually a replica of the hill where the excavation is going on, Kalehöyük. Although this mound does not fully function as a green roof, it provides insulation and prevents rain water runoff.

However, none of the museums has planted local vegetation in their garden, roof or open spaces. The issue of water efficiency, which is vital in green museums, is also missing in all of the museums except the Erimtan Archaeology and Arts Museum which recycles its water. Among the museums visited, the Erimtan Archaeology and Arts Museum was the greenest because materials from the old buildings were used for construction, non-toxic indoor materials were chosen and storm water is collected and used for irrigation. However, many other museums have a potential to become green. For example, the Kaman Kalehöyük Museum can be turned green with minor inputs like planting local vegetation on the roof and other open spaces, using solar panels and incorporating water reuse systems.

Answers to the third question differ from museum to museum. While a few museums were very interested and attracted by the idea of being green, others were indifferent. Two museum officials actually asked for author's consultancy for improving their environmental sustainability of their museums. Apart from the Rahmi M. Koç and

Erimtan Museums, other museums justified their lack of concern with economic issues as a reason for not supporting the idea. For instance, the official of Feza Gürsoy Science Center stated "It will not be possible to turn this museum in to green. Municipality will never provide the extra expenses for a green museum. It will be too expensive for them." The cost of achieving green museum features was incorrectly perceived by administrators as being high because the effects of cost saving implementations in the long run even middle run were not considered. One museum mentioned a bureaucratic obstacle, pointing out that their historical museum building was under protection and no change could be made without a tedious procedure set by the responsible commission. They said "The High Council of Monuments (Anıtlar Yüksek Kurulu) is very strict on even minor changes in historical buildings."

5.1.4 Conclusion

The surveys revealed three different conclusions. Firstly, apart from the Rahmi M. Koç Museum and the MTA Energy Park, the green and sustainable museum concept is not well-known in Ankara. Secondly, although some museums do have features compatible with LEED criteria or other rating systems, they are not aware of them. Thirdly, some of these museums have a high potential to become green with only minor improvements, at least at the "Certified" level of LEED. It is regretful that while the green approach to buildings is widely practiced in the building construction sector in Ankara, this does not apply to museums.

It was surprising that in Ankara there was such little information about the green concept in museums, in spite of the fact that there is a green museum example in Konya. Education provided by the Ministry of Culture to museum directors and staff about environmental sustainability is essential. With achievement of green consciousness, museums in Ankara can be made green or at least partially green by implementing some sustainable practices. The following sections will discuss the realization of this possibility.

5.2 The possibility of a Green Museum in Ankara

The aim of the following section is to discuss the possibility of opening a green museum in Ankara. This part includes general information about Ankara, its potentials and the author's suggestions and opinions, forming the core issues of this thesis. Obstacles, gathered from the meetings with municipality and museum officials, are also mentioned.

5.2.1 General Information about Ankara

The city of Ankara, capital of Turkey, is located in the center of Anatolia, at an altitude of 850 meters. In Ankara, the summers are warm and dry; the winters are cold with some snow. Ankara province is a predominantly fertile steppe land, with forested areas in the northeast. The city is situated in a favorable geography in relation to its height, climate and natural surroundings. The city of Ankara is a modern metropolis of 5.6 million inhabitants[52]. Ankara has a rich cultural heritage, as evidenced by: a citadel, many Roman and Seljuk ruins, and old buildings from the Ottoman times. The remains of these old civilizations can be observed at the abundant historical sites in the city. Being at the center of Anatolia, it is easily accessible. As a capital it has the advantage of being able to draw a lot of citizens.

5.2.2 Potentials of Ankara

Ankara has a substantial green building experience. The city presents many green building examples with LEED (21) and BREEAM (1) certification. Eser Building with a Platinum LEED certificate mentioned in Chapter 3 is one of the most prominent examples of outstanding green building design in Turkey. The Eser Building shows that a similar initiative for museums can be successful in Ankara, illustrating that Ankara has many easily accessible resources and choices for green and sustainable design, making it a potential site for a green museum. The following paragraphs will review and examine these issues.

[52] The information was gathered from: http://www.tuik.gov.tr/PreHaberBultenleri.do?id=33705.

5.2.2.1. Role of Ministries and Municipalities

In Turkey, a country-wide project was started in 2017 by the Ministry of Environment and Urban Planning (Çevre ve Şehircilik Bakanlığı), called "Zero Waste" (Figure 28). It aims to encourage and inform the country's municipalities about sorting, collecting, and recycling waste, and therefore, to prevent excess use of raw materials and energy consumption (What is Zero Waste, n.d.). In addition, the Ministry of Environment and Urban Planning formulated another country-wide regulation in 2019. According to the new rules, it is prohibited to give plastic bags to consumers free of charge. Stores have to charge 0.25 Turkish liras for a single-use plastic bag. Ankara, like many other municipalities in Turkey, already had a program for collecting and recycling plastic, glass, cardboard, and paper waste, and increase their efforts after the Zero Waste Project went into effect. For instance, the city of Ankara's largest municipal district, Çankaya has programs[53] for the reclaiming of packing materials, used vegetable oil and electronic waste (Çevre Hizmetleri, n.d.).

The Ankara Metropolitan Municipality Department of Environmental Protection and Control (Ankara Büyükşehir Belediyesi Çevre Koruma ve Kontrol Dairesi Başkanlığı) started an education program, called the Academy of Environment and Landscaping (Çevre ve Peyzaj Akademisi), and opened to the public via their website[54]. This online program provides consultations on how to implement solar energy, wind tribunes and rain water management, and includes an informative guide on local plants of Ankara and other related topics.

The Ankara Metropolitan Municipality also has plans to install solar panels on top of sport centers, using green energy with an additional aim of being an example to the public. Moreover, Çankaya Municipality also has an energy efficiency department (Energi Verimliliği Birimi, n.d.). The mission of this unit is to carry out energy efficient systems and projects for the Çankaya Municipality investments. In short, Ankara has very high potential for green practices and can play an important role in disseminating environmental consciousness. Municipalities provide sufficient resources. In addition, they are responsive to the needs of their citizens, and the mayors are elected and answerable to their voters. As politicians, they have to please their

[53] The list of the activities can be seen on: http://www.cankaya.bel.tr/pages/221/CEVRE-HIZMETLERI/.

[54] https://ankara.bel.tr/cevrevepeyzajakademisi/neden-cevre-ve-peyzaj-akademisi/.

voters and satisfy their needs in order to be successful in the next election. One good example of a responsible municipality is Konya's Selçuklu, which has constructed the only green museum in Turkey.

5.2.2.2 Role of Other Institutions

Apart from sustainable practices and educational programs of municipalities, other institutions in Ankara are also very active about environmental issues. For example, the Chamber of Industry of Ankara (Ankara Sanayi Odası) published a report about the renewable energy potential of Ankara. A very beneficial source for the green movement, it includes subjects about energy, energy choices, renewable energy and their potential in Turkey and Ankara (Ankara Sanayi Odası, 2011: 3). In addition, the presence of headquarters of Türkiye Mimarlar ve Mühendisler Odaları Birliği (TMMOB), as well as Ministry of Environment and Urbanisation are worth mentioning here.

5.2.2.3 Suppliers

Unexpectedly, there is a variety of green material suppliers throughout Turkey. Ankara is very fortunate when it comes to green material production and distribution. For example, Dalsan Company fabricates spray plaster, hand plaster, jointing compounds, floor mortar and screed according to LEED and BREEAM indoor quality standards (http://www.dalsan.com.tr/tr/ContentPage/ContentPageIndex/40). Knauf, on the other hand, manufactures environmentally friendly construction supplies like insulation materials, dry lining systems, plasters and accessories, thermal insulation composite systems, paints, floor screed, floor systems, and construction equipment and tools (http://www.knauf.com.tr/tr/knauf-hakkinda/knauf-tuerkiye/). Saray Company produces aluminum profiles, composite panels and PVC profiles conforming to EDP standards like many other eco-friendly companies (https://saray.com/en/about-us/). In addition, many well-known paint companies, such as Polisan, Filli Boya and Marshall, produce eco-friendly and non-toxic wall paints for vigilant customers. There are many other environmentally conscious companies; the most recognized, advertised and easily accessed ones were mentioned here.

Last but not least, one of the green building consulting firms mentioned in the history section of this paper, ECOBUILD, is located in Ankara. This consulting firm is available for construction of new buildings, major renovations and technical support.

5.3 Suggestions for a Green Museum in Ankara

This section investigates the possibilities of starting a museum in Ankara in terms of selection of location, materials for construction, energy sources, vegetation, water management and material selection.

Whether to construct a new building or to renovate an old one for a green museum, the first step is to draw up a green policy and plan. The architectural exterior and interior design should be outlined according to this policy and plan. Different approaches are necessitated for old or new museum buildings. Each type of museum building needs a different policy, techniques and applications, related to its mission.

When the type of collections to be exhibited in a possible green museum in Ankara, there are many choices. The collections of this museum can be of any type as long as the museum has green features. However, a green museum about the city itself would be preferable since it is missing in Ankara. Another suitable candidate would be a museum about sustainable environment which would demonstrate green practices in action.

5.3.1 Choices of Building Location

This choice will differ, depending on whether the building is a newly constructed building or an existing building to renovate. It will also depend upon the amount of the budget allocated for this project.

5.3.1.1 New Building

If it is a new construction, the site selection of the building is very critical because it affects other options such as energy choice, lighting, heating, cooling, transportation or ventilation. The museum should be located on a site that receives ample sun light

and wind, and should be situated at or near the center of city for easy accessibility. When selecting a new site, all physical conditions should be examined and taken into account.

One of the possibilities for the location of a new building is a slum (gecekondu) area, which has recently been demolished and is in ruins at present (Figure 29). These slum regions are quite near the center of the city. A construction of a green museum and garden on these brownfields would add an environmental value to these areas and gain extra points for a LEED certificate. Moreover, construction materials from the demolished buildings can be reused for a new museum. Some of the slum houses can also be conserved and converted into a city museum with green features. Thus, houses which have constituted a large portions of the building capital for a long period in Ankara could be saved for future generations.

Another possibility is the creation of a green museum by Bilkent University, either on or off campus. As a center of education, Bilkent University is expected to fulfill its role in environmental sustainability through a green museum. In addition to the current green implementations on the campus, the construction of a new green museum would be an asset.

Alternatively, a new site on the fringe of the city with transportation opportunities could be selected. This museum could be reached by metro or bus. An added shuttle service would improve transportation possibilities. This alternative has the advantage of being built from scratch. Thus, every detail can be considered and easily fulfilled according to the budget allocated.

5.3.1.2 Existing Building

It is environmentally more acceptable according to LEED criteria to renovate an old building as a green museum (Cottrell, 2014: 69). If an existing building in Ankara is selected for a green museum, a possible location might be the citadel (Figure 30) or Hamamönü region where many historical buildings, typical old Ankara houses, are situated. These regions are both located in the center of the city, and are cultural points of interest.

Another option is abandoned hospitals. Last year six hospitals[55] were emptied of patients and staff and were transferred to Ankara Şehir Hospital at Bilkent. Two of these are Numune Hospital (1924) (Figure 31) and Ankara Hospital (1957), structures of which have historical and architectural significance. These two hospitals were built more than half a century ago and are valuable architectural examples of their period. Now, some buildings of Numune Hospital are being used by the District Health Authority. The empty buildings have a central position in the city and are easy to reach, being close to Ulus, the old district of the city.

Ankara has five old caravanserais (Kurşunlu Han, Mahmut Paşa Bedesteni, Sulu Han, Çengel Han, Safran Han). The last two are being used as museums at present. The remaining three are centrally located, occupied by shops at present but could be turned into a museum if desired.

One more option is the renovation of old industrial buildings. They provide large exhibition spaces and are now situated near the center, as the city grew around them, such as Siteler and İskitler Sanayi Sitesi. Ankara has a successful example with the case of CERmodern, a train repair workshop turned into a modern art gallery.

It seems that renovating an existing building for a new green museum in Ankara has more advantages over a new building. In old buildings existing materials can be used. In addition, old buildings might be conveniently accessible because of their central location. Finally, special value would be added in the case of an abandoned historical building.

5.3.2 Energy Choices

According to the Chamber of Industry of Ankara's energy potential report, the city of Ankara is unsuitable in terms of wind generated energy (Ankara Sanayi Odası, 2011: 50). Similarly, although some towns around Ankara such as Polatlı, Kızılcahaman, Kayaş and Haymana have geothermal resources which are being used in heating in residences, the center of Ankara lacks this opportunity (Ankara Sanayi Odası, 2011:

[55] The information was gathered from: https://ato.org.tr/announcement/show/436.

47). Nevertheless, solar energy is being used in many new buildings. Although Ankara is not as sunny as Antalya, as a comparison, it still has much more sunshine than Germany where solar energy is widely practiced (Ankara Sanayi Odası, 2011: 46).

In a new green museum building, solar energy is attainable; roofs, windows and garden can be used for this purpose. Existing buildings might need some alterations to accommodate solar panels.

5.3.3 Material Selection and Supplies

Apart from the materials produced by the industrial companies mentioned above, a type of stone specific to Ankara, the local andesite, known as "Ankara Taşı", can be used in the construction of a new green museum building (Figure 32). In Ankara, there are many quarries and local companies which supply andesite and other local stones for construction. This local stone has already been used in many of the historical buildings in Ankara (Karahan, 2018: 2). Volcanic tuff and pumice stone, which are light kinds of stones, are readily available in Ankara stores and can be used in heat and sound insulation.

5.3.4 Water Management

Ankara is in a water poor region because of its geographic location. Climate change is already worsening this shortage, making the issue of water very critical. Even at present, there is difficulty in supplying municipal water especially during summers. Ankara water is supplied 98% from dams and 2% from ground water (Su ve Yaşam, 2012: 23). With the increase of the population and the reduction of rain and snow, the rapidly decreasing amount of water in the dams pose a great threat for the future. For this reason, every strategy for water efficiency and conservation in a museum in Ankara should be implemented. These strategies include rain water management, gray water reuse, efficient plumbing fixtures and installing sub meters to track consumption. These measures are similar for both old and new buildings.

5.3.5 Vegetation

It is easy to determine which plants could be used in the walls, roofs and garden of a green museum in Ankara. Many grass, scrubs and trees, both local and adapted, exist which have accommodated themselves to the climate of the city. These can be classified as ground cover plants such as *Sedum spurium*, flower plants such as geranium (*Pelargonium zonale*), shrubs such as red robin (*Photinia fraseri*) or lilac (*Syringa vulgaris*), shade trees such as alder (*Carpinus betulus*), plane (*Platanus orientalis*), horse-chestnut (*Aesculus hippocastaneum*) or maple (*Acer platanoides*), fruit trees such as apple (*Malus domestica*) or cherry tree (*Prunus avium*) and ornamental trees such as locust (*Robinia pseudoacaica*). Detailed information exists about the adapted plant types, features and their ecological needs in the Academy of Environment and Landscaping website of the Metropolitan Municipality (Güleç, n.d.). This information should also be made available to museum visitors, as well as to the general public. Selection of local plants will link the museum with the natural identity of the city and visitors will feel closer to the museum, hopefully enhancing their attachment to the building.

5.3.6 Air Quality

Ambient air quality in Ankara is unhealthy especially during winters and in the city center. This restricts the use of natural ventilation in a green museum. It also increases the use of air conditioning and therefore electricity consumption. A green roof and green wall can easily be constructed in museum buildings, helping to reduce air pollution. Indoor air quality can be maintained by purchasing materials from eco-friendly and certified companies in Ankara.

5.4 Obstacles to a Green Museum in Ankara

The major obstacle revealed in this research was the lack of information and motivation about the green concept. It is very important to know what a green museum is, what its features are and what its advantages are. To be able to provide sufficient knowledge about green museums, this subject should be introduced into the curriculum of museology to better educate students. Also, museum staff should be trained. Thus, there can be some hope of raised consciousness about sustainability and

green practices. Green museums provide real life examples for a green world, and they are also a means of educating the public about environmental sustainability. Motivation to open new green museums can only be induced after proper knowledge about the green concept.

The second obstacle in implementing green practices in museums in Ankara is economic, as it could be understood in the interviews with museum officials. They opposed suggestions for green practices in their museums because of economic concerns. Their main perception is that these green practices cost too much and necessitate sophisticated techniques. However, this perception is totally wrong because in the long term, green practices in museums are economical and do not always need very advanced technologies. In many cases, small improvements can lead to sustainable outcomes. Many affordable green technologies to achieve green results exist today such as replacing light bulbs with LED ones, installing water efficient fixtures, waste collection and reuse, planting local vegetation in the garden, rainwater collection and reuse, using a permeable surface in parking places etc. Sponsors could be found for major expenditures.

Another difficulty is encountered when an old building is chosen for the site of a green museum. The High Council of Monuments (Anıtlar Yüksek Kurulu) has authority over the renovation of all historical buildings in Turkey. Contractors have to get permission from them for their architectural plans and they are not allowed to make major changes in the original structure. This problem might be overcome by making minor changes in the building to green it without major modifications as mentioned in the paragraph above.

5.5 Advantages of a Green Museum in Ankara

Presence of a green museum in Ankara will have several advantages listed below:

- It will contribute to the improvement of environment.
- It will provide an educational opportunity for a sustainable environment.
- It will raise awareness about the environmental issues in Ankara.
- It will bring prestige and attraction to the city, thus adding an economic value.
- It will be an example for other museums and cities.

When all these advantages are considered, it would seem that a green museum in Ankara is not only possible but also environmentally, socially and economically beneficial.

5.6 Conclusion

In conclusion, the situation in Ankara on the subject of green choices is very favorable. The availability of opportunities and resources make the green museum project feasible. The potential of Ankara's municipalities should be used. Environmentally conscious companies in the private sector can also contribute to these efforts. The LEED certificate level targeted for a green museum in Ankara will depend upon the financial resources allocated for this purpose. It would be more feasible to renovate one of the many existing old buildings in Ankara. These proposals can be expanded further. At this point, the author has just presented some possibilities based on specific experience and observations. The author's knowledge of LEED principles also contributed to this assessment.

Lastly, obstacles that were mentioned can be overcome, as the author has tried to demonstrate. Green applications and methodologies are limitless and new technologies will continue to be developed in the future for oncoming ecological problems. Having a green approach, steady motivation, strong will, accessible information, and training are the most effective factors to achieve a successful outcome. Even a small contribution to a healthy environment through simple measures is valuable.

CHAPTER 6

CONCLUSION

6.1 The Threat of Climate Change

At present, the relationship between humankind and nature is broken. The irrefutable hazardous effects of climate change have been mentioned all through this thesis. Some of these devastating effects are natural disasters such as floods, extreme temperatures; and droughts; glacial melt down; extinction of many animal and plant species; forest fires; and the appearance of new illnesses. Climate change is the direct result of the complex developments of humanity over time, industrialization, burning of fossil fuels, consumerism and population increase. Not only for humans but for all living things, the threat of climate change becomes clearer and more urgent each day. Imminent results of climate change has led to an increased awareness of the need to protect the environment through the integration of green practices. Consequently, the concept of green in various sectors have gained widespread attention. Green practices are ideologically safe and do not disturb the order of society. Therefore, advocates of environmentalism can focus on a limited program for change however, achieving sustainability means major changes need to be made in the political and economic structure.

6.2 Green Buildings

The building industry is an important area of interest because buildings are one of the major contributors to consumption of energy, water and resources. The concept of green buildings has emerged because of these negative effects. Green buildings minimize the consumption of natural resources and energy through the efficient and

intelligent use of energy, water, materials and building site. In order to encourage and help in the construction of green buildings, several associations have been established around the world.

Although there are internationally acclaimed green building organizations and rating systems, many countries have developed their own according to their needs. This thesis follows the principles of LEED because it is one of the most widespread and recognized green building rating tools. Apart from LEED, many countries use other systems such as BREEAM, DGNB or Passivhaus; in Turkey mostly LEED but also the BREEAM rating system are used. A green and an environmentally sustainable building is economical, healthy and has a marketing value as well. Green offices, green hotels and green residences are always preferred by environmentally aware individuals. As the trend in the building sector changes to green, it is expected that rating systems will be increasingly used all through the world.

6.3 Green Museums

Museums, similar to other buildings, are also part of this green trend. In fact, since they consume additional resources and energy to maintain a constant temperature and humidity to preserve their collections, their effect on a sustainable environment is even more important than other buildings. The definition of a green museum is one that places concepts of environmental sustainability into its policy, planning, construction, programming, operations, exhibitions and education (Brophy&Wylie, 2013). According to green building rating tools, a green building, hence a museum, needs to implement as many as possible of these specific principles, such as site selection for a new building, green transportation choices, energy conservation, efficient water management, environmentally friendly material selection and healthy indoor air quality. In addition to implementing these green practices, as trusted public institutions (Saunders, 2008: 293), museums are uniquely situated to lead environmental sustainability through education and exhibitions.

People have difficulties in comprehending the complex mechanisms of climate change and environmental pollution, and in adopting environmentally friendly behaviors. Green museums can clarify these issues by using their resources and their unique communications channels to engage communities and equip citizens with knowledge that will enable them to take action towards a sustainable environment. By targeting mainly children, they have a power to affect the future, thus making green museums a partner for solutions to the deterioration of the global environment.

Today, many museums are under an ever increasing threat of climate change (Saunders, 2008: 291). High temperature damages collections, forest fires force museums to move their collections, and some museums are exposed to rising sea water or river floods[56]. Potential dangers should provide an additional justification for museums to become green.

When the distribution of LEED certified museums is considered, the majority of museums are situated in the U.S. Although the green building approach is being embraced more and more every day in Turkey, there is only one certified green museum: the Konya Tropical Butterfly Garden, which was awarded a Silver LEED Certificate. Their educational methods and perspective to museology is an inspiration for other museums. In fact, this museum is a manifestation of the environmentally sustainable approach of the Konya Selçuklu municipality, which has constructed other green buildings in the city.

In order to popularize green museums in the world and in Turkey, the author would like to suggest a separate LEED Guideline specific to museums, as it already exists for schools, hospitals and retail. This guideline would include specifications for green team, green exhibitions and green education. Similarly, Turkey should develop its own comprehensive green building rating tool to be used in different types of buildings, including museums. Every country has different conditions peculiar to its

[56] Detailed information can be found here: https://icom.museum/en/news/climate-change-and-copyright-laws-the-challenge-of-safeguarding-our-heritage/.

climate, environment, rules and regulations, administrative structures which makes a standard LEED unsuitable for every situation.

6.4 Is a Green Museum Possible in Ankara?

Many more green museums need to be founded in Turkey. Thus, in this thesis, the possibility of opening a green museum in Ankara, the capital, was examined as a case study. To investigate this possibility, employees of seven museums in and around Ankara were interviewed, in order to assess the level of knowledge about green museums and green practices. Selected questions were asked and answered by the museum officials. The main result indicates that the green concept is not well known in museums in Ankara. Although a few museums had actually implemented some of the green practices, they were not aware of it. After conducting the interviews, the author informed the staff about the green museum concept, hoping to raise awareness.

Despite the fact that the museums are rather unfamiliar with the green idea, it is still highly possible to open a green museum in Ankara when the availability of resources and initiatives of the city are considered. For example, the local andesite can be used to construct new buildings; abundant solar energy could be used to produce electricity; and a lot of companies are available to provide green materials. Many historical buildings that can be renovated and many suitable central areas to build a new green museum exist. For example, in the citadel area many historical houses and inns, emptied hospitals and deserted factories can be renewed to become a green museum. Moreover, demolished slum areas, municipality lots and university campuses can be used to make new museum buildings. Environmentally friendly activities and practices of ministries and municipalities are noteworthy examples of positive initiatives in Ankara. However, some obstacles need to be overcome: absence of information on techniques of green practices and unfounded fear of economic costs. To address these concerns, decision makers, officials of ministries and museums and museum staff have to be made aware of climate change, be motivated towards a sustainable environment, and be informed about cost-benefit relationships and mechanisms of green applications to museums. Universities, green

consultancy firms and international museum organizations can assist in this endeavor.

6.5 A Last Word

Climate change is not just a local, regional, or national issue, it is a global crisis. Green museums are significant instruments for combating this emergency. Green museums are not only environmentally friendly but they are also socially and economically beneficial. Many resources and technology exist at present for museums to become green and more environmentally sustainable and affordable appear every day in the world and Turkey. Now, it is much easier for museums to be built green or become green. Even minor changes in existing buildings can make a difference. As stated by Sarah Brophy and Elizabeth Wylie, "going green is a journey, not a destination" (2008: 61).

This thesis is the first and only research in Turkey about green museums. It discusses the concept of green museums, provides historical information about green buildings and museums, examines green practices in detail and propose to create a green museum in Ankara. The author hopes that this introductory text will contribute to a new perception by museum officials, make green changes in existing museums, inspire new research and guide colleagues in future studies on green museums. It would be a special achievement for the author if a green museum is established in Ankara. If so, this museum would serve as a catalyst for green museums in Ankara, following the pioneering example of the Konya Tropical Butterfly Garden. All existing museums in Turkey, regardless of the type of their collection, should try to become green as much as their resources allow, and all future museums should be born green. The author plans to improve her knowledge and experience on green museums and to contribute to the green museum movement in Turkey.

Green museums are a requirement now, not a choice. Museums have unique power and responsibility to model and teach the methods of preserving the planet, in their capacity as places of authority and keepers of culture. Green museum are best

positioned to share environmental sustainability with broadest audience in the most powerful way (Brophy & Wylie, 2008: 45). The approaching threat of climate change will, sooner or later, necessitate policies favoring environmental sustainability, green cities and green museums.

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FIGURES

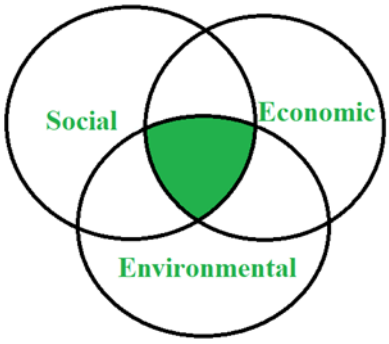

Figure 1. Usual representation of sustainability as three intersecting dimensions.

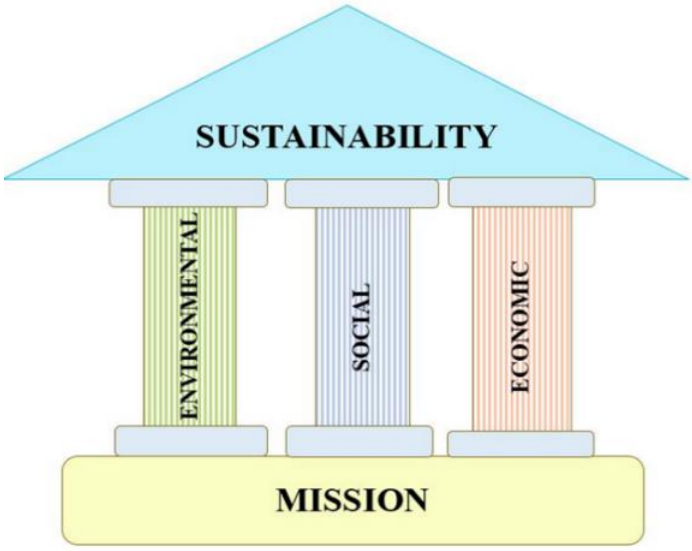

Figure 2. Four basic elements of sustainable museums.

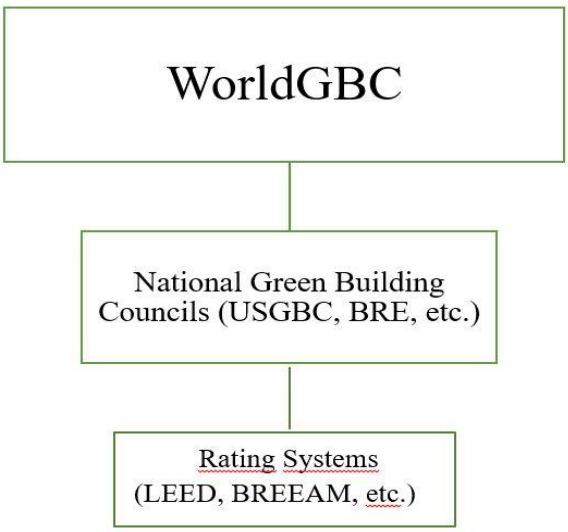

Figure 3. The ranking of green building structures.

Figure 4. Eser Holding Central Office. (https://www.altensis.com/en/project/eser-holding-merkez-ofisi-ilk-leed-platin-sertifikali-bina/)

Figure 5. First LEED Platinum Award in Turkey given to Eser Green Building.

Figure 6. Mark Twain Historic House and Museum, One of the earliest LEED certified museums in the world.
(http://phbcatalyst.com/portfolio/the-mark-twain-house-education-and-visitors-center-hartford-connecticut/)

Figure 7. Pittsburg Children's Museum. (https://pittsburghkids.org/about)

Figure 8. General view of California Academy of Sciences.
(https://www.calacademy.org/efficient-daily-operations)

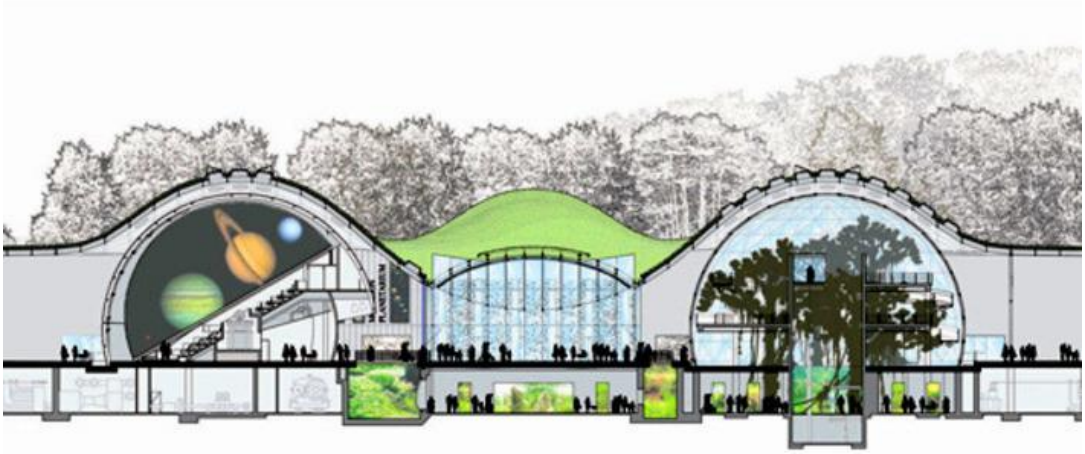

Figure 9. Schematic design of CAS.
(https://greenbuildingbrain.org/items/california_academy_of_sciences)

Figure 10. The green roof of CAS with native Californian plants.
(https://www.calacademy.org/exhibits/living-roof)

Figure 11. The air view of the CAS's roof. (https://arch-com.net/en/architectural-articles/908cec16-california-academy-of-sciences#images-gallery-11)

Figure 12. Bird's eye view of the Konya Tropical Butterfly Garden. (http://www.arkiv.com.tr/galeri/detay/261337/3/proje/7986)

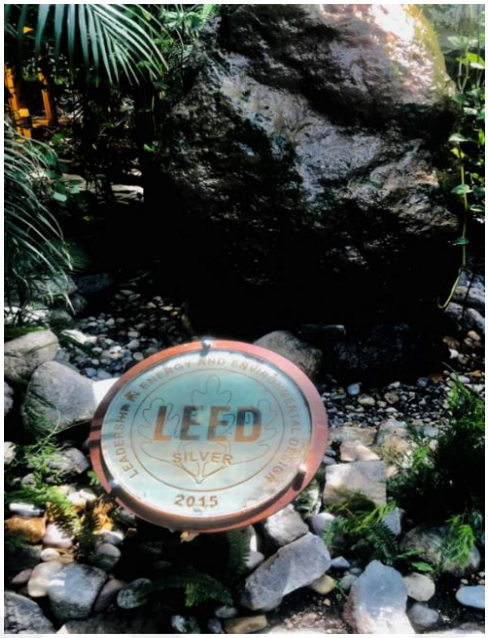

Figure 13. LEED Silver certification of the Konya Tropical Butterfly Garden building.

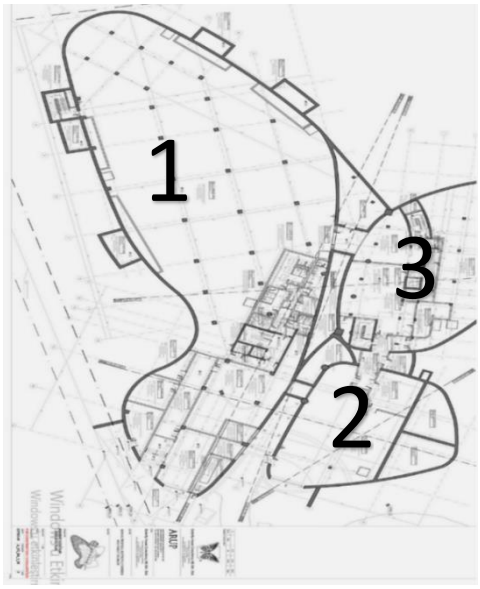

Figure 14. Different sections of the Konya Tropical Butterfly Garden building. (https://www.arup.com/tr-tr/projects/butterfly-garden-project)

Figure 15. The visitors' route passes through artificial tunnels and ponds.

Figure 16. Egg shaped chambers in a special section of the Konya Tropical Butterfly Garden, are devoted to life cycles and samples of insects.

Figure 17. A special section of the Konya Tropical Butterfly Garden exhibits classification and the samples of butterflies.

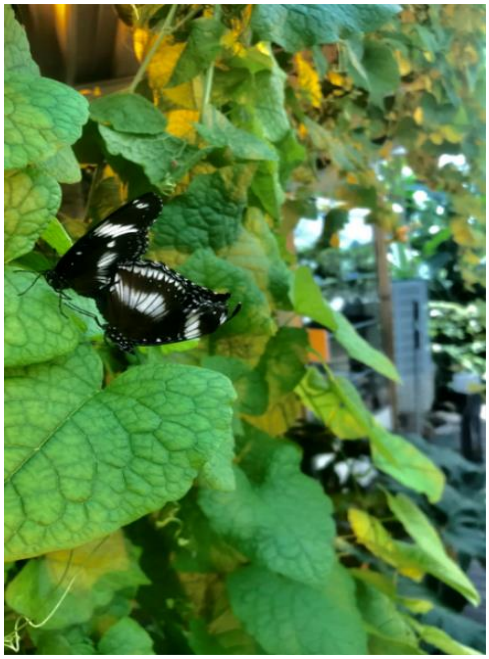

Figure 18. Konya Tropical Butterfly Garden gives the opportunity to observe many different kinds of tropical plants.

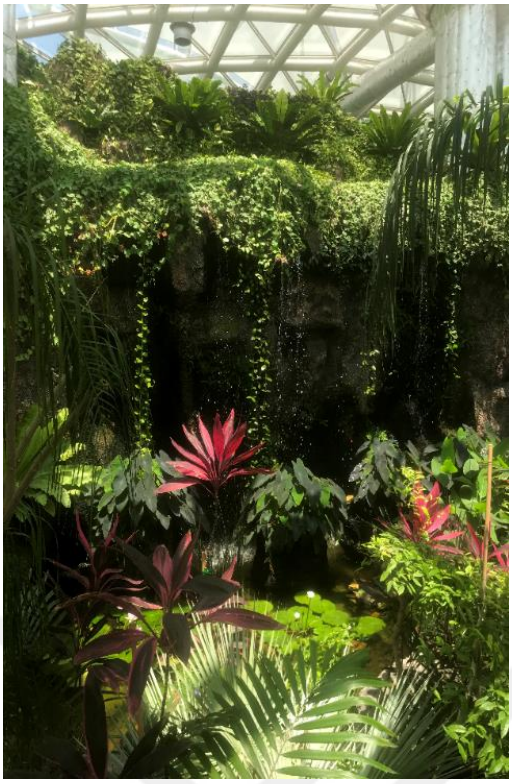

Figure 19. Konya Tropical Butterfly Garden embodies many butterfly and tropical plant species.

Figure 20. Night view of the Konya Tropical Butterfly Garden. (https://konyakultur.gov.tr/index.php?route=modules/towns&town_id=11)

Figure 21. The general view of Museum of Anatolian Civilizations, Ankara.

Figure 22. Erimtan Archaeology and Arts Museum, Ankara.

Figure 23. Rahmi M.Koç Museum, Ankara.

Figure 24. Industry and Technology Museum, Ankara.
(https://www.mkek.gov.tr/muze/)

Figure 25. Feza Gürsey Science Center, Ankara.

Figure 26. Kaman Kalehöyük Archaeology Museum, Kırşehir.

Figure 27. MTA Şehit Mehmet Alan Energy Park, Ankara.

Figure 28. The official logo of Zero Waste Project. (https://sifiratik.gov.tr/kutuphane/kurumsal-kimlik)

Figure 29. The view of demolished slum area in Ankara.

Figure 30. Entrance gate to the citadel of Ankara.

Figure 31. Historical Numune Hospital, Ankara

Figure 32. Local stone of Ankara, Andesite.

APPENDIX A

Green and Sustainability, a Typology of Differences

(Yanarella, et al. 2009: 297)

Dimensions	Green	Sustainable
Relation to sustainability tripod	Only one leg (environmental improvement)	All three legs (environment health, economy vitality, social justice)
Focus	Individual components	Interplay of individual components and whole system
Tactics/strategy	Tactical application of activities that involve "picking low-hanging fruit"; promoting individual changes and reforms to make world less unsustainable	Strategic discovery of the proper scale that will make successive policy steps and actions easier and less costly by designing and implementing a sustainable, self-balancing system
Political orientation	Conventional, "pragmatic realist," reformist	Innovative, visionary, revolutionary ("going to the roots")
Scale	Individual devices, products, indicators, practices, buildings as most tractable level for greening	City region as the level at which human and social disequilibriums and ecological insults can be dynamically rebalanced
Risks or excesses	Greenwashing	Utopian fantasizing or top-down authoritarian policy action
Definition of success	Infinite progress of incremental improvements	Reduction of ecological footprint to a city region's fair Earth-share

APPENDIX B

Milestones of Sustainability, Green Buildings and Green Museums

Dates	Events
1962	Rachel Carson's book *"Silent Spring"*
1968	Garrit Hardin's book "*The Tragedy of the Commons"*
1970	First Celebration of Earth Day
1971	AAM educational handbook: *Museums and the Environment*
1972	First UN Environmental Conference in Stockholm
	First ICOM Conference on Museums and the Environment in France
1974	Coyote Point Museum in California
1987	The Report of the Bruntland Commision: *Our Common Future*
1990	Second ICOM Conference on Museology and the Environment in France
	First Passivhaus Building
	BREEAM Rating System
1992	Second UN Environmental Conference in Rio
1997	Kyoto Protocol
1998	LEED Rating System
2002	Third UN Environmental Conference in Johannesburg
	Establishment of WorldGBC
2003 - 2004[57]	The Mark Twain House and Museum in Hartford, Connecticut, and ECHO Leahy Center, Vermont
2006	CAM Green Museums Initiative Committee
2007	ÇEDBİK
2008	AAM *PIC Green Committee*
	OMSI *Green Exhibit Certification*
2009	Unilever Central Office in İstanbul, Turkey's first LEED Certified Green Building

[57] There is conflicting information about the dates of these two museums.

2012	Fourth UN Environmental Conference in Rio
2013	The Report of a Summit in Baltimore on Sustainability Standards in Museums
2015	Paris Agreement
	Tropical Butterfly Garden in Konya, Turkey's First LEED Certified Green Museum

APPENDIX C

The strategies and stages of OMSI's Green Exhibit Checklist

(https://omsi.edu/sites/default/files/ExhibitSEED_Green%20Exhibit%20Checklist.pdf)

Green Exhibit Checklist

The Green Exhibit Checklist (GEC) is a tool to evaluate the environmental sustainability of exhibits. The goal of the checklist is to inspire exhibit teams to reduce the environmental impacts of exhibit production.

The Green Exhibit Checklist can be a useful tool in early planning to help set project goals. Then, once the exhibit is on the floor, the checklist is used to assess the final outcome.

The GEC awards points in 5 KEY STRATEGIES:

- Reduce new material consumption
- Use local resources
- Reduce waste
- Reduce energy consumption
- Reduce products with toxic emissions

A sixth category awards points for innovation in the design and construction of the exhibit. This encourages exhibit teams to strive for new and creative solutions to reduce environmental impacts.

Step 1 Team sets the goal for the exhibit: Platinum, Gold, Silver, or Bronze.

Step 2 Designer and fabricator review checklist to find the best strategies for meeting the goal.

Step 3 After production, the fabricator fills out the GEC with the relevant material information.

Step 4 Exhibit team conducts walk-through, using the material information to award points.

APPENDIX D

Konya Butterfly Garden and Insect Museum LEED Score Card (https://www.usgbc.org/projects/butterfly-garden-and-insect-museum?view=scorecard)

1000043752, Selcuklu, Konya

Butterfly Garden and Insect Museum

LEED BD+C: New Construction (v2009) — SILVER, AWARDED MAR 2015

SUSTAINABLE SITES — AWARDED: 22 / 26

SSp1	Construction activity pollution prevention	REQUIRED
SSc1	Site selection	1 / 1
SSc2	Development density and community connectivity	5 / 5
SSc3	Brownfield redevelopment	0 / 1
SSc4.1	Alternative transportation - public transportation access	6 / 6
SSc4.2	Alternative transportation - bicycle storage and changing rooms	1 / 1
SSc4.3	Alternative transportation - low-emitting and fuel-efficient vehicles	3 / 3
SSc4.4	Alternative transportation - parking capacity	2 / 2
SSc5.1	Site development - protect or restore habitat	1 / 1
SSc5.2	Site development - maximize open space	1 / 1
SSc6.1	Stormwater design - quantity control	0 / 1
SSc6.2	Stormwater design - quality control	0 / 1
SSc7.1	Heat island effect - nonroof	1 / 1
SSc7.2	Heat island effect - roof	1 / 1
SSc8	Light pollution reduction	0 / 1

WATER EFFICIENCY — AWARDED: 10 / 10

WEp1	Water use reduction	REQUIRED
WEc1	Water efficient landscaping	4 / 4
WEc2	Innovative wastewater technologies	2 / 2
WEc3	Water use reduction	4 / 4

ENERGY & ATMOSPHERE — AWARDED: 4 / 35

EAp1	Fundamental commissioning of building energy systems	REQUIRED
EAp2	Minimum energy performance	REQUIRED
EAp3	Fundamental refrigerant Mgmt	REQUIRED
EAc1	Optimize energy performance	1 / 19
EAc2	On-site renewable energy	0 / 7
EAc3	Enhanced commissioning	0 / 2
EAc4	Enhanced refrigerant Mgmt	2 / 2
EAc5	Measurement and verification	1 / 3
EAc6	Green power	0 / 2

MATERIAL & RESOURCES — AWARDED: 6 / 14

MRp1	Storage and collection of recyclables	REQUIRED
MRc1.1	Building reuse - maintain existing walls, floors and roof	0 / 3
MRc1.2	Building reuse - maintain interior nonstructural elements	0 / 1
MRc2	Construction waste Mgmt	2 / 2
MRc3	Materials reuse	0 / 2
MRc4	Recycled content	2 / 2

MATERIAL & RESOURCES — CONTINUED

MRc5	Regional materials	2 / 2
MRc6	Rapidly renewable materials	0 / 1
MRc7	Certified wood	0 / 1

INDOOR ENVIRONMENTAL QUALITY — AWARDED: 5 / 23

EQp1	Minimum IAQ performance	REQUIRED
EQp2	Environmental Tobacco Smoke (ETS) control	REQUIRED
EQc1	Outdoor air delivery monitoring	0 / 1
EQc2	Increased ventilation	0 / 1
EQc3.1	Construction IAQ Mgmt plan - during construction	1 / 1
EQc3.2	Construction IAQ Mgmt plan - before occupancy	1 / 1
EQc4.1	Low-emitting materials - adhesives and sealants	0 / 1
EQc4.2	Low-emitting materials - paints and coatings	1 / 1
EQc4.3	Low-emitting materials - flooring systems	0 / 1
EQc4.4	Low-emitting materials - composite wood and agrifiber products	0 / 1
EQc5	Indoor chemical and pollutant source control	1 / 1
EQc6.1	Controllability of systems - lighting	1 / 1
EQc6.2	Controllability of systems - thermal comfort	0 / 1
EQc7.1	Thermal comfort - design	0 / 1
EQc7.2	Thermal comfort - verification	0 / 1
EQc8.1	Daylight and views - daylight	0 / 1
EQc8.2	Daylight and views - views	0 / 1
EQpc123	Designing with Nature, Biophilic Design for the Indoor Environment	REQUIRED
EQpc124	Performance-based IAQ design and assessment	REQUIRED

INNOVATION — AWARDED: 6 / 6

IDc1	Innovation in design	5 / 5
IDc2	LEED Accredited Professional	1 / 1

REGIONAL PRIORITY — AWARDED: 2 / 4

EAc1	Optimize energy performance	1 / 1
EAc2	On-site renewable energy	0 / 1
EQc7.2	Thermal comfort - verification	0 / 1
MRc1.2	Building reuse - maintain interior nonstructural elements	0 / 1
SSc6.1	Stormwater design - quantity control	0 / 1
SSc7.2	Heat island effect - roof	1 / 1

TOTAL 55 / 110

40-49 Points	50-59 Points	60-79 Points	80+ Points
CERTIFIED	SILVER	GOLD	PLATINUM