Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

Towards a Sustainable Green Design for Museums and Heritage Sites: A Comprehensive Approach to Protecting Cultural and Environmental Heritage^{*}

Menatallah Abdelatef Faculty of Archeology , Cairo University <u>mennaabdelatef113@gmail.com</u>

Abstract:

This study aims to explore the applications of sustainable green design in museums and heritage sites, focusing on the importance of using sustainable practices to preserve cultural heritage and reduce environmental impacts. The researcher used a descriptive and analytical approach, collecting data through two surveys: one directed at the students of the Faculty of Archaeology at Cairo University and the other aimed at faculty members. Data was also collected from various sources such as previous studies, environmental reports, and case studies. The study included models of green museums. The results showed that green design contributes to improving energy efficiency, protecting artifacts from environmental degradation, and enhancing the visitor experience. The study recommends integrating green design practices into academic curricula, increasing government support for sustainable projects, and raising environmental awareness among professionals in the field. It also suggests encouraging collaboration across disciplines and developing sustainable environmental policies.

Keywords: Green Museums; Green Architecture; Green Design; Sustainability; Sustainable design; Green Buildings; Green Technology

^{*} Presented at the International Conference on Green Design and Smart Cities under the slogan :Green Practices in the Digital Age"" El Gouna, Egypt 24:26 January 2025

Research Introduction:

In light of the increasing environmental challenges faced by the world today, adopting sustainable green design concepts has become essential, especially in the fields of cultural and natural heritage preservation. Archaeological sites and museums are a fundamental part of a nation's identity and history, making their preservation vital not only from a cultural perspective but also from an environmental standpoint. Sustainable green design represents an innovative solution that helps strike a balance between heritage conservation and environmental protection by applying practices and technologies aimed at reducing environmental impact and improving resource efficiency. This study aims to explore how these practices can be implemented in archaeological sites and museums and their impact on preserving cultural heritage while minimizing harmful environmental effects.

The research problem:

The importance of sustainable design in museums and heritage sites is growing due to increasing environmental pressures and challenges related to cultural heritage preservation. This research aims to study how to integrate sustainability principles into the architectural design of these sites while preserving their cultural values. This requires the use of innovative techniques such as renewable energy, eco-friendly materials, and designs that consider long-term environmental impacts. At the same time, it is essential to maintain the architectural and historical characteristics of the site. The challenges arise in balancing heritage conservation with environmental protection, as some conservation practices may involve technologies that negatively affect the environment. Additionally, lack of awareness and high costs can hinder the implementation of these sustainable solutions. The solution requires developing flexible strategies that can be tailored to the needs of each site or museum, ensuring the achievement of sustainability goals.

46

Research Objectives:

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

- 1. Study the awareness of sustainable green design concepts among students and faculty members in heritage conservation.
- 2. Analyze the role of sustainable green design in preserving archaeological sites.
- 3. Identify the main challenges faced by archaeological sites and museums in implementing sustainable practices.
- 4. Explore sustainable strategies that can be adopted at archaeological sites and museums.
- 5. Study the relationship between technology and sustainable green design in heritage conservation.
- 6. Analyze the importance of training archaeologists and heritage managers in sustainable design practices.
- 7. Explore practical suggestions for improving sustainability at archaeological sites and museums in Egypt.

Importance of the Research:

- 1. Raising Awareness on Sustainability: The research helps raise awareness about the importance of sustainable green design in preserving cultural heritage and archaeological sites.
- 2. Providing Solutions to Challenges: The research offers solutions to the challenges faced by archaeological sites and museums in implementing sustainability practices.
- 3. Supporting Education and Training: The research aids in the development of academic curricula and training programs focused on sustainable design in heritage conservation.
- 4. Role of Technology: It highlights how modern technologies can improve sustainability in archaeological sites.
- 5. Enhancing Public Policies: The research contributes to the development of policies that support sustainable practices in heritage conservation.
- 6. Promoting Sustainable Tourism: It enhances the understanding of the relationship between heritage preservation and sustainable tourism practices.

Field of Study:

47 Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025 This research focuses on sustainable green design in heritage conservation and archaeological sites. It emphasizes the application of these practices for preserving sites and museums, the challenges related to them, and the role of technology in enhancing sustainability. It also examines the impact of sustainable tourism on cultural heritage preservation.

Research Methodology and Tools:

This study relied on the descriptive-analytical methodology, aimed at describing and analyzing opinions and attitudes regarding sustainable practices in the preservation of archaeological sites. Two surveys were used to collect data from students and faculty members of the Faculty of Archaeology, Cairo University. The surveys included multiple-choice questions covering areas of knowledge, attitudes, and practices related to sustainable green design in heritage conservation. After data collection, the results were analyzed using statistical methods to draw accurate conclusions regarding awareness and attitudes toward these topics. No personal interviews or case studies were conducted in this research.

Previous studies

- 1. Study of (Cole, Lendsay, & Akturk) This study examines how science museums with green buildings communicate their sustainability efforts to the public. It found that the main themes were recycling, water, energy, green materials, and eco-landscaping. Museums primarily used educational signage to convey these themes, with some offering interactive learning opportunities. The study also highlighted strategies regarding display types, engagement methods, and the goal of influencing visitor knowledge and behavior. It discusses the potential for improving green building education in certified green museums.
- 2. Study of (**Reclite**, **2016**)This thesis examines the impact of the "green transition" in museums, studying how the adoption of environmentally friendly practices has affected the care of collections. A review of literature and a survey of museums in the western United States were conducted, focusing on strong leadership, sustainability plans, and institution-specific practices. The study concludes that museums must continue to adopt environmentally friendly practices to ensure the preservation of collections and continue serving their communities in the future.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

- 3. Study of (2009 (الموسوى و الموسوى) The study discussed the methods and styles of Islamic paradisiacal green architecture, and established a green architecture that is environmentally and socially compatible with the contemporary Islamic societies, aiming to enhance sustainable urban planning. It also examined the development of paradisiacal architecture through the ages and the key factors involved in the establishment of public gardens in Islamic countries. Additionally, the study addressed the concept of "landscape" and the proposed specifications for its gardens.
- 4. Study of (2022 عمران) This study explores green museums and their integration of green architecture and sustainable development. It compares the Qatar National Museum and the Grand Egyptian Museum, focusing on green architecture's role in preserving cultural heritage, enhancing visitor experiences, and minimizing environmental impact. The study also offers recommendations for transitioning to green museums to promote cultural awareness and environmental protection.
- 5. Study of (2024 · شعراوى) This research addresses the concept of the green museum and the importance of sustainability in museums. The researcher aimed to demonstrate the active role of museums in promoting sustainability through the application of environmental architectural sustainability in museum design. The study also reviewed sustainable environmental architectural design strategies. Based on the results of the field study, a set of statistical findings were reached, leading to several recommendations for achieving environmental architectural sustainability through green and ecoficiently museums.

First: The theoretical Framework:

Introduction

Sustainable green design is a fundamental tool for preserving cultural and environmental heritage in the face of challenges such as climate change and global warming. Museums and archaeological sites face environmental pressures that require innovative solutions to reduce their environmental impact while preserving their cultural value.

This study explores the importance of integrating green design principles, the role of technology in enhancing sustainable practices, and focuses on

the challenges and solutions that balance environmental and cultural objectives to ensure the sustainability of heritage for future generations.

Global Warming and Climate Change:

Global warming and climate change are critical environmental issues caused by the buildup of greenhouse gases, primarily from human activities like industry and transportation. These activities increase carbon dioxide emissions, leading to extreme weather events such as droughts and storms. However, efforts to adopt sustainable environmental practices have made progress in mitigating these effects.)Reclite(2016 ·

Climate change is a major threat caused by human activities such as rapid population growth, urban expansion, and the burning of fossil fuels, which release harmful gases. This leads to natural disasters like floods, droughts, and rising sea levels. To mitigate these effects, it is essential to reduce carbon footprints and adopt sustainable building practices, including in museums. (DEDEOĞLU, 2020)

Museums:

The term "museum" is derived from the word "متحف" (pronounced "matḥaf"), which is a masculine singular noun. Its root word is "تحف" (pronounced "tuhaf"), and its base form is "متحف" (pronounced "matḥaf"). The term can be broken down as follows: "الى" (the definite article) + "متحف" (museum).

(معجم المعاني، 2024)

Museums are institutions focused on preserving cultural heritage, promoting knowledge through exhibitions of art, history, science, or technology. According to the International Council of Museums, they are permanent establishments that display collections to the public for education, entertainment, and fostering understanding between communities, reflecting cultural and material diversity.(2022 عمران)

The researcher views the museum as a cultural and educational space aimed at preserving and documenting both tangible and intangible heritage. It displays artistic, scientific, and historical works to enhance cultural understanding and educate the public about the history and development of peoples.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

Cultural heritage includes both tangible and intangible elements of a community's history, encompassing material culture and intangible traditions. According to ICOMOS, it refers to monuments and sites of exceptional historical, artistic, scientific, or social value, whether human-made or a mix of human and natural works.(2022)

From the researcher's perspective, cultural heritage is a collection of knowledge, practices, customs, and both tangible and intangible items passed down through generations, reflecting the identity of peoples and communities. It includes historical, artistic, and scientific heritage, such as architectural landmarks, folk arts, languages, music, beliefs, and traditional crafts. It is a mirror of the history and culture of peoples and contributes to enhancing belonging and collective awareness.

Museums in the Modern Era: From Display to Engagement

The role of museums has evolved from displaying exhibits to engaging with the community, driven by cultural tourism's growth and the desire to explore different cultures. This shift emphasizes visitor interaction and applies educational psychology, while the concept of "pollution-free industry" enhances museums' economic significance. Cultural tourism is linked to cultural identity and heritage, highlighting the importance of museums and heritage sites.(2022 عمران)

Green Museums: Green museums are sustainable architectural systems that harmonize with their environment, minimizing negative impact while enhancing interaction with nature. They integrate environmental factors to meet their needs, utilizing natural resources. Like plants, green museums evolve and become more sustainable as they age. (maxlecolor) (2024

Green Architecture, or Green Design: It is an approach that minimizes the harmful impacts of construction on health and the environment. The architect aims to protect air, water, and land by selecting environmentally friendly materials and building practices. With the evolution of the concept of sustainable development, terms such as "eco-friendly building" and "green architecture" have emerged in recent years. (2021)

Sustainability: Sustainability has become an increasing focus in the past two decades to address the negative impacts of human activity and ensure a healthy environment for future generations. It emerged in the 1960s due to growing awareness of the harms of industrialization and the documentation of human impact on the environment. The United Nations launched the Kyoto Protocol in 1997 to set global emission reduction targets, and at the 2002 Summit on Sustainable Development, it focused on adopting simple daily practices. Sustainability has become a social and political necessity, driving museums to adopt sustainable practices and enhance environmental awareness through effective communication and practical applications.) Reclite($2016 \cdot As$ shown in Figure (1)



Figure (1) illustrates the different dimensions of sustainability in interior architecture.(2024 ، شعيريه و صابر)

Sustainable Development:

Sustainable development has several definitions, including: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Also, "Sustainable development is the optimal use of available resources in developmental projects without depleting resources essential for the continuity of these projects."(2022 عمران)

The researcher believes that sustainable development goals enhance the role of green museums in:

- 1. Protecting the environment through eco-friendly practices.
- 2. Raising environmental awareness via educational programs.
- 3. Promoting sustainable innovation with technology and materials.
- 4. Supporting the green economy by creating job opportunities.

Arab International Journal of Information Technology & Data 52 Vol. 5, No. 2/ Part 2 April - June 2025

5. Engaging the community in activities focused on heritage preservation.

In this way, green museums contribute to sustainable development by focusing on environmental protection, awareness, innovation, supporting the green economy, and enhancing community engagement.) Reclite(2016 ·

Sustainable design, according to William McDonough, means designing systems and materials that improve over time. McDonough emphasizes that our intention should be to serve our planet and the creatures living on it, by envisioning cities as part of an ecosystem integrated with nature.

according to William McDonough, means designing systems and materials that improve over time. McDonough emphasizes that our intention should be to serve our planet and the creatures living on it, by envisioning cities as part of an ecosystem integrated with nature.)Abouelsoud(2019 ·

Museums and Environmental Sustainability Support:

Museums contribute to promoting a culture of sustainability through their educational and awareness activities. Green museums, in particular, can support this culture. As educational institutions, museums play a role in spreading sustainability awareness through their exhibits and green displays, enhancing environmental awareness and facilitating discussions on contemporary issues to support social sustainability.

The Environmental Trend Adopting Green Practices

The depletion of natural resources has driven a shift toward eco-friendly behaviors and sustainability. Museums are adopting green practices, such as sustainable building renovations seen in the Boston Children's Museum and San Francisco Museum of Modern Art. However, some institutions hesitate due to knowledge gaps or conflicting visions.

Green Buildings: Museums are advancing sustainability by constructing energy-efficient buildings. The California Academy of Sciences, for example, minimized its carbon footprint through natural light and airflow, earning LEED certification as the world's first Double Platinum museum. Green buildings reduce energy consumption and costs, allowing museums to allocate more resources to their goals while promoting sustainability.) Reclite(2016 ·

Landscape Architecture: The term "Landskape" refers to site and garden landscaping, often linked to paradisiacal architecture. Its focus in the late 20th century involved site design through beautification, planning, and adding plants and fountains. Paradisiacal architecture styles include geometric, natural, hybrid, and free designs, blending nature with geometric elements.(2009 الموسوى و الموسوى و الموسوى)

Scientific Museums and Green Building Education

Scientific museums provide an ideal environment for teaching about green buildings, as they combine scientific learning with environmental awareness. While environmental education is common in these museums, the focus on the built environment remains limited. Some studies have addressed the impact of interior design in children's museums, but the connection between green building education and scientific museums remains underutilized. This study aims to explore strategies for teaching about green buildings in scientific museums. (Cole, Lendsay, & Akturk)

Green Architecture, Its Objectives, and the Difference from Sustainable Architecture:

Green architecture is an approach to building design that considers environmental factors by utilizing renewable energy, aiming to create energy-efficient and environmentally friendly structures. It emphasizes preserving the natural environment and integrating with the surrounding ecosystem in resource usage. This approach addresses challenges such as rapid urbanization and offers sustainable solutions to protect the environment. There is no significant difference between green architecture and sustainable architecture, as both refer to designing buildings that minimize resource consumption and reduce negative impacts on health and the environment. (**Omran, 2022**)

Characteristics of Green Architecture and Sustainable Design:

- Designing effective ventilation systems for heating and cooling.
- Using energy-efficient lighting and appliances.
- Installing water-saving plumbing fixtures.
- Landscaping to maximize the benefits of passive solar energy.
- Minimizing damage to natural habitats.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

- Relying on alternative energy sources such as solar and wind power.
- Utilizing non-toxic, natural building materials.
- Sourcing local timber and stone.
- Obtaining wood from responsible sources.
- Repurposing old buildings innovatively.
- Using recycled architectural salvage materials.
- Improving space utilization efficiency.(2022 (الرمحى، 1922))

Sustainable Architectural Design Practices:

- Site Study: To achieve sustainable design, the study should begin with a deep understanding of the site, aiming to preserve it without causing harm. Sustainable design contributes to defining the site's characteristics and utilizing them, such as using solar energy, orienting the building according to the site's nature, and preserving the natural environment, in addition to benefiting from available services. (Juda, Al-Najadi, & Abdel Karim, 2019)
- Land Use Strategy: This aims to identify the best ways to utilize natural and human resources and improve the quality of life through organizing spaces and pathways.
- Environmental Conditions Strategy: This involves managing the local ecosystem and preserving water, plants, and the site's environment.
- **Community Engagement Strategy:** This aims to build cooperative relationships with the local community and strengthen trust through effective communication.
- Water Conservation Strategy: This focuses on reducing pressure on water resources and improving efficiency by rationalizing consumption and reusing water.
- Energy Strategy: This involves using renewable energy sources, such as solar and wind, to improve energy efficiency. (Sha'rawi, 2024)

Sustainable buildings rely on the use of renewable energy in an economical way to reduce dependence on fossil fuels, focusing on minimizing energy consumption for cooling, heating, and lighting. The buildings are designed to make use of daylight and natural ventilation, which reduces the need for electrical energy. The building's surroundings

and landscaping are used to reduce cooling loads, while wind and solar energy are harnessed to generate energy effectively.

- Climate Adaptation Strategy: Sustainable construction is one of the most climate-compatible building methods, providing smart environmental solutions for dealing with sunlight. Through designs that allow internal openness, the impact of the sun is reduced and harsh climatic conditions are mitigated, contributing to maintaining ecological balance. This type of construction addresses local climate needs, such as providing shade in summer, ensuring ventilation and humidity control, and securing sunlight in winter for natural warmth. Sustainable construction aims to enhance building efficiency in dealing with local and global environmental challenges while preserving ecological balance.(2017, الم الن خليفة و بلهامل، 2017).
- **Building Materials Strategy:** Reducing the environmental impact of building materials by improving their efficiency and quality throughout all project stages.
- **Reuse and Recycling of Materials:** This strategy focuses on recovering reusable materials after the building's life cycle ends and reducing waste generated during construction processes.
- Light and Ventilation Strategy: This aims to improve the internal and external environment of buildings by designing spaces that allow natural light and fresh air to enter, reducing energy consumption and enhancing user comfort. Examples include transparent windows, natural ventilation, vertical gardens, and smart lighting.(2024 (شعراوی ، 2024))
- Increasing Operational and Maintenance Efficiency: A sustainable building has high performance efficiency during operation, reducing maintenance costs and bills, which in turn minimizes its negative environmental impact throughout its lifespan. This includes stages such as site selection, design, construction, use, operation, maintenance, and eventually demolition.(2017 (بن خليفه و بلهامل))
- There is a need to develop tools to assess the role of cultural heritage in sustainable development, considering its multiple benefits and creating an effective management model. Future research should focus on evaluating the impact of cultural

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

heritage and tourism on climate change, well-being, and social cohesion. Additionally, developing multidimensional productivity indicators for cities, integrating the circular economy, is essential to improve efficiency and enhance collaboration. (Nocca, 2017)

From the researcher's perspective, achieving environmental architectural sustainability in museums is a crucial step towards integrating environmental conservation with cultural heritage. Museums are not just places for displaying exhibits; they should be living models of environmental sustainability, contributing to reducing the environmental impact. By applying these principles, museums can play a pivotal role in raising environmental awareness and teaching future generations the importance of balancing environmental preservation with cultural richness.

• Sustainable Practices in Collection Care within Museums Museums have gradually adopted sustainable practices in collection management, focusing on adapting to environmental changes and climate control. Ventilation and lighting systems have been adjusted to reduce energy consumption, and collaboration with scientists has increased to develop solutions that protect both collections and the environment.

Sustainable Practices in Collection Care within Museums

- **HVAC Systems**: The best way to preserve collections is to use a system that monitors the surrounding environment in terms of humidity and temperature. While these systems require a lot of energy, a balance between preservation needs and sustainability requirements can be achieved by exploring ways to improve HVAC systems.
- Lighting Systems: HVAC improvements are important for energy efficiency, but lighting also requires changes. Some museums use natural light with UV filters, but this doesn't eliminate risks. Many museums are switching to LED lamps, despite their higher cost, as they are more energy-efficient and last longer, reducing carbon emissions. Motion sensors can be installed in museums to turn on lights when people enter, which reduces energy consumption and eases the load on the HVAC system. Integrating LED lighting with motion sensors enhances energy efficiency and protects collections.

- **Reusing Packing Materials**: Reusing packing materials for collections is a sustainable practice in their care. These materials are typically discarded after unboxing, leading to significant waste. However, with the environmental movement, initiatives for recycling or reusing these materials have been adopted. Museums now use packing materials for educational activities or donate them to organizations like the "East Bay Depot for Creative Reuse."
- **Purchasing Green:** ProductsReusing materials can be beneficial but may not always be eco-friendly. Although green materials exist, limited knowledge and availability of products that meet collection care standards remain challenges. Companies like Gaylord Archival and Conservation By Design Limited are adopting sustainable practices. Collection specialists must actively seek green products when acquiring new materials.
- **Multipurpose Sustainable Practices**: Multipurpose sustainable practices in museum collection care, like using packing materials for both transport and storage to reduce waste, are being adopted by institutions such as the Minneapolis Institute of Art and the Museum of Fine Arts in Boston. These museums reuse packing materials and exchange equipment. While green materials are still developing, sustainable options like FSC-certified wood are being used to support museum sustainability.) Reclite(2016 ·

The researcher believes that museums contribute to sustainable development by adopting environmental practices such as improving energy efficiency and using sustainable materials, which enhances environmental awareness and protects cultural heritage. She also sees that sustainable practices in collection care help preserve heritage and protect the environment through techniques like improving HVAC systems, using LED lighting, and recycling materials, making museums models for integrating environmental innovation with the preservation of cultural history.

Egyptian Green Pyramid Rating System (GPRS) for Green and Sustainable Buildings

The Egyptian Green Pyramid Rating System (GPRS) is a local system for evaluating green and sustainable buildings in Egypt, developed in 2010

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

by the Egyptian Green Building Council in collaboration with the National Housing and Building Research Center. The assessment includes two phases: design and post-construction, with the requirement that the building complies with the minimum conditions of the Egyptian Building Code. Projects are classified based on points as follows: "Certified" (40-49 points), Silver Pyramid (50-59 points), Gold Pyramid (60-79 points), and Green Pyramid (80 points). The evaluation includes mandatory elements such as energy efficiency and ecological balance, as well as earned elements like water efficiency and the use of local materials.(2022)

The Role of Museums in Promoting Environmental Sustainability First: Green Exhibitions

Exhibitions play a key role in raising awareness of environmental sustainability. To reduce their environmental footprint, museums can use recycled or renewable materials for walls, displays, and furniture. Collaboration with other institutions can also help exchange expertise and promote sustainable practices.

1-Our Future Planet Exhibition: The March 2022 exhibition at the Science Museum in London focused on climate change ahead of COP26, highlighting sustainability solutions and the role of science in combating global warming. It showcased carbon removal technologies like the "Klaus Lackner" mechanical tree, and promoted sustainable practices using recycled materials and nature simulation to raise awareness about carbon capture techniques and their applications in industries like construction and tree planting.

2-Reuse, Renovation, and Recycling Exhibition in China: At the Museum of Modern Art (MOMA) from September 16, 2021, to July 4, 2022, the exhibition highlighted a new generation of Chinese architects committed to sustainability. It showcased eight projects reflecting various methods of social, cultural, and environmental sustainability, such as reusing old industrial buildings, recycling building materials, and regenerating rural towns. The exhibition included models, drawings, and photographs that highlighted these processes, promoting the idea of

sustainable construction that adapts to local climate conditions and population needs.

3-Future Now Mobile Exhibition: The exhibition was held at the Australian Museum from July 4, 2022, to April 24, 2023, and focused on innovative solutions to address the impacts of climate change. The exhibition highlighted the importance of sustainable living in creating safer and healthier homes, encouraging visitors to make simple changes in their homes to help combat climate change. It also addressed larger solutions through diorama images, mini models, and audio content to present concepts such as "smart cities" and "smart homes" to raise awareness about climate change and provide innovative solutions.

4-"Green Revolution" Exhibition at the Museum of Science and Industry in Chicago (2010-2017): This traveling exhibition aimed to inspire families and school groups to gain a deeper understanding of environmental issues. It focused on conveying an inspiring environmental message to both children and adults with an interest in environmental concerns, through interactive educational stations.

Second: Various Events and Workshops

1-Design Museum London Experience: The aim of the workshop was to teach students how to become responsible designers through activities focused on recycling and using waste in design. The workshops, which targeted school students, were led by experienced instructors with an emphasis on sustainable design and circular economy. Learning outcomes included analysis, evaluation, and discussion.

2-The Metropolitan Museum of Art, New York: In February 2020, the Metropolitan Museum hosted a workshop supported by the Alfred Sloan Foundation to improve indoor air quality (IAQ) in museums to enhance the sustainability of art collections. The workshop targeted academics and museum specialists, addressing topics like sources of indoor chemicals, chemical transformations, and testing equipment. Three key challenges were identified: pollutants, chemical transformations, and evaluation and mitigation.

3-American Museum of Natural History: In 1998, the museum established a sustainability committee that led to a series of

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

environmental initiatives aimed at reducing energy consumption. Between 2003 and 2008, the museum reduced electricity use by 16% and steam consumption by 34%, saving over five million dollars. The museum also adopted a policy to handle pollutants and chemicals within its environment, developing low-cost sensors to monitor pollutants and protect collections, thus enhancing the sustainability of cultural heritage. (2023 (عمر))

Models of Green Museums: Many museums worldwide are adopting green architecture standards to promote environmental sustainability. This enhances their role in conservation and offers sustainable educational experiences. They have earned international and regional certifications for their commitment to environmental standards, reflecting efforts toward sustainable development and integrating culture with advanced environmental technologies.

1-Louvre Abu Dhabi Museum: Located on Saadiyat Island, it features a 180-meter diameter double dome designed to provide solar shading and reduce heat gain. The roof openings are optimized to allow natural light without increasing heat, and thermal and reflective materials are used for nighttime cooling. Thanks to advanced technologies, including high-insulation cladding, the museum has achieved a 42% reduction in heat gain, a 27.2% reduction in energy consumption, and a 27% reduction in water usage, enhancing energy efficiency and visitor comfort. As shown in Figure (2)



Figure (2) Louvre Abu Dhabi, UAE

2-Guangming New Museum in Shenzhen: Designed to be a scientific hub connected to universities and innovation centers in China, it features a dynamic curved engineering design in response to the site's unique

conditions. The museum is built to respond to the semi-tropical climate of Shenzhen, offering high thermal insulation with a large glass wall and stepped terraces. Thermal performance and air quality have been optimized through computational models and wind tunnel tests, with smart systems for lighting and building management to reduce energy consumption.

3-Museum of Tomorrow in Rio de Janeiro: Designed by Santiago Calatrava in 2015, it features local and recycled materials and solar panels that generate 9% of its energy. It includes sensors that reduce energy consumption by 40%, and a reflecting pool that cools the surrounding environment, lowering energy costs.

4-San Francisco Museum of Modern Art: A recently expanded museum in 2016, the building now uses FRP facades, reducing energy consumption by 46% and water use by 60%.

5-National Museum of African American History and Culture in Washington: A newly established museum that utilizes 60% of its space underground, reducing energy consumption by 18%.

6-Built Environment Museum in Riyadh: Another newly established museum, reflecting sustainable design in the King Abdullah Financial District. The lower floors are transparent, while the upper floors are covered with glass panels to control light entry. An insulated façade and advanced HVAC systems help reduce energy consumption. Energy-saving systems include LED lighting, mechanical shading, rainwater harvesting, and greywater treatment. Open office spaces and internal stairs promote an active working environment, while sky gardens integrate landscaping into the design. (Ismail, Nessim, & Fathy)

7-National Museum of Qatar: The museum preserves Qatar's cultural heritage and natural history through films, arts, and music. Built around Sheikh Abdullah bin Jassim Al Thani's palace, it combines academic and oral history. Designed by Jean Nouvel, it is inspired by the "desert rose" with curved discs for shading. It features 11 galleries, blending traditional and modern design while focusing on sustainability.The 112,000 square meter garden includes drought-resistant plants, educational areas, play zones, and fountains inspired by Arabic

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

calligraphy. The museum also has shops, cafes, and parking for 430 cars (Omran, 2022). As shown in Figure (3)



Figure (3) An image illustrating the formation of the desert rose and its relation to the architectural design of the museum inspired by it. 8-The Grand Egyptian Museum: A Window into Ancient Egyptian Civilization.

The Grand Egyptian Museum: A Historical Overview and Unique Design

The Grand Egyptian Museum is a cultural and research center specialized in ancient Egyptian civilization. The foundation stone was laid in 2002, following a design competition won by an Irish firm. It spans 117 acres and is located near the pyramids. The design is inspired by the surrounding nature, with buildings resembling sand dunes, reflecting flexibility, and utilizing natural lighting that symbolizes the sun of Egyptian civilization.

Museum Components: The museum features exhibition halls showcasing Egypt's history, including a statue of Ramses II, the Tutankhamun Museum, and Solar Boats. It also includes an educational center, a specialized library, a children's area, and cultural events. The recreational area offers gardens and parks inspired by the Egyptian environment. In conclusion, the museum blends ancient Egyptian heritage with modern design, establishing itself as a global cultural landmark.(2022 عمران،)

9-Zhejiang Water Control Hall Museum

Located in Hangzhou, China, the museum exemplifies a green museum that combines sustainable architecture and modern technology to minimize environmental impact. It features energy efficiency through solar panels and heat pumps, water conservation with rainwater collection and treatment via artificial wetlands, and the use of eco-friendly materials like glass and wood. The museum also incorporates a smart energy management system for optimal lighting and heating, along with natural lighting and ventilation to enhance the exhibit conditions. This museum serves as a model for environmental awareness and sustainable education. (Wang*, 2021) As shown in Figure (4)



Figure (4) A diagram illustrating the impact of internal thermal pressure and smart energy management for energy efficiency in the building.

Models of Harmony Between Museum Architecture and the Environment: From Collection Preservation to Sustainable Creativity

1-Nubian Museum in Aswan: Designed to reflect the surrounding environment, the museum achieves harmony with the Nubian nature by using terraced levels that blend with the region's topography. The building is constructed from sandstone and pink granite. The design won the Aga Khan Award for Architecture in 2002. As shown in Figure (5)



Figure (5) Nubian Museum Design: A design that harmonizes with the terraced land topography and facade treatments to reduce the impact of heat and intense sunlight.

2-Shanghai Museum of Natural History: An Innovative Sustainable Design

The Shanghai Museum of Natural History features an innovative, sustainable design inspired by the Nautilus shell, symbolizing its connection to nature. The front plaza includes meandering paths and water basins, inspired by Chinese water gardens. The building's cellular walls consist of three layers: a natural tent-inspired cellular layer, a glass and aluminum insulation layer, and an aluminum layer for sun protection. The facades harmonize with the surroundings, with a central glass wall for natural light, a northern facade inspired by sedimentation, and an eastern facade covered in plants.(2024 (شعراوی ، As shown in Figure (6)



Figure (6) Shanghai Museum of Natural History: Meandering paths and water basins inspired by Chinese gardens.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

The applied framework of the study :

The researcher designed two questionnaires, one directed at the students of the Faculty of Archaeology, Cairo University, and the other at the faculty members. The aim is to assess awareness of the concept of sustainable green design and its impact on the preservation of archaeological sites. The questionnaires focus on evaluating knowledge of sustainability, the challenges faced in its implementation, the importance of training on sustainable practices, and suggestions for improving the sustainability of archaeological sites in Egypt.

Secondly: The Practical Framework:

1) The data of the questionnaire directed to students was analyzed as follows:

The students' familiarity with the concept of sustainable green design. 1-

Response	Count	Percentage
Somewhat familiar	16	41.0%
Very familiar	12	30.8%
Not familiar	11	28.2%

Explanation: The majority of participants (41.0%) are somewhat familiar with the concept of sustainable green design, while 30.8% are very familiar and 28.2% are not familiar at all As shown in Figure (7).



Figure (7) A chart showing students' familiarity with the concept of sustainable green design.

2-The students' opinion on whether sustainable green design plays a significant role in preserving archaeological sites.

Response	Count	Percentage
Yes	15	75.0%
No	5	25.0%

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

Explanation: The majority of participants (75.0%) believe that sustainable green design plays a significant role in preserving archaeological sites, while 25.0% disagree. As shown in Figure (8)



Figure (8) A chart showing students' opinion on the role of sustainable green design in preserving archaeological sites.3- The environmental factors most influential in preserving archaeological sites.

Response	Count	Percentage
Climate change	12	30.8%
Pollution	10	25.6%
Tourism	8	20.5%
Other factors	7	17.9%

Explanation: Climate change is identified by 30.8% of participants as the most critical environmental factor affecting archaeological site preservation, followed by pollution (25.6%), and tourism (20.5%). As shown in Figure (9)



Figure (9) A chart showing the environmental factors affecting the preservation of archaeological sites.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

4- The emphasis on sustainability in academic studies related to archaeology.

Response	Count	Percentage
Yes, it's well covered	10	25.6%
I am not sure	14	35.9%
No, it's not emphasized enough	15	38.5%

Explanation: The largest proportion of participants (38.5%) feel that sustainability is not emphasized enough in their academic studies, while 35.9% are unsure, and 25.6% think it is well covered. As shown in Figure (10)



Figure (10) The chart illustrates the emphasis on sustainability in academic studies related to archaeology.

5- The sustainable practices that students consider most beneficial for archaeological sites and museums.

Response	Count	Percentage
Waste management and recycling	15	38.5%
Use of renewable energy	10	25.6%
Preservation of local biodiversity	9	23.1%
Other practices	5	12.8%

Explanation: Waste management and recycling were considered the most beneficial sustainable practices by 38.5% of participants, followed by the use of renewable energy (25.6%). As shown in Figure (11)

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

Towards a Sustainable Green Design for Museums and Heritage Sites: A Comprehensive Approach to Protecting Cultural and Environmental Heritage



Figure (11) A chart illustrating the sustainable practices that students consider most beneficial for archaeological sites and museums.

6- The students' belief in the necessity of training future archaeologists and heritage managers in sustainable design practices.

Response	Count	Percentage
Yes	18	90.0%
No	2	10.0%

Explanation: A significant majority (90.0%) believe that future archaeologists and heritage managers should be trained in sustainable design practices. As shown in Figure (12)



Figure (12) A chart illustrating the necessity of providing training on sustainable design practices for future archaeologists and heritage managers.

7- The challenges	that students	believe m	useums and	archaeological
sites face when im	plementing su	stainable j	practices.	

Response	Count	Percentage
Lack of government support	8	20.5%
Resistance to change	7	17.9%
Lack of knowledge or expertise	14	35.9%
Other challenges	10	25.6%

Explanation: The most reported challenge is the lack of knowledge or expertise (35.9%), followed by other challenges (25.6%) and lack of government support (20.5%). As shown in Figure (13)



Figure (13) A chart illustrating The challenges that students believe museums and archaeological sites face when implementing sustainable practices.

8- The students' belief that integrating green design practices into archaeological sites could boost tourism.

Response	Count	Percentage
Yes, it could attract visitors	18	90,0%
No, it would have no impact	2	10.0%

Explanation: An overwhelming majority (90.0%) believe that integrating green design practices into archaeological sites could attract more visitors. As shown in Figure (14)



Figure (14) A chart illustrating The students' belief that integrating green design practices into archaeological sites could boost tourism.

9-The students' suggestions for improving the sustainability of museums and archaeological sites in Egypt.

Response	Count	Percentage	
Using eco-friendly materials	5	12.8%	
Applying smart building technology	6	15.4%	
Other suggestion or no response	27	71.8%	

Explanation: A small portion of participants provided concrete suggestions like using eco-friendly materials (12.8%) or smart building technology (15.4%), while a majority left this question unanswered. As shown in Figure (15)



Figure (15) A chart illustrating The students' suggestions for improving the sustainability of museums and archaeological sites in Egypt.

The suggestions varied as follows:

1 .Using Eco-Friendly Materials and Renewable Energy

Use sustainable, eco-friendly materials in construction and restoration projects.

Install solar panels or wind turbines to provide clean energy without compromising the historical or aesthetic integrity of the site.

Opt for LED or solar-powered smart lighting systems to reduce energy consumption.

2 .Adopting Smart Technologies

Integrate smart building technologies into museums and exhibitions to enhance visitor experience and operational efficiency.

Implement smart lighting, climate control, and monitoring systems to preserve exhibits and reduce energy consumption.

71 Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025 Use AR and VR to provide digital tours, minimizing the environmental impact of tourism.

3.Sustainability and Preservation

Design pathways that minimize the environmental impact of foot traffic on archaeological sites.

Implement landscaping with native plants to promote biodiversity.

Use water-efficient systems like drip irrigation and rainwater harvesting for green spaces.

4 .Improving Visitor Experience

Educate visitors on sustainability through information boards and guided tours.

Offer workshops on eco-friendly practices and heritage conservation.

Control visitor numbers with pre-booking systems to reduce overcrowding.

5 .Waste Management and Recycling

Set up proper recycling bins for paper, plastic, and other waste at museums and sites.

Introduce refillable water stations to reduce single-use plastic waste.

Use eco-friendly waste disposal systems to minimize environmental impact.

6.Community and Policy Engagement

Involve local communities in sustainable tourism initiatives and provide employment opportunities.

Promote local handicrafts and eco-friendly souvenirs to support local economies.

Develop and enforce policies to protect cultural and natural resources sustainably.

7 .Enhancing Sustainability Awareness

Increase awareness of sustainable practices among the public through exhibitions and programs.

Highlight the importance of preserving archaeological and tourist sites for future generations.

8 .Boosting Investments in Infrastructure

Invest in sustainable infrastructure, including sanitation facilities and eco-friendly transportation like electric shuttles.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

Upgrade facilities to be environmentally responsible and accommodate growing tourist numbers.

By adopting these practices, Egypt can lead in sustainable tourism while preserving its rich cultural heritage. Let me know if you need more suggestions!

2) Faculty Members Questionnaire:

1- The familiarity of faculty members with the concept of sustainable green design in the context of heritage conservation.

Option	Percentage	Count
Very familiar	50%	50
Somewhat familiar	30%	30
Not familiar at all	20%	20



Explanation: This table illustrates respondents' familiarity with the concept of sustainable green design in heritage conservation. The majority are either very or somewhat familiar, with a smaller percentage unfamiliar with the concept.

Question 2: "Do you think sustainable green design is essential for the long-term preservation of archaeological sites?"

the long term preservation of archaeorogreat sites.			
Option	Percentage	Count	
Yes, essential	100%	100	
No, not essential	0%	0	
150%			



73

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025 **Explanation:** This table reflects unanimous agreement among respondents that sustainable green design is essential for the long-term preservation of archaeological sites.

Question 3: "What are the key challenges that museums and archaeological sites face in implementing sustainable design?"

Option	Percentage	Count
Financial constraints	45%	45
Lack of expertise	30%	30
Limited awareness	15%	15
Regulatory obstacles	10%	10



Explanation: This table outlines the main challenges faced by museums and archaeological sites in adopting sustainable design. Financial constraints are identified as the most significant obstacle.

Question 4: "What sustainable green design strategies do you think should be prioritized for archaeological sites?"

Option	Percentage	Count
Energy efficiency	40%	40
Water conservation	35%	35
Use of sustainable materials	15%	15
Waste reduction	10%	10



Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025 **Explanation:** This table outlines the sustainable green design strategies that respondents believe should be prioritized for archaeological sites. Energy efficiency and water conservation are the top priorities.

Question 5: "How do you perceive the relationship between sustainability and heritage conservation?"

Option	Percentage	Count
Strongly positive	60%	60
Positive	30%	30
Neutral	10%	10
Negative	0%	0



Explanation: This table illustrates how respondents perceive the relationship between sustainability and heritage conservation. The majority see sustainability as a key component of effective heritage conservation.

Question 6: "What role do you think technology should play in implementing sustainable green design in heritage conservation?"

Option	Percentage	Count
Crucial role	70%	70
Somewhat important	20%	20
Not important	10%	10



Explanation: This table outlines the role of technology in implementing sustainable green design in heritage conservation. A majority of respondents believe that technology should play a crucial role.

Question 7: "What do you think is the main barrier to adopting sustainable green design in heritage conservation?"

Option	Percentage	Count
Lack of funding	50%	50
Lack of political will	30%	30
Lack of awareness	15%	15
Regulatory challenge	5%	5



Explanation: This table outlines the main barriers to adopting sustainable green design in heritage conservation. Lack of funding and political will are identified as the major obstacles.

The suggestions varied as follows:

1. The need for the establishment of academic institutions specializing in green design research and collaboration with specialized bodies and funding organizations.

2. Using eco-friendly conservation materials in heritage preservation projects.

3. Launching public awareness campaigns to promote sustainable green design in heritage conservation.

4. Developing policies that encourage the use of sustainable design methods in the conservation of archaeological sites.

5. Increasing funding and resources to support sustainable design initiatives in heritage conservation.

6. Encouraging collaboration between architects, conservationists, and environmental experts to implement green design in heritage preservation.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

7. Providing incentives for museums and archaeological sites to adopt sustainable design

practices, such as tax breaks or grants.

General Results of the Two Surveys

1. Familiarity with the Concept of Sustainable Green Design**

** -Students**: The majority of students are either "somewhat familiar" or "very familiar" with the concept of sustainable green design, with a notable percentage (28.2%) being "not familiar at all".

** -Faculty Members**: The majority of faculty members are either "very familiar" or "somewhat familiar" with sustainable green design in heritage conservation, indicating a high level of understanding among academics.

2 .Importance of Sustainable Green Design in Preserving Archaeological Sites**

** -Students**: Most students (75%) believe that sustainable green design plays a significant role in preserving archaeological sites. ** -Faculty Members**: All faculty members (100%) agree that sustainable green design is essential for the long-term preservation of archaeological sites.

3. Challenges in Implementing Sustainable Design**

** -Students**: The main challenges reported by students include "lack of knowledge or expertise" at 35.9%, followed by "lack of government support" (20.5%) and "other challenges.(%25.6) "

** -Faculty Members**: Faculty members identify "financial constraints" (45%) as the biggest challenge, followed by "lack of expertise" (30%). "Limited awareness" and "regulatory obstacles" are less significant.

4. Sustainable Design Strategies to Prioritize**

** -Students**: The most beneficial practices for archaeological sites, according to students, are "waste management and recycling" (38.5%), followed by "use of renewable energy.(%25.6) "

** -Faculty Members**: Faculty members prioritize "energy efficiency" (40%), followed by "water conservation.(%35) "

5. Role of Technology in Sustainable Green Design**

** -Students**: Most students (90%) believe that integrating green design into archaeological sites could attract more visitors, indicating the belief that technology can help enhance the appeal of these sites.

** -Faculty Members**: Faculty members largely agree that technology plays a crucial role in implementing sustainable green design, with 70% seeing it as essential.

6. Training in Sustainable Design**

** -Students**: 90% of students support the idea that future archaeologists and heritage managers should be trained in sustainable design practices.

** -Faculty Members**: Faculty members also agree on the importance of including such training in academic programs to ensure sustainable heritage conservation.

7. Suggestions for Improving Sustainability in Archaeological Sites and Museums**

** -Students**: Students suggest using eco-friendly materials, adopting smart technologies, and improving waste management as key sustainable practices.

** -Faculty Members**: Faculty members suggest increasing funding, raising public awareness, and developing policies to encourage the use of sustainable design in heritage conservation.

Overall Conclusions:

- There is broad consensus among both students and faculty members on the importance of sustainable green design in preserving cultural heritage and archaeological sites.
- The main challenges identified include lack of knowledge or expertise and financial constraints, w hile improving energy efficiency and water conservation are common priorities.
- Technology is seen as a crucial factor in implementing sustainable green design, with the belief that integrating these practices can enhance tourism and positively impact both the environment and cultural heritage.

Recommendations for the Study

1. Enhance Education and Training

- Integrate sustainable green design into archaeology and heritage management curricula.
- Encourage continuous professional development to stay updated on sustainable practices.

2. Increase Support

 Governments and institutions should provide funding and incentives for adopting green design strategies in conservation.

Arab International Journal of Information , Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

• Enforce policies for sustainability in heritage conservation.

3. Promote Awareness and Community Involvement

- Launch public awareness campaigns about sustainable green design in heritage preservation.
- Involve local communities in conservation and sustainable tourism initiatives.

4. Foster Collaboration

- Encourage collaboration between archaeologists, conservationists, architects, and environmental experts for innovative solutions.
- Partner with tech companies to develop sustainable technologies for heritage sites.

5. Prioritize Sustainable Practices

- Focus on energy efficiency, water conservation, and waste management in conservation efforts.
- Implement renewable energy solutions and energyefficient systems.

6. Incorporate Technology and Innovation

- Use AR and VR to reduce tourism's environmental impact and enhance visitor experiences.
- Develop technologies to monitor and preserve environmental conditions in heritage sites.

7. Develop Green Certification

- Introduce a certification system to recognize institutions adopting sustainable design practices.
- Encourage eco-conscious tourism by promoting certified sustainable heritage sites.

8. Encourage Sustainable Tourism

- Limit overcrowding at heritage sites with visitor management strategies.
- Educate tourists on sustainable practices to protect heritage sites.

By following these steps, Egypt can lead in sustainable tourism and heritage conservation, preserving its cultural legacy for future generations.

Annex (1) The Questionnaire Directed to Students

Do you think future archaeologists .6 and heritage managers should be trained in sustainable design	red y of sity	Prepared by: Menna Moha Abdelatef, 4th-year student, Facult Archaeology, Cairo Univer
?practices	e.1 Agn	How familiar are you with th ?concept of sustainable green de
Yes O	0	Very familiar
No O	0	Somewhat familiar
Maybe 🔘	0	Not familiar
What challenges do you think .7 museums and archaeological sites face when implementing sustainable ?practices	n .2 e in tes	Do you think that sustainable gree design can play a significant ro ?preserving archaeological s Yes
High costs	0	No
High costs O	0 🎫	Unsure
Lack of knowledge or expertise		
Resistance to change	e.a	In your opinion, what are the mo
Lack of government support	nite	affect archaeological
- (A) O	lon	7pronueva
0 100	0	Climate change
	0	Pollution
	0	Tourism
Do you believe that integrating .8 green design practices into archaeological sites could boost ?tourism	0	احروا
	t 4 our	Do you think there is sufficient emphasis on sustainability in y
Yes, it could attract more visitors	d to	academic studies relate
No. it would have no impact	-97	- All Charge
	0	Yes, it's well covered
Unsure ()	0	No, it's not emphasized enough I am not sure
What suggestions do you have for .9 Improving the sustainability of museums and	1.5 for ms	What sustainable practices woul you consider most beneficia ?archaeological sites and muse
?archaeological sites in Egypt	0	Lise of renewable energy
0.2753	0	Eco-friendly building materials
(e) and (e)	0	Waste management and recycling
	0	Preservation of local biodiversity
Contraction Contraction	0	land.

Annex (1) The Questionnaire Directed to Faculty Members

What green design practices do you .5 believe would be most beneficial for the preservation of archaeological ?sites and museums	Prepared by: Menna Mohamed Abdelatef, 4th-year student, Faculty of Archaeology, Cairo University
Renewable energy sources	
Use of eco-friendly materials	How familiar are you with the 1
Eco-conscious site planning	concept of sustainable green design
Waste management and recycling	in the context of heritage
0	7conservation
U Inc.	Very familiar
	Very familiar O
How do you perceive the role of .5	Somewhat familiar
technology in advancing sustainable ?design in archaeology	Not familiar
Crucial in improving efficiency and O	
Moderately helpful	Do you think sustainable green .2
Not very helpful	design is essential for the long-term
	?preservation of archaeological sites
	Yes O
What steps do you think need to be .7 taken to encourage the integration of	No
7green design in heritage conservation	Unsure O
Option 1	pa l
Public awareness campaigns	What are the key shallonges that 2
More research funding	museums and archaeological sites
Collaboration with environmental	face in implementing sustainable
experts	?design
0 الجريد:	Einancial constraints
Do you think sustainable design can .8	Lock of specialized knowledge
through tourism and cultural	Political and regulatory barriers
7preservation	Lack of public awareness
Yes, it can significantly boost O	0 اعدى
No, the impact is minimal	
Unsure O	
	In your opinion, should sustainable .4 design principles be integrated into
What other suggestions do you 9	academic programs for archaeology
have for integrating sustainable	?and heritage management
design in the conservation of Parchaeological sites and museums	Yes, it should be a core subject
-luie)	No, it is not necessary
	It could be optional

References:

- Aziza Maher Abouelsoud ليوليو, 2019). استر اتيجيات التصميم المستدام لمستقبل Aziza Maher Abouelsoud . تصميم منتجات أفضل. مجله الفنون والعلوم التطبيقيه، الثالث (السادس).
- Cole, L. B., Lendsay, G., & Akturk, A. (n.d.). Green building education in the green museum: design strategies in eight case study museums. *Routledge*.
- DEDEOĞLU, D. (2020). *GREEN MUSEUMS: AN INTRODUCTION AND A POSSIBLE IMPLEMENTATION IN ANKARA*. İhsan Doğramacı Bilkent University.
- Ismail, M. M., Nessim, A. A., & Fathy, F. (n.d.). Factors affecting museum buildings and heritage spaces in terms of energy optimization and comfort.
- Nocca, F. (2017). The Role of Cultural Heritage in Sustainable Development: Multidimensional Indicators as Decision-Making Tool. *Sustainability*, p. 25.
- Reclite, A. M. (2016). *THE EVOLVING MUSEUM: GOING GREEN IN COLLECTIONS MANAGEMENT PRACTICE AND POLICY*. San Francisco, California: San Francisco State University.
- Wang*, F. (2021). The Application of Green Energy-Saving Technology in Building Design—Take Zhejiang Water Control Museum architectural design as an example. *Earth and Environmental Science*.

اربج عيسى خليل الرمحي. (نيسان, 2022). إشكالية العلاقة بين العمارة الخضراء والعمارة

المستدامة. المجلة العربية للنشر العلمي، الصفحات 617-630.

ايمان صلاح عمر. (نوفمبر, 2023). دور المتحف في تعزيز الاستدامه. مجله جمعيه تراث مصر، 2(2)، الصفحات 31-57.

82

جميله سليمان جوخر سالم. (اكتوبر, 2021). العماره الداخليه الصديقه للبيئه. *المجله المصربه للدراسات المتخصصه* ، الصفحات 19-59.

Arab International Journal of Information Technology & Data Vol. 5, No. 2/ Part 2 April - June 2025

Towards a Sustainable Green Design for Museums and Heritage Sites: A Comprehensive Approach to Protecting Cultural and Environmental Heritage

المجلة العربية الدولية لتكنولوجيا المعلومات والبيانات المجلد الخامس – العدد الثاني/ الجزء الثاني (أبريل – يونيو 2025)

نحو تصميم أخضر مستدام للمتاحف والمواقع التراثية: مقاربة شاملة لحماية التراث الثقافي والبيئي

منة الله عبد اللطيف

كلية الآثار جامعة القاهرة mennaabdelatef113@gmail.com

المستخلص

تهدف هذه الدراسة إلى استكشاف تطبيقات التصميم الأخضر المستدام في المتاحف والمواقع التراثية، مع التركيز على أهمية استخدام الممارسات المستدامة للحفاظ على التراث الثقافي وتقليل الآثار البيئية. استخدمت الباحثة منهجًا وصفيًا وتحليليًا، حيث جمعت البيانات من خلال استبيانين: أحدهما موجه إلى طلاب كلية الآثار بجامعة القاهرة، والآخر موجه إلى أعضاء هيئة التدريس. كما تم جمع البيانات من مصادر متنوعة مثل الدراسات السابقة، والتقارير البيئية، ودراسات الحالة. شملت الدراسة نماذج لمتاحف خضراء. أظهرت النتائج أن التصميم الأخضر يساهم في تحسين كفاءة استخدام الطاقة، وحماية القطع الأثرية من التدهور البيئي، وتعزيز تجربة الزوار، توصي الدراسة بدمج ممارسات التصميم الأخضر في المناهج الأكاديمية، وزيادة دعم الحكومة للمشاريع المستدامة، ورفع الوعي البيئي بين المهنيين في هذا المجال. كما تقترح تشجيع التعاون بين التخصصات المختلفة وتطوير سياسات بيئية مستدامة. الأخضر ؛ الاستدامة؛ التخضراء؛ العمارة الخضراء؛ الماني الم