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The Role of Innovative Modern Technology and Digital Transformation in Reviving Egypt's Cultural Heritage and Historical Insights (Case Study of the Grand Egyptian Museum)

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Abstract

Egypt, renowned as the cradle of civilization, is among the world's most culturally significant nations. Cultural heritage and tourism are deeply interconnected, representing two sides of the same coin. In the context of the rapidly growing global tourism industry, the integration of innovative technology has become crucial for revitalizing Egypt's cultural heritage. Technology helps improve the infrastructure network, increase tourism revenues, and invest in digital innovation. There are still some challenges, including high implementation costs, limited digital literacy, workforce gaps, and a lack of widespread digital culture, all of which require greater attention and effort. Although Ancient Egypt remains a subject of mystery for researchers, technological advances have significantly advanced efforts to reveal aspects of ancient Egyptian civilization. These tools have enabled scholars to delve more deeply into Egypt's cultural heritage and ancient history. Technology has been used to reconstruct the layouts of ancient structures and restore damaged artifacts to their original condition. Technology can also translate inscriptions and analyze symbols within their historical contexts, facilitating a better understanding of the messages left by ancient Egyptians.

1. Introduction

Egypt is one of the most important historical locations in the world, boasting a valuable cultural heritage and numerous archaeological sites. Many of these sites are inscribed on UNESCO's World Heritage List. Egypt is widely regarded as the land of peace, culture, and civilization, with a history extending over 7,000 years. Tourism and archaeology are essential components of Egypt's national economy and community development. Cultural tourism has increasingly relied on innovative technology to enhance services and preserve Egypt's cultural heritage. (Cooper and Fletcher, 2005). According to the Ministry of Tourism and Antiquities, Egypt recorded 15.7 million tourists in 2024 and is expected to reach 17 million by the end of 2025, thanks to the opening of the Grand Egyptian Museum that year (Ministry of Tourism and Antiquities, 2025). The tourists come to Egypt to explore its rich cultural

legacy, iconic monuments, and diverse attractions. Technology has significantly enhanced tourism services, enabling visitors to access archaeological sites, plan itineraries, and choose from a range of tour packages (Conrady and Roland, 2007).

The Grand Egyptian Museum (GEM) serves as a case study for this research, standing as a landmark achievement in the global heritage sector by merging ancient civilization with modern innovation. GEM connects the past, present and future; it is a symbol of Egypt's cultural heritage and modern innovation and a model for 21st-century museums. GEM, a human achievement, brings together ancient history, modern technology, culture, tourism, education, and entertainment. It stands as a global model for how technology can preserve the past while enhancing the future. It is really a gift from Egypt to the world. Through the integration of innovative technologies, interactive learning, and sustainable design, GEM is redefining what a museum can be in the digital age (Sánchez-Martín et al., 2025). This research highlights that GEM is more than a repository of antiquities—it is a living cultural ecosystem and a symbol of national pride, offering digital transformative experiences for future generations. The official opening of the Grand Egyptian Museum (GEM) was on November 1st, 2025. The museum is poised to become a global center of excellence in heritage preservation, museology, education, and smart tourism. It represents not only a gift from Egypt to the world but also a blueprint for how nations can preserve cultural identity while embracing innovation and sustainable development (Taher et al., 2025).

This study examines the role of digital transformation and innovative technologies in enhancing cultural tourism, with the Grand Egyptian Museum (GEM) as a key case study. This research evaluates how emerging technologies enhance visitors' experiences and support the preservation of cultural heritage. It concludes with recommendations for broader adoption of the digital applications to enhance operational efficiency and ensure the sustainable development of Egypt's cultural heritage. Therefore, the focus of innovative technologies is to enhance the services offered while also maintaining Egypt's identity and national cultural heritage. It helps reconstruct incomplete artifacts, clarifies ancient inscriptions, and provides virtual tours of inaccessible temples, tombs, and old cities. It also provides detailed information on monumental construction projects and royal ceremonies, with interactive videos that illustrate daily life in ancient Egypt. These technological advancements not only enhance the archaeological and historical research process but also make Egypt's cultural heritage more accessible by offering immersive cultural and educational experiences (El-Sayed and Abdel Nasser, 2024).

This study adopted a mixed-methods approach, integrating quantitative and qualitative methods to comprehensively examine the role of modern technology and digital transformation in enhancing Egypt's cultural heritage. The quantitative component consisted of structured questionnaires and direct observational techniques designed to collect data on user interactions with innovative technologies in cultural settings. These methods enabled the evaluation of key variables, including user satisfaction, technology accessibility, and service efficiency. The qualitative component involved analyzing multimedia content, including documentary videos, academic articles, and official websites related to digitalization in cultural heritage. This approach provided in-depth insights into the application, impact, and challenges of emerging technologies in this field. The combined methodology enabled the researcher to assess the practical applications of digital tools in cultural tourism, identify and anticipate the main challenges associated with technological adoption, and recommend best practices based on evidence and comparative analysis. Additionally, the research draws on prior case studies and professional experiences within the culture, tourism and hospitality sectors to contextualize findings and support the achievement of the study's main objectives.

2.The Importance of Innovative Technology in Preserving Egypt's Cultural Heritage

Technology plays a vital role in preserving cultural heritage and making it accessible to everyone worldwide. Ancient constructions, manuscripts and artifacts can now be accessed through AI-emerged applications. These technologies help protect heritage from damage, theft, or natural disasters. Archaeological sites and ancient cities can now be explored, providing a deeper understanding of ancient civilizations. Technology helps analyze ancient texts and reconstruct missing parts of artifacts. It can also be used to translate unknown languages and ancient inscriptions, thereby facilitating a deeper understanding of historical texts (El-Sayed and Abdel Nasser, 2024). Technology has a positive impact on cultural heritage by preserving and digitally documenting it. It creates a virtual copy of the monumental sites and ancient artifacts. It is also used to document intangible heritage, such as customs and traditions, through audio and video recordings. In fact, technology plays a crucial role in documenting cultural heritage through 3D scanning and high-resolution imaging. It helps create digital copies of tangible heritage, including archaeological sites, ancient artifacts, and historical manuscripts. These copies could be used in case the original items are damaged. As for intangible heritage, audiovisual recording technologies are primarily used to preserve social relationships, habits, and traditions (Baek et al., 2025).

Furthermore, technology enables the tracking of lost or stolen artifacts through artificial intelligence applications and global databases. Intelligent security systems are also used to protect museums and archaeological sites from theft or vandalism, as well as to safeguard cultural heritage against the falsification of facts. Technology focuses on reconstructing lost heritage by using 3D modeling software to recreate monuments destroyed by natural disasters or war. Additionally, modern projects such as digital libraries help protect heritage from the ravages of time. Technology has been utilized to provide detailed insights into potential architectural and historical features, enabling experts to identify optimal excavation sites with remarkable accuracy. It can also conduct detailed surveys of monumental areas using 3D imaging technology to reveal hidden structures, buried buildings, and the layout of ancient constructions (Figure 1). This Project requires a considerable investment in intelligent infrastructure, metadata cultural platforms, and highly qualified human resources to perform the requested tasks (Wang et al., 2025).

Figure 1. Technology has been used to reconstruct the layouts of ancient constructions and to restore historic buildings, as shown in https://www.researchgate.net/figure/Tourist.

UNESCO plays a crucial role in promoting ethical artificial intelligence for the preservation of cultural heritage, highlighting the intersection of technology and heritage. It assists in exploring the future of Artificial Intelligence in cultural preservation and gaining insights into potential technological and cultural developments. UNESCO is working diligently to protect the world's cultural heritage and highlight the relationship between intelligent technology and cultural preservation. It also recognizes the importance of the world's cultural heritage, as well as the potential benefits and ethical concerns associated with Artificial Intelligence. The key principles are human rights, Integrity, Transparency, Oversight, and Copyrights. It demonstrates that humans must exercise caution when utilizing Artificial Intelligence in historical locations and cultural sites to preserve authenticity and integrity (UNESCO, 2021). Artificial Intelligence (AI) will affect certain aspects of cultural heritage, including art restoration, digital archiving, text restoration, and language translation and revitalization. AI can perform tasks such as image understanding, speech recognition, language translation, and decision-making in certain situations. It provides innovative ways to preserve our heritage, habits, language, and customs that reflect Egypt's history and identity (Wang et al., 2025).

The Ministry of Tourism and Antiquities is leading a major initiative to document and digitize Egypt's cultural heritage. A core focus of the Project is to digitally present ancient artifacts, especially those that are physically inaccessible due to deterioration or environmental threats. The initiative incorporates cutting-edge technologies, including virtual reality, augmented reality, audio holography, and interactive environments to reconstruct and display these invaluable cultural assets. The primary objectives of the Project include digitally reconstructing damaged or decayed ancient artifacts and inscriptions to preserve and interpret lost historical knowledge. It creates a historical database to highlight Egypt's national identity and promote its rich historical legacy through digital platforms (Casillo et al., 2025).

3. The Potential Initiatives and Digital Strategies to Enhance Egypt's Cultural Heritage

The Ministry of Tourism and Antiquities, in collaboration with the Ministry of Communication and Information Technology, is documenting and digitizing Egypt's cultural heritage. This Project aims to establish a digital platform with a historical and cultural archive database, making it easier and more accessible. It focuses on presenting ancient structures and artifacts, some of which are inaccessible due to poor condition or environmental factors. The Project will present a digital model of artifacts, old inscriptions, and ancient constructions. It improves digital platforms for cultural heritage and streamlines documentation processes through innovative digital approaches and collaborative cultural events (Gattiglia,2025). This platform is designed to showcase the richness of Egypt's cultural heritage and promote the legacy of its great civilization. Therefore, integrating technology into cultural tourism offers transformative opportunities to enhance visitor engagement, promote cultural heritage, and increase competitiveness worldwide (Ignatowicz et al., 2025).

The government collaborated with Meta to launch the "Instagram Project Revival," a virtual initiative to restore the original appearance of ancient artifacts. Technology enables the visitors to access the museum's official Instagram page to view the monument as it appeared in the past, with a full 3D copy. It has been launched to revive the incomplete and damaged artifacts. It presents the imagination with a visual representation of daily life in ancient Egypt. It provides easy access to historical references without requiring printed evidence. Technology provides all information and details as soon as the monument's code is scanned.

Technology is also used to decode ancient texts, read ancient inscriptions, and analyze the scenes depicted on them (Figure 2). It offers translations into various languages and provides detailed descriptions of the monument when the user points the camera at it. These tools have been designed not only to enhance the visitor experience but also to preserve Egypt's cultural heritage and keep it alive for new generations (Abdelhady et al., 2025).

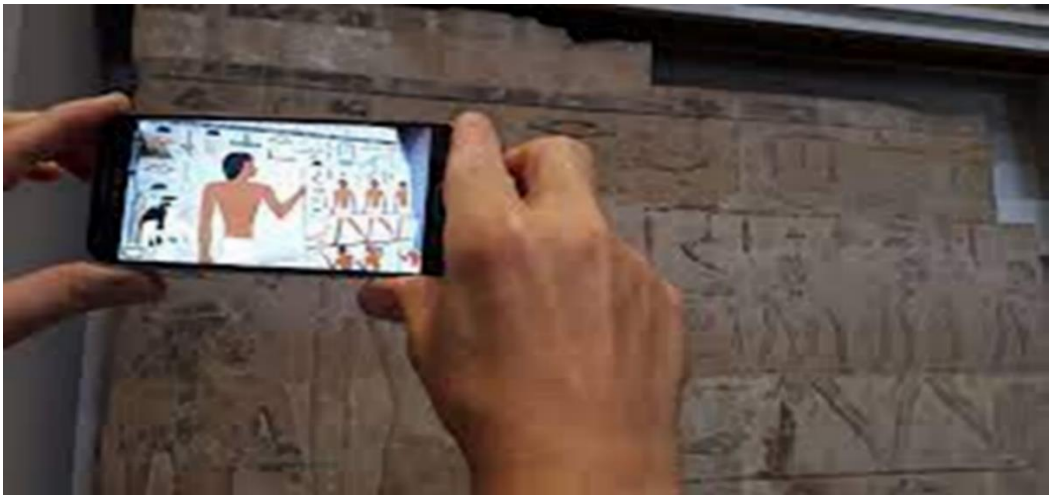

Figure 2. Technology is used to reveal ancient inscriptions and analyze the scenes depicted on them, as shown in The Rahotep Experience: AR as a tool to enhance the visitor experience at the monuments.

However, technology allows users to view 3D reconstructions of ancient monuments; there are still several challenges, including ethical concerns about data privacy, automation, and the potential erosion of human interaction. Technology should be viewed as a complement to human expertise, rather than a replacement for it. The roles of historians, archaeologists, and cultural specialists remain crucial in ensuring authenticity and integrity. To address these challenges, the government must collaborate to establish ethical frameworks and regulatory standards for the deployment of AI in all sectors. The strategic implementation of technology, including airport operations, management of tourist flows, pricing optimization, and safety and security at historical archaeological sites. Looking ahead, innovative technologies are expected to play a central role in sustainable tourism development, enhancing workforce efficiency, reducing operational costs, and preserving Egypt's cultural heritage (Magdalena and Young, 2023).

4.Virtual Reality (VR) and Augmented Reality (AR) in Reviving Egypt's Cultural Heritage

Virtual reality (VR) and augmented reality (AR) are closely related but distinct. Augmented reality integrates digital elements with the physical world, but virtual reality creates entirely immersive virtual environments. Visitors can enjoy an enriched atmosphere and digital environment by utilizing innovative technology during their vacations. Technology allows travelers to virtually access any archaeological sites worldwide and explore nearby monumental locations and archaeological sites (Zhang et al., 2025). Visitors can also connect their smart devices to interactive screens at historical locations, allowing them to participate in historical-themed entertainment and cultural initiatives. Technology enables the creation of accurate digital reconstructions of historical sites, allowing users to explore ancient landscapes and access areas that are physically inaccessible. Collaborations with institutions such as the Grand Egyptian Museum enable virtual navigation of galleries,

examination of 3D models of artifacts, and a sense of presence in the ancient world (Lu et al., 2025).

Virtual reality (VR) has been used to connect users with a 3D artificial environment. VR provides real-world events in a virtual world. VR has completely replaced the actual environment with a virtual atmosphere. It focuses on virtual tours and the 3D exploration of tombs, temples, and ancient buildings. It connects users to a virtual world, enabling them to create interactive, immersive experiences at historical locations. It allows users to explore the items from a 3D perspective, providing a realistic, cultural, and educational experience. It has utilized digital technologies to present facts in a virtual environment, enabling users to interact with the real world. VR is increasingly being utilized as an innovative emerging technology to immerse travelers in virtual environments (Chen et al., 2024). It presents factual, realistic representations within a simulated environment while users remain physically in the real world. For example, the location can be digitally transformed to display historical scenes, monumental shows, or cultural movies. This technology not only enriches the visitor experience but also enhances the visual and educational value of Egypt's cultural heritage and historical archaeological sites (Cunha et al., 2025).

On the other side, augmented reality (AR) focuses on adding digital elements to the real world rather than replacing it. AR is partially overlaid on the real facts, allowing the monument to be viewed in its original appearance. Visitors can explore ancient monumental artifacts and reconstruct ancient locations in their original designs, with original inscriptions and unfinished artifacts. AR highlights the reconstruction of ancient buildings, statue coloring, interactive overlays, and incomplete or damaged statues (Figure 3). AR combines digital elements with the physical world. It primarily focuses on enhancing the monument's content rather than replacing it, thereby improving its overall image. It connects digital content with the physical world, enhancing users' perceptions and improving travelers' experiences by overlaying it onto the physical environment (Fady,2024).

Figure 3. The Original Statue of Khasekhemwy
The Copy of the Statue Created by AR Technology
Retrieved from https://asharq.com/amp/culture/107382

Augmented reality (AR) enhances real-world settings by overlaying digital content without replacing the actual environment. It is represented as a bridge between the digital and physical worlds, improving users' perception by layering digital visuals into the real environments. Visitors can use their smartphones to scan any historical content or monumental object equipped with AR technology (Elshahawy et al., 2023). It reveals interactive content, including the whole image and detailed information about the monumental object, by scanning the registered barcode. It also allows travelers to view historical landscapes and cultural scenes superimposed on their physical surroundings. By integrating digital content into real-world environments, AR offers an engaging, informative, and immersive way to present and preserve heritage. Egypt's strategic efforts to document its ancient civilization using advanced technologies underscore a broader commitment to innovation, accessibility, and cultural preservation (Ibrahim,2025).

5. The Relationship between Augmented Reality and Virtual Reality

Augmented Reality (AR) and Virtual Reality (VR) offer innovative, immersive ways to explore Ancient Egypt. AR enhances real-world environments by overlaying digital content, while VR creates fully virtual spaces that allow users to explore reconstructions of ancient sites. Technology can enhance site visits by offering interactive 3D models of artifacts or by guiding visitors to uncover historical narratives. At archaeological sites such as the Great Pyramid of Giza, connected to the Grand Egyptian Museum, it can visually reconstruct how structures appeared in different historical periods or reveal inaccessible interior chambers. It can animate historical figures, artifacts, and architectural structures through smart devices and digital applications, offering learners a more engaging understanding of ancient Egypt (Mosaad et al., 2025).

- However, augmented reality (AR) primarily focuses on adding digital elements to the real world to enhance the real-world perspective, while virtual reality (VR) completely replaces the real world with a virtual environment.
- AR seamlessly merges digital content with real-world environments. It does not require a headset, Apple Glasses, or other digital 3D devices. It only requires a digital camera or a smartphone application that the user has downloaded. It connects digital content with the physical world, allowing users to receive information visually, as they do in the real world (Wardiani et al., 2025).
- Virtual reality has been created to connect users with a 3D artificial environment. It is actually bringing the real events into the virtual world. It included digital virtual elements that appear to be real content, making users feel as if they exist in this world. It needs to utilize advanced digital devices, such as 3D cameras, Apple Glasses, headsets, Meta Quest, or PlayStation applications (Martusciello et al., 2025).
- However, augmented reality is added to real facts, allowing the monument to be viewed in its original appearance. In contrast, virtual reality completely replaces the actual environment with a virtual environment (Wardiani et al., 2025).

6. The Advantages and Disadvantages

Acording to Yang and Liu (2024)and (Karadzhov and Chuchulayna (2024):

- Technology provides travelers with excellent services and amazing experiences. For example, Google Expeditions is a virtual platform that lets travelers visit destinations around the world.
- It provides users with easy communication, flexibility, and accessibility, allowing them to visit different locations worldwide at any time, in multiple languages.

- It provides safety and security services without the risks inherent in the real world, while also preserving the natural environment. Therefore, it reduces the tour's costs and reduces the negative impact on the environment.
- It offers future potential, especially in investment, and creates numerous job opportunities across all sectors.
- On the other hand, the disadvantages include high costs, infrastructure, and maintenance, among others.
- Technology may be more challenging and complex to use, requiring additional technical training to prepare skilled workers in this field.
- It can simulate real-world social interactions, and some users have recently shown a preference for virtual interactions over physical ones.
- New systems need to be set up to prevent information hacks; they also lead to health and mental issues due to overuse, as well as digital gaps among users.
- However, innovative technologies are more flexible and accessible; almost all travelers prefer to visit actual, real places. They create many job opportunities that definitely require the human touch.

7. Description of the Grand Egyptian Museum (GEM) as the Research Case Study

The Grand Egyptian Museum (GEM) is one of the world's most prominent museums. GEM is the largest museum in the world dedicated to a single civilization. Its architectural design aligns with sustainable development standards. It has both symbolic and monumental elements, with the structure taking the form of a triangular geometry. These features not only elevate the museum's functionality but also make it a model of innovative cultural tourism (UNESCO, 2025). More than a traditional museum, it is conceived as a multifunctional cultural complex that integrates educational, research, conference, and entertainment facilities. It represents a landmark achievement in museology, cultural preservation, and tourism innovation. As the world's largest museum devoted to one civilization, it embodies Egypt's ancient legacy while embracing modern technologies to enhance cultural experiences (Sarah, 2025).

Figure 4. The entire area surrounding the Grand Egyptian Museum near the Great Pyramids of Giza. Retrieved from https://www.skynewsarabia.com/amp/varieties.

GEM is the largest archaeological museum in the world, housing a collection of valuable artifacts and unique treasures. It is located on the iconic Giza Plateau near the Great Pyramids (Figure 4). It is an exceptional location, directly facing the iconic pyramids of Giza, one of the Seven Wonders of the World. The museum's structure is aligned with the area's historical

landscape. It stands as one of the most significant cultural projects in modern history. It bridges the ancient past with the modern future—making Egypt's Civilization accessible, engaging, and inspirational for audiences around the world. It includes show galleries and exhibition halls, equipped with 5G technology, a historic library, retail outlets, and open-air spaces. The children's museum, conference convention center, and restoration workshop have been added to the grand museum (Mohammed,2025).

The museum's architectural design takes the form of an angled triangle. The entrance hall features large statues representing the great kings of ancient Egypt, displayed in the grand staircase hall. This unique display method showcases some of ancient Egypt's most important statues, spanning from the Old Kingdom to the Greco-Roman period. The restored solar ship of King Khofu, previously located at the Solar Boat Museum adjacent to the Great Pyramids, has been relocated to the museum, where the complete collection of King Tutankhamun is now displayed. The Grand Statue of King Ramesses II was relocated from downtown Cairo to the Grand Museum. In 2018, the statue was relocated within the museum during construction due to its large size, approximately 82 tons and 12 meters high (Sarah,2025).

Additionally, the hanging obelisk associated with Ramesses II was brought from the city of Tanis (Current San El Hagar). However, the obelisk was broken; it was restored and now stands proudly in front of the Grant Museum (Figure 5). Visitors can walk beneath the obelisk and see the king's cartouche carved on its underside. These innovative tools enable visitors to view the statue and obelisk as a virtual reimagining of daily life in ancient Egypt during the king's reign (Eid,2024).

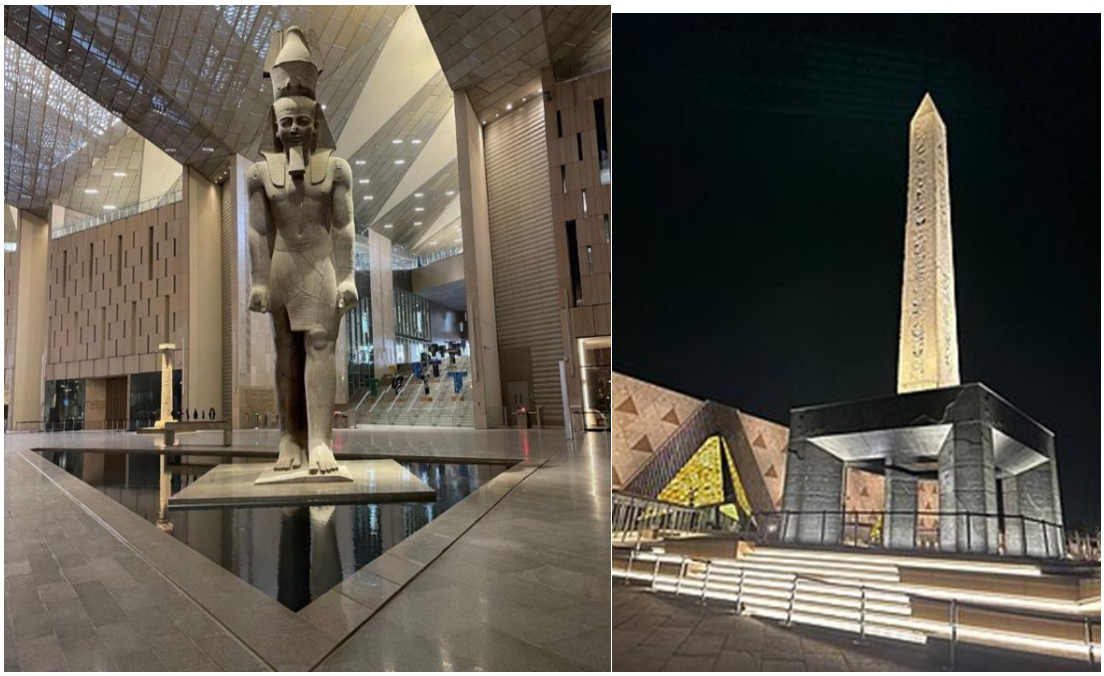

Figure 5. Statue of Ramses II in the Grand Egyptian Museum, and Hanging Obelisk brought from Tanis (San El Hager), standing in front of the museum. Retrieved from https://www.dailynewsegypt.com

8. The Grand Egyptian Museum as a Leading Example Using the Standards of Sustainable Development:

The Grand Egyptian Museum (GEM) has recently received international awards as a global cultural icon, not only in Egypt but also worldwide. The museum has been certified as the best green designation for meeting the standards of quality assurance, occupational health

and safety practices, and effective environmental management. It was certified as a green building, with its construction design meeting high international standards. It is recognized as the world's most significant museum for its architectural design, its reflection of local cultural heritage, and its support for sustainable development. Technology reflects the use of clean energy and the integration of solar power, natural lighting, and ventilation systems (Özdemir and Zonah, 2025). The Prix Versailles Award was given to the museum in 2024. This award, presented by UNESCO, recognized GEM as one of the world's best museums. In the same year, it won the Best Project Award at the FIDIC International Contract Users Awards, which was presented to the museum in London. Additionally, it has been granted an EDGE Advance International Certification for its green building, and the World Bank accredited it as the first in the Middle East and Africa to hold this certification (Abdelatef,2025).

GEM has been designed as a sustainable, digitally equipped cultural center that aligns with Egypt's vision for smart tourism and digital transformation. The main features of its infrastructure include exhibition galleries, immersive showrooms, and cinemas equipped with 5G technology, offering immersive storytelling experiences. Technology offers visitors an extraordinary experience, presenting them with headlines about ancient Egyptian history and valuable artifacts. Visitors can enjoy amazing experiences within the cultural and historical environment of ancient Egyptian civilization (Parry,2013). As a leading example of technology, it not only creates an immersive experience but also takes visitors on a journey through ancient Egypt. It offers a comprehensive narrative of Tutankhamun's life. The technology enables visitors to view a 3D model of the golden mask of Tutankhamun (Figure 6). The exhibition's modern approach allows visitors to step into the king's tomb and explore the rare discoveries. The king's exhibition at the Grand Museum brings his iconic collection to life, making Egypt's ancient history more accessible and engaging for tourists worldwide (Carrozzino and Bergamasco, 2010).

Figure 6. 3D Model Show of Tutankhamun's Golden Mask Using Modern Technology. Retrieved from https://egypttimetravel.com/king-tutankhamun-exhibition-at-gem/

King Tutankhamun was one of the kings who ruled Egypt during the 18th Dynasty; his iconic collection included his unique golden mask, valuable jewelry, ceremonial items, and numerous other ancient objects that reveal the rich history of Tutankhamun. The complete treasures of the king will be showcased in the exhibition gallery, which features more than 5,000 rare pieces. They are displayed in the museum alongside the king's golden mask and his funeral coffins (Sherine,2024). The technology allows one to view the 3D golden mask and witness its creation in the ancient royal workshops. It also provides the history of the

king and details the materials, tools, and techniques used to manufacture these valuable artifacts. It offers detailed information about the royal mummies, including their ancient mumification rituals and practices. It also offers interactive videos that show the mummification process, as per ancient Egyptian practices and traditions (Abd Halim and Jad,2024). GEM offers a historical narrative tour of ancient Egyptian civilization, providing insights into its artifacts. As part of the digital transformation, innovative operational systems will be available to visitors. Visitors can conduct virtual tours, access artifact information through smart apps, and explore cultural narratives through digital storytelling. They can also explore the museum's artifacts and 3D reconstructions of monumental objects, and view images of ancient monuments (Ali et al., 2024).

9. Grand Egyptian Museum (GEM), with its Grand Opening Celebration as a Model of 21st-century Museums:

The idea for the new museum was announced in 1992, and the foundation stone was laid in 2002. Construction operations began in 2005 and were completed in 2021. GEM was unofficially opened to visitors in 2023 to explore the museum's areas and report any issues before its grand official opening. The museum features a unique collection of ancient Egyptian artifacts that does not exist anywhere else in the world. They represent the different historical periods from the early pre-dynastic period to the end of the Roman era. The museum features 12 exhibition galleries designed to accommodate over 100,000 artifacts, including unique masterpieces displayed for the first time. GEM will present a revolutionary experience in the museum's sciences and serve as a historical landmark in Egypt (Eid,2024).

Egypt held an impressive ceremony, attended by European and Arab royals and presidents, to mark the grand opening of the Grand Egyptian Museum. VIP officials, delegations, leaders, public figures, and media representatives from around the world were invited to cover this great event (Figure 7). GEM was officially opened on November 1st, 2025, with a series of celebratory ceremonies. Technology played a vital part during the museum's opening celebration, with fireworks lighting up the sky above (Figure 8). The celebration featured a fantastic light-and-music show, with massive screens displaying Egypt's ancient monuments. Performers have been dressed in pharaonic costumes, crowned with golden headpieces, and holding scepters. The museum will open to the public on November 4th, 2025, coinciding with the anniversary of the discovery of the tomb of the great king Tutankhamun in November 1922 (Sarah,2025).

Figure 7. Impressive ceremony, attended by European and Arab royals and presidents, to mark the Opening of the Grand Museum. Retrieved from https://abcnews.go.com/International/egypts-grand-museum

Figure 8. Technology was extensively used during the opening ceremony of the Grand Egyptian Museum at Giza on November 1st, 2025, by Khaled Desouki.

GEM is a prominent example of how modern technology is enhancing cultural tourism in Egypt. The museum is equipped with advanced technologies that offer visitors immersive experiences, allowing them to explore monumental collections, priceless artifacts, and the rich legacy of ancient Egypt. Visitors can conduct virtual tours of the museum's halls, interact with 3D models of artifacts, and gain insights into ancient Egyptian civilization. These experiences serve both educational and entertainment purposes, enabling a deeper understanding of Egypt's archaeological heritage and cultural significance (Mohammed and Khairy, 2024). The government is currently utilizing technology to connect the museum with the Great Pyramids. It returned to tell the story of the pyramids' builders; this tool is the first experience presented in the Pyramids area, using 3D Light and Sound technology. During the Show, visitors can virtually tour the monumental area and learn about ancient Egyptian history. They can also learn about the construction of the Great Pyramids and explore the ceremonies of ancient Egyptians. This Project is part of a plan to develop and modernize Egypt's archaeological sites. It provides visitors with interactive experiences that include knowledge, culture, learning, documentation, research, and entertainment (Derda and Predescu, 2025).

The technological features enhance the museum's educational value, visitor engagement, and scientific utility. These figures demonstrate GEM's role not only as a cultural organization but also as a leading example of sustainable development and global heritage preservation. The integration of innovative technologies into the Grand Egyptian Museum underscores Egypt's strategic approach to digital transformation. Through immersive digital exhibitions, GEM serves as a model for 21st-century museology. GEM is not only a gift from Egypt to the world but also a beacon of innovation, preserving the grandeur of one of the world's oldest civilizations for future generations (Sarah,2025).

10. The Digital Tour Guide as a Smart Tool to explore Egypt's Historical and Cultural Attractions

The digital or audio tour guide is essential for accessing the country's tourist attractions. The tours could be organized online using digital applications. These applications could be downloaded on visitors' smartphones (Olsen and Michael, 2016). The digital tour guides provided the following features:

- The locations overview gives detailed information and a historical description of the destination.

- The high-quality map application enables visitors to determine and visit nearby attractions, national parks, cultural landmarks, or historical locations.
- It provides sample itineraries and directions to keep the tours more efficient and smoothly managed.
- It offers a broader range of options for finding the best accommodations in historic locations.
- The digital tour guide provided high-quality location videos, photo galleries, and recommended videos about the historical destination (Shikhri and Lanir, 2024).

The digital tour guide has recently been used to organize the visitors' tours and excursions. It could be used if visitors are unable to travel, or if they want to explore new destinations and virtually visit tourist locations and cultural destinations worldwide. This innovative application is helpful for online sessions, history lessons, and virtual cultural tours, all without leaving the comfort of the home. It is also called a welcome digital book or guest guidebook. Customers use an electronic online guidebook to learn more about cultural proprieties, local historical attractions, and city heritage landmarks. The guide presents intangible services essential for both customers and business operators. It saves time and effort, improves customer and owner relations, offers a unique guest experience that increases loyalty, and makes it easy to add and receive updates (Xu et al., 2025).

The digital audio guide plays a crucial role in providing a wealth of information about Egypt's historical archaeological sites, cultural landmarks, and tourist attractions. It has been designed to provide more information about ancient Egyptian Civilization, with its richness in cultural, archaeological, historical, and architectural features. It presents an overview of ancient artifacts, iconic landmarks, and key themes of ancient Egyptian Civilization. The audio guide will allow visitors to engage deeply with the exhibits, providing greater accessibility and personal connections, and offering the option to explore the locations virtually or in person at the site. The digital tour guide, powered by advanced AI, provides detailed information and access to historical and cultural sites. It can present the transaction in different languages, explore historical destinations, choose cultural locations, and other cultural historical platforms. These tools have been used to explore Egyptian cultural heritage, offering accessible and immersive experiences—particularly beneficial for those unable to visit in person. Through virtual tours and mobile platforms, users can explore historic museums, unique monuments, and archaeological sites from their own devices, enhancing educational and cultural outreach (Huang et al, 2025).

11. Potential Outstanding Projects Related to the Grand Egyptian Museum:

The Grand Egyptian Museum is situated adjacent to the Great Pyramids of Giza. Touristic Walkway has been constructed to connect the GEM with the Great Pyramids. The path extends to 1.45 km between the museum and the pyramids. The visitors will enjoy panoramic views of the pyramids and the cultural landscape of the monumental area. This Project boasts excellent infrastructure and landscaping areas that complement the ancient Egyptian civilization and its legendary wonders. It becomes a great tourist gateway, confirming Egypt's historical position as a premier cultural and historical destination. It is not only designed as a passageway but also constructed to reflect Egypt's rich cultural heritage and modern vision. The technology has been used in the monumental area, as seen in the Great Pyramid, to showcase the rich history of ancient Egypt (Isha,2025).

One of the most significant outstanding projects is a modern transportation initiative that aims to connect the Grand Egyptian Museum with Cairo's iconic historical landmarks. It connects the Grand Museum with the Great Pyramids, Historic Cairo, and other notable sites. Hop-on, hop-off transportation is a modern sightseeing option that allows visitors to explore

the city's attractions at their own pace. It allows visitors to get on and off at any point, enabling them to watch the city's landmarks and cultural locations. This service offers more flexibility during the stay; visitors can choose the bus, specify the start and end points, and the duration of their stay at each station. Visitors could start from wherever they want and finish anywhere. The transportation is equipped with experienced guides and a friendly team. It provides door-to-door service, allowing one to choose the best accommodation based on the next destination and opening up more options for practicing various activities. The hop-on, hop-off bus is considered one of the most accessible and flexible modes of transportation in many capital cities worldwide, including Cairo, New York, Dubai, London, Paris, and Madrid. It allows visitors to explore the city's historic locations and tourist attractions (Caitlin and Erin, 2025).

The other Project is the Illusions Museum, as a proposal to be attached to the Grand Museum. It originated as a unique concept, but it later evolved into a multifaceted space that combines entertainment and education. This idea relies on human vision and perception, meaning the eyes can see things the brain cannot understand. This exhibition explores a form of digital art that utilizes digital technologies and communication media to reach large audiences and create alternative spaces in the digital realm. The concept of illusions in museums primarily relies on the idea that figures overlap to reveal hidden objects or details. Specialists presented a detailed study of what happens to the eyes and the perception of pain when viewing the optical illusion (Riya, 2020).

However, the illusionistic museums included showrooms and playrooms with didactic games, as well as libraries, cinemas, and other facilities. These technologies highlighted visitors' perceptions and vision, suggesting that the human brain may not be able to comprehend how the eyes perceive. The idea for the Illusions museums originated as a fantastic and unique project. This Project proved helpful for both educational and entertainment purposes. The Illusion Museum presents a unique and exciting experience for its visitors. This idea suggests that people's vision and perception often reveal aspects that the mind cannot. This experience will enhance human perception, allowing the eyes to see things the brain cannot understand. Modern technology has led to illusion museums that present a diverse range of fine arts, fantastic collections, and excellent entertainment. It creates a concept for future modern museums and establishes new exhibitions. The concept of illusion provides a space for imagination and helps to shape the future design of illusion museums. However, the illusion's facts became an integral part of human perception, even when people were aware of it, and it attracted visitors to spend time there (Riya,2020).

12. The Future of Digitalization and Innovative Technology Regarding Egypt's Cultural Heritage (Opportunities and Challenges)

Modern Technology and Digital Transformation are currently playing a vital role in reviving Egypt's Cultural Heritage and Historical Insights. The technology facilitates various approaches to innovation in cultural heritage preservation. It helps achieve the goals of sustainable cultural heritage management and provides a wealth of information to forecast the best ways to restore cultural monuments. It preserves cultural heritage, making it more suitable for future generations. These technologies offer an outstanding experience and provide excellent channels for audiences to connect with their cultural heritage and historical identity. They enable them to explore their history through virtual reality reconstructions or augmented reality overlays, creating unique architectural designs of ancient monumental constructions (Jennifer,2025).

Technology poses challenges in human interactions with cultural heritage. The reason to use innovative technologies is to enhance, not replace, the personal touch. Cultural heritage

preservation requires human knowledge and understanding of the cultural significance provided by historians, archaeologists, and specialists. In addition to the above-mentioned, innovative technology creates new investment opportunities, especially for travel operators working in smart cultural tourism. This field faces several challenges, including the high cost of infrastructure and maintenance, the shortage of skilled personnel, and the effective use of these applications. This Project still requires human specialists to explain Egypt's historical aspects and cultural heritage, and further studies are needed (Magdalena and Young, 2023).

It is expected that technology will enhance services at historical locations and manage high-traffic areas. It has also offered competitive pricing policies and income-generating strategies, and has presented smart tourism ecosystems. Therefore, innovative technologies support sustainable tourism development by enhancing workforce performance, reducing effort and costs, and increasing efficiency in monumental sites. Technology is increasing the number of virtual tours of Egypt's historical locations and cultural heritage landmarks. It also enhances visitors' security and safety, providing highly efficient performance. These tools not only enhance visitors' satisfaction but also streamline the planning process, reduce reliance on physical tours, and increase overall tourism efficiency. Digital applications can be downloaded to smart devices, offering easy access and providing information on locations, directions, transportation facilities, city attractions, and more. They focus on promoting mobile learning and exploring technologies that can be accessed anytime, anywhere, and on any smart device worldwide (Nassar and Hassan, 2024).

These tools offer insights into archaeological and architectural features. This initiative aligns with Egypt's broader vision to digitize its cultural heritage, making it more sustainable, accessible, and engaging for both local and international audiences. They also support cultural initiatives, upgrade the management systems, and enhance documentation processes. Therefore, innovative emerging technologies are beneficial to cultural heritage preservation, considering both ethical issues and the values of innovation. Scientific research, executive professionals, the local community, and civil society must collaborate to uphold ethical principles and integrity in the development and application of artificial intelligence. They must create policies and strategies to promote ethical standards, protect national cultural heritage, and support the development of artificial intelligence and other digital technologies (Huang et al., 2025).

However, the sector faces challenges, including high costs associated with setting up and maintaining digital infrastructure and a shortage of professionals skilled in modern technologies. Positive opportunities remain for investment in training, partnerships, and innovation. Egypt has already taken proactive steps by investing in training and education, establishing ethical standards, and collaborating with cultural organizations in this field. It highlights the importance of ethical data use in preserving human interactions related to the country's cultural heritage (Yang and Ren, 2025).

Conclusion

Egypt is known as the land of Peace, Culture, History, and Civilization. The government is working hard to support sustainable development at archaeological sites and manage Egypt's cultural heritage. It has undertaken a significant national project to document and digitize Egypt's cultural heritage. Technology is in urgent demand across all sectors, in light of recent global challenges and revolutionary advances in digitalization and artificial intelligence. Technology helps travelers save time and effort, organize their tours, improve customer service, and create an incredible image of Egypt's attractions. However, modern technology is more accessible, and some visitors still look forward to real, targeted locations

with physical human interaction. As a case study of the Grand Egyptian Museum, it represents a historical advancement in both cultural heritage preservation and tourism innovation. It is considered the world's largest museum dedicated to a single civilization, connecting the past, present, and future. It offers a comprehensive experience that highlights Egypt's ancient civilization alongside 21st-century technology.

Therefore, innovative technology has been applied at the Grand Egyptian Museum; it could also be implemented at the Great Pyramids at Giza, located adjacent to the museum. Visitors can enjoy a marvelous experience exploring the pyramids' history. The technology allows visitors to explore the Great Pyramids. The digital approach could be applied to other archaeological sites in Egypt, such as the Saqqara Complex, Karnak and Luxor temples, and others. They can take virtual tours of the royal tombs, temples, museums, and other locations. They could explore the detailed layout of the location, including its interior design, ancient inscriptions, hidden parts, and burial chambers. It offers a straightforward way for students, researchers, and visitors to learn about Egypt's rich history, vibrant civilization, and diverse cultural heritage. They explore the secrets of ancient Egyptian civilization, including wall paintings, hieroglyphic inscriptions, religious rituals, and funerary practices.

However, almost all of the ancient artifacts have been moved to the Grand Egyptian Museum at Giza. The Egyptian Museum, located in Tahrir Square, opened in 1902 and remains a 123-year-old archaeological masterpiece in downtown Cairo. It is the largest and oldest museum in the Middle East, as well as one of the most significant historical landmarks and cultural institutions in Egypt. It remains the primary destination for tourists worldwide interested in Egyptology. The museum houses a unique collection of ancient artifacts spanning Pre-History to the end of the Greek and Roman eras.

The Tahrir Museum is considered the oldest in the region, and its building is a registered monument. The museum is situated in Downtown Cairo, renowned for its extraordinary artistic and historical significance. It focuses on education, academic research, historical studies, and cultural activities. The museum will continue to house valuable and rare artifacts, such as the Narmer Palette, the oldest political manuscript in the history of ancient Egypt. The statues of Khafre, Menkaure, and other unique monuments are worthy of highlighting. With the ongoing transfer of the museum's collections, there is a question about the future of the Tahrir Museum and how it will maintain its historical value. The museum is one of the most important dedicated to ancient Egyptian civilization and a global center for the study of ancient antiquities and Egyptology. Furthermore, the museum's basement houses thousands of ancient artifacts; however, these artifacts will be brought to light and displayed in their rightful place in the museum.

Results

- GEM is a model of the 21st-century museum, featuring eco-friendly architecture, green spaces, and smart infrastructure.
- The museum includes not only galleries and exhibitions but also cinemas, a children's museum, retail areas, a historic library, a restoration center, and educational workshops, positioning it as a multifunctional cultural complex.
- Smart applications, digital tour guides, virtual tours, and online ticketing systems make GEM globally accessible. It also provides a cultural, educational and entertainment value to both local and global audiences.
- It is expected that GEM will significantly increase demand for historical hotels, modern transportation, traditional heritage crafts, and retail services in the vicinity of the

museum. It also contributes to economic growth, creating many investment opportunities and job opportunities for local people.

- The tourist walkway connecting GEM to the Giza Plateau enhances physical access and offers panoramic views, integrating ancient monuments with modern infrastructure.
- Through tools like the digital tour guide, hop-on hop-off transport system, and proposed Museum of Illusions, GEM offers an engaging, flexible, and inclusive approach to exploring Egypt's history.
- These features are particularly beneficial for remote users, educators, and individuals with mobility or health limitations, aligning with global trends toward accessible and immersive tourism.
- The museum enhances Egypt's diplomacy, projecting a modern and progressive national image. It serves as a global model for preserving and presenting ancient heritage through innovative and forward-thinking approaches.
- The future of cultural tourism in Egypt will involve a new approach based on AI travel technology, virtual tour innovation, augmented reality, and applications that benefit the tourism sector.
- As for the museum sector, it will depend mainly on AI technology. The travelers will be able to use the virtual tour and digital guides before or upon arrival at the targeted destinations.
- However, this field presents several challenges, including high costs, limited workforce experience, and inadequate infrastructure. There is still an excellent opportunity to invest in smart tourism and AI projects in Egypt.
- Tourism and culture are two sides of the same coin, supporting both local society and national income. They rely on AI and innovative technologies to enhance the services presented, while preserving national cultural heritage and ecological systems. It is part of the high demand for more options of green resources and pure energy tools.
- Modern innovative technologies enhance guest service experiences, saving time and effort while delivering higher quality and greater efficiency.

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دور التكنولوجيا الحديثة المبتكرة والتحول الرقمي في إحياء التراث الثقافي والرؤى التاريخية لمصر (دراسة حالة المتحف المصري الكبير)

صبرى العزازى

مدرس الإرشاد السياحى– المعهد المصرى العالى للسياحة والفنادق – شيراتون

معلومات المقالة

الكلمات المفتاحية

مصر القديمة؛

الحضارة؛

التراث الثقافي؛

الرقمنة؛

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الملخص

تعرف مصر بأنها مهد الحضارة، وتُعد من أهم الدول ثقافيا. التراث الثقافي والسياحة مرتبطان ارتباطًا وثيقًا، حيث يمثلان وجهين لعملة واحدة. في ظل التطور السريع لصناعة السياحة العالمية، أصبح دمج التكنولوجيا المبتكرة أمرًا حيويًا لإحياء التراث الثقافي المصري. تساعد التكنولوجيا في تحسين شبكة البنية التحتية، وزيادة عائدات السياحة، والاستثمار في الابتكار الرقمي. لا تزال هناك بعض التحديات، بما في ذلك ارتفاع تكاليف التنفيذ، وانخفاض مستوى الثقافة الرقمية، والفجوات في القوى العاملة، ونقص الثقافة الرقمية ، وكلها تتطلب اهتمامًا وجهدًا أكبر. وعلى الرغم من أن مصر القديمة ما زالت موضوعًا للغموض بالنسبة للباحثين، إلا أن التقدم التكنولوجي ساهم بشكل كبير في تعزيز الجهود لكشف جوانب الحضارة المصرية القديمة. وقد مكّنت هذه الأدوات العلماء من التعمق أكثر في التراث الثقافي والتاريخ القديم لمصر. وقد تم استخدام التكنولوجيا لإعادة بناء تخطيطات المبانى القديمة واستعادة القطع الأثرية التالفة إلى حالتها الأصلية. يمكن للتكنولوجيا أيضًا ترجمة النقوش وتحليل الرموز ضمن سياقاتها التاريخية، مما يسهل فهمًا أفضل للرسائل التي تركها المصريون القدماء.