

Article

The value of digital preservation in reviving colonial cultural heritage in Egypt

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Abstract: This study explores the potential of digital preservation in the documentation of colonial cultural heritage in Egypt. It also explores the stories behind historical wars to revive these sites and attract different segments of visitors. Documentation of these sites should enhance Egyptian colonial cultural heritage sites, which include battlefields, war memorials, commanders' palaces, assassination and murder spots, cemeteries, and mausoleums. The purpose of this study was fulfilled through field visits supplemented with in-depth interviews with experts on colonial heritage sites in Egypt. The findings showed that technology could play a key role in implementing the storytelling documentation and interpretation of colonial history and its relevant events at the Egyptian sites. However, to date, these sites have not made the best use of technology for digital preservation and documentation due to many challenges. The study recommends that decision-makers should integrate technological innovation, which can revitalize the communities built on the ruins of colonialism and revive the heritage of popular resistance. Technological innovation could be implemented not only in digital preservation and documentation but also in service and marketing of these colonial heritage sites.

Keywords: colonial heritage; technological innovation; heritage documentation; AI application; digital preservation

1. Introduction

Egypt, a country steeped in rich history and cultural heritage, boasts a diverse array of colonial heritage sites that offer a unique glimpse into its colonial past under French, British, and Ottoman rules. Colonial heritage sites reflect tangible reminders of Egypt's complex historical narrative. Understanding the significance and challenges surrounding these sites help shed light on the complexities of preserving and interpreting Egypt's colonial legacy. Colonial heritage sites in Egypt are not extensively exploited, despite their availability and diversity due to historical sensitivity and preservation efforts. The bulk of this form of heritage has only been documented through images, newspapers, and a few documentaries. It has not yet been scientifically documented using various technological techniques, exposing this form of heritage to extinction and neglect, with the likelihood that it will not be recovered because there is no professional archive (Chang and Chiang, 2012).

Egyptian colonial heritage is a vital part of Egypt's identity, and it is remarkably

significant to keep Egyptian colonial heritage and create an archive for saving such heritage. Despite the increasing recognition of the importance of preserving colonial heritage, the limited availability of specific literature about the digital preservation of Egyptian colonial sites calls for studies on this issue. The shortage of scholarly works may reflect both a lack of dedicated research initiatives and the intricate nature of balancing digital methodologies with the nuanced historical context of colonial heritage in Egypt. Notwithstanding, addressing this gap is crucial not only for the essential protection of these cultural treasures but also for fostering a deeper understanding of the preservation of Egypt's colonial legacy. This requires collaboration and coordination among various stakeholders, including researchers, local communities, governmental bodies, and international organizations (Reinhard, 2019). Colonial heritage is threatened with ending for various reasons, including the absence of maintenance and changing social and economic conditions. Digital technology has developed rapidly; artificial intelligence, virtual reality, multimedia, networks, and databases provide vital tools for heritage documentation as a new way of conserving heritage by using technology to strengthen the identity of the place and create a sustainable future (Fitzgerald et al., 2014).

This study adopts the concept of colonization presented by Ferro (2005), which defined it as “the occupation of a foreign land” and taking control of an area or a country that is not their own, using force, and sending people to live there. The study draws on field visits to numerous sites designated as having colonial heritage. This was supplemented with in-depth interviews with experts on colonial heritage preservation. Digital and cyber archaeologists suggest working to build and generate immense data on colonial heritage, develop databases and suggest working patterns for protecting and preserving archaeological monuments and sites depending on technological innovation. Hence, approval of the painful experiences associated with colonialism means a commitment to preserving historical memory to protect these sites (Stobiecka, 2020). More especially, this study explores the different tools that make colonial heritage accessible, preserving and reviving all forms of tangible and intangible colonial heritage to provide a comprehensive approach and integrate information from diverse sources to help understand different perspectives, change ways of thinking, and generally provide a basis for decisions related to the intervention. The research presents the role of digital documentation in many aspects, including strengthening the identity of the place and creating a sustainable future. Thus, documenting colonial cultural heritage is vital for preserving cultural identity. Moreover, digital methods and techniques can link data from historical documents and disseminate it for better understanding and awareness (Cameron, 2021). To conclude, this study assesses the current state of colonial cultural heritage sites in Egypt, identifies their historical significance and ensures the long-term preservation of colonial-era sites. The study explores the digital preservation technologies available for documenting cultural heritage sites, knowledge sharing among diverse stakeholders, and ensuring their perspectives are incorporated. It explores examples of successful implementations of digital preservation technologies and how digital documentation contributes to sustainable preservation.

2. Review of literature

Heritage is history, memory, image, (Howard, 2003) and identity depicting a piece of a cultural community through time in their minds (Harrison, 2010). Colonial cultural heritage is defined as tangible and intangible heritage that has value from the historical perspective and reflects the community's power and identity (Ashworth, 2013). It could be divided into two categories:

- 1) Intangible heritage represents diverse expressions and cultural aspects that relate to people's memories and experiences and could be inherited from generation to generation, such as rituals, oral traditions, storytelling, and performing arts (Harrison and Rose, 2010).
- 2) Tangible heritage could be divided into two types (Vecco, 2010):
 - a) Movable heritage that includes works of painting and monumental sculpture (Quinlisk, 2009).
 - b) Immovable heritage, which includes monuments, architectural works, and groups of separated or connected buildings that are significant because of their building typology, their architectural order and style, and their identity or their historical position (Ivanc and Gomes, 2015).

Digital technologies could not only "preserve" but also "intertwine" the tangible and intangible value of colonial cultural heritage in Egypt (Sobaih and Naguib, 2022). They are considered a visible aspect of a society's memory with both tangible and intangible heritage. The digitizing process can thus be used to pique their interest in historical places and museums (Varbova and Zhechkov, 2018). The primary goal is to create a digital heritage that is accessible to everyone by combining historical resources with digital tools, as well as to enable the public, particularly younger generations, to value and preserve their heritage through the implementation of digital cultural heritage in a variety of programs. The digitization of cultural heritage affords an effective platform for managing heritage collections, thus providing educational, scientific, and cultural ways of transmitting and conserving such collections. By preserving and protecting colonial cultural sites, Egypt can ensure the preservation of collective memory and the identity of future generations.

Studies on colonial heritage (Cheer and Reeves, 2015) have covered different aspects regarding the colonial heritage from the perspective of the effects of colonialism (Marschall, 2016) and its results, whether material or moral and the extent of its compatibility with colonial policies at the time, (Tucker, 2019) while demonstrating the right of the local population to possess their heritage that coincides with the colonial periods (Nicolaïdis et al., 2014). As it is a vital and principal part of national identity, the importance of preserving and recording this heritage using various technological means has not been fully addressed despite its importance as part of the history of any nation (Chirikure et al., 2016). Preserving heritage helps attracting different groups, whether local or international and a vital role as a soft force to present thorny political issues (El Shakry, 2015). This research helps in reusing these sites distinctly and integrating them into the tourist map. The limited number of scholarly works that integrate digital approaches with the sensitive historical context of Egypt's colonial legacy. Addressing the gap is critical for efficiently protecting these cultural riches and promoting a broader knowledge of Egypt's colonial heritage

(Darweish and Sulin, 2021). It is important to delve into different fields to find valuable insights and approaches that can contribute to digital preservation in a colonial heritage context (Long 2000).

The conservation of colonial heritage needs to protect both tangible and intangible heritage (Chang and Chiang 2012). Preserving that type of heritage means conveying culture with its significant values intact and accessible to the greatest degree possible (Oostindie, 2008). Preservation is the attentive planning and management of historical resources, which depends on a good documentation process (Gbamwuan and Agidi, 2023). Technological documentation of colonial heritage sites serves a range of goals, from preservation and accurate representation to interdisciplinary research on the sustainable management and appreciation of cultural heritage for present and future generations. Digitization is defined as the “conversion” of analogue information in any form (text, photographs, voice, etc.) to a digital method; hence, the content can be processed and transmitted through digital tools. It includes several types, such as temporary, general, private, and catalogue, as well as sites and museum registers (Ioannides et al., 2008). This tool secures the heritage of deposited objects and provides specific information whether excavated, selected, deposited, or excluded. Moreover, the records and archives of historical societies, governmental or excavation records and archival documents, college and university archives, special collections archives, museum records, and religious archives (Bauer et al., 2023). Using digitalization significantly contributes to the display of colonial cultural heritage sites by offering innovative ways to present and interpret these historical sites like the creation of interactive and engaging educational materials for public awareness, and understanding (Youn and Uzzell, 2016) and appreciation of colonial heritage sites as an interactive method for a new type of tourism in Egypt. Besides, creating digital archives ensures that information about colonial heritage sites is easily accessible, updated, and available to share with researchers, scholars, and the public worldwide (Kølvraa and Knudsen, 2020). In the end, documenting tangible and intangible heritage is viewed as a scientific documentation process to record for research, study, preservation, and publication of ownership rights to the collections (Ioannides et al., 2010). The potential of colonial heritage sites in Egypt has been viewed from two different points of view. First, a positive stance that they should be managed like any other form of heritage, regardless of the associations connected to them. Second view the management of colonial heritage negatively maintaining that it is not relevant as it provokes awful emotions and that such heritage resources should be discarded (Jeffreys, 2012).

Colonial heritage sites provide tangible evidence of Egypt’s colonial history and how they offer insights into shaping Egypt’s development and identity (El Shakry, 2007). These sites display a fusion of different architectural styles and cultural influences from the colonial powers (Jacobs, 2010). They serve as living testimonies that Egypt possesses, reflecting the interactions between local traditions and foreign elements. Colonial heritage sites provide invaluable resources for scholars, researchers, and students to understand Egypt’s colonial past. While not extensively exploited, colonial heritage sites have the potential to contribute to Egypt’s tourism sector. The sites can attract visitors interested in exploring the country’s multi-layered history (Youn and Uzzell, 2016), thereby diversifying tourism offerings and generating

economic benefits for local communities. By preserving and conserving colonial heritage sites, Egypt can ensure the continuity of collective memory and the transmission of historical knowledge to future generations (Park, 2016) and it allows for fostering a sense of identity and promoting cultural heritage appreciation. Understanding the importance of colonial heritage sites in Egypt encourages efforts to document, protect, and interpret these sites responsibly (Ali, 2023). It facilitates a more comprehensive understanding of Egypt's historical narrative, promotes cultural diversity, and contributes to preserving it as a global heritage. The diversity of historical places and events enhances the study and documentation of Egyptian colonial cultural heritage sites, which include (Rico, 2008) mansions/palaces and houses of leaders, ceremonies, protocols and external relations, battlefields, war memorials, assassination and killing locations, cemeteries/tombs, and mausoleums.

2.1. Digitalization of colonial cultural heritage sites

Recognizing the significance of Egypt's colonial heritage sites promotes cultural diversity and contributes to preserving them as a global heritage (Cheer and Reeves, 2015). The technological documenting of colonial cultural assets is the process of turning physical data of movable or immovable cultural heritage into multidimensional digital archives utilizing digital technology, which facilitates the recreation of colonial cultural heritage sites (Chirikure et al., 2016). Technological documentation of Egyptian Colonial Heritage sites includes various cultural, educational, scientific, technical, legal, and other information (Kasusse et al., 2016). There are several ways in which digitalization enhances the display of colonial cultural heritage (Owens, 2019) as follows:

- 1) Virtual reconstructions: digital tools such as 3D modelling and virtual reality (VR) allow for the creation of immersive virtual reconstructions of colonial-era sites. Visitors can explore these reconstructions online or through VR headsets, providing a dynamic and realistic experience of the site as it might have appeared in the past.
- 2) Interactive exhibits: digitalization enables the development of interactive exhibits in museums or online platforms. Touchscreens and interactive displays can engage visitors by providing detailed information, historical context, and multimedia content related to colonial cultural heritage (Newell, 2012).
- 3) Online platforms and virtual tours: websites and online platforms dedicated to colonial cultural heritage sites offer virtual tours, allowing users to explore these sites remotely. High-resolution images, 360-degree panoramas, and informative annotations contribute to a rich and informative virtual experience.
- 4) Augmented reality (AR) applications: augmented reality applications on smartphones and tablets can overlay digital information onto the physical environment, enhancing the visitor's understanding of colonial-era sites. AR features can include historical images, virtual guides, and multimedia content triggered by specific locations.
- 5) Digital archives and documentation: digitalization facilitates the creation of comprehensive archives of colonial cultural heritage sites. High-quality photographs, 3D scans, and digital documentation contribute to detailed and

accurate records, which can be used for research, conservation, and educational purposes.

- 6) Educational platforms and e-learning: digital platforms support educational initiatives by providing e-learning modules and resources related to colonial cultural heritage. They can deliver interactive classes and audiovisual activities to keep every participant involved (Zaagsma, 2023).
- 7) Visual content and public participation: Digitalization allows the gathering of collective content, such as user-generated photographs. Public participation via electronic pages, which include public opinions in the narrative.
- 8) Geographic information system are used to build precise maps and reconstructions of colonial cultural heritage sites.
- 9) E-narrative or electronic narrative is an approach that combines multimedia elements including audio recordings, animations, and films to communicate the tale of locations from the colonial era. It can be integrated into digital platforms.
- 10) The digitization of records plays a critical role in the preservation of cultural heritage through the creation of digital archives, which guarantee the preservation of important historical data, artefacts, and documentation in a digital form that is simple to access, amend, preserve, and manage throughout time. According to Wong (2014), digitalization provides innovative, interactive, and inclusive experiences. Digitalization enables a variety of innovative ways to present colonial heritage sites and stories, investigate them, and educate people about them (Figure 1). It promotes public access to them, and aids in people's understanding of their past and admiration of various cultures and customs.



Figure 1. How digitalization contributes to the display of colonial cultural heritage.
Source: Beale and Reilly (2017).

The aims of technological documentation in the colonial heritage include preserving the physical and cultural aspects of colonial heritage sites to encourage a new type of tourism. It also aims at raising public awareness, understanding, and appreciation of colonial heritage sites, leading to assistance in preservation efforts and ensuring that information about colonial heritage sites is easily accessible and updated

and can be shared with researchers, scholars, and the public worldwide. Technological documentation makes a key role in conserving the colonial heritage in various aspects. The process involves creating detailed records, such as photographs, sketches, and written descriptions, to capture the current state of colonial heritage sites. In today's digital age, it also includes creating digital archives, databases, and virtual reconstructions, ensuring global accessibility and preservation. Documenting colonial heritage helps us appreciate our cultural heritage, drive future innovation, and foster a better understanding of our shared history, besides focusing on and emphasizing the national identity, especially for youth (Amorim, 2007). These efforts contribute to the sustainable management and appreciation of cultural heritage for present and future generations (Joubert and Biernacka, 2015).

2.2. Virtual Heritage (VH)

Stone (2013) defined war heritage as any physical signs where war-related death, suffering, conflict, or atrocities occur beside battlefield sites, concentration camps, prisons, massacre sites, mass graves, and artefacts. The International Council of Museums (ICOM) advocates adopting digital technology to endow cultural heritage with new narratives and communication methods. The combination of digital technology and war heritage can provide the chance to make a more engaging sensory and emotional experience. Virtual heritage is the result of the process of digitization of cultural heritage that focuses on recreating tangible or intangible cultural heritage by making realistic 3D models (Bowen et al., 2023). Virtual heritage refers the adoption of interactive technologies to record, pre-serve, or recreate artefacts, sites, and historical, artistic, and religious, which have cultural significance to deliver the results to the audience to provide educational experiences and presenting content. Additionally, virtual heritage consists of three major phases, which are 3D documentation, 3D representation, and 3D dissemination (Tan and Rahaman, 2009).

- 1) 3D documentation includes collecting data about cultural heritage. Objects under study vary from site investigation, measurement taking and sketching. Data can also be gathered from origins like ancient maps, photographs, paintings, and written documents (Bruno et al., 2010). Multiple techniques are available to capture the data for heritage objects, such as 3D laser scanning or photogrammetry.
- 2) 3D representation includes 3D imitation of heritage objects by using the captured data.
- 3) 3D dissemination of virtual heritage includes the presentation of the created 3D models to the users (Nicastro and Puma, 2019).

3. Methods

The study explores colonial heritage in Egypt. This study reminds the policy makers to rethink of colonial heritage tourism, conservation, and reuse and how to interpret controversial heritage. The research adopted field visits to all the most common and classified as colonial heritage sites in Egypt. The visits included Denshway Incident, Bahr Al-Baqar massacre, Commonwealth war cemeteries at El-Amein, The Mamelukes' Massacre, The military shelter of Israeli forces in 1967, 1973,

The Digging of the Old Suez Canal, Martyrdom area of Abdel Moneim Riyad, Six-day War, Naksa Day 67.

The purpose of these visits is to understand the state of these sites, its classification and how it could be preserved. In addition, government reports and diverse related documents were used to understand the historical background and conservation. The visits are supplemented with semi-structured in-depth interviews with a number of experts on colonial heritage sites. There were 18 interviews conducted with government officials, university professors and archeologists, who have experience with colonial heritage in Egypt. These experts were purposively selected based on their knowledge and experiences with Egyptian colonial heritage. The purpose of the interviews were to achieve the research purpose on colonial heritage conservation and the role of technological innovation in this preservation. The interviews lasted approximately one hour. Each interview was recorded with the interviewee's consent. All the people involved were made anonymous to keep their identities.

The visits and interviews data were analyzed manually and organized under five themes. These themes were colonial cultural heritage sites in Egypt, axes of Egyptian colonial cultural heritage sites, digital preservation contribution to heritage preservation, challenges in Digital Preservation of colonial cultural heritage and strategies to mitigate the challenges and undertake colonial cultural heritage preservation. The following section presents and discusses these five themes.

4. Results and discussion

4.1. Colonial cultural heritage sites in Egypt

Interviewees confirmed that Egypt has a long history of colonial influences, particularly during Ottoman and British control in the 19th and early 20th centuries (**Table 1**). Colonial cultural heritage sites in Egypt often reflect the architectural, social, and economic changes brought about by foreign powers during this period. The colonial cultural heritage can be classified into seven eras with related sites (**Table 1**). The interviews confirmed that colonial heritage sites in Egypt offer a fascinating journey through different epochs of foreign influence and rule. These sites have been meticulously classified based on their historical chronology and presence in Egypt. The Ottoman Era (1517–1798) marks a significant period of Ottoman governance that left enduring architectural and cultural imprints across the country. Egypt vis-à-vis the “sovereign rights” of the Ottoman Sultan in Egypt versus those of the local governor of Egypt, the Khedive. By the late 18th century, Egypt’s combination of weak political importance and strategic geographic location made it an attractive “candidate for annexation” (Fagan, 2004, p. 46). The nations of France and Britain launched colonial expansion in Egypt. Thus, the French invasion of Egypt eliminated Mameluke’s rule and ushered in the beginning of the Ottoman Empire. The French Occupation (1798–1801) led by Napoleon Bonaparte introduced transformative changes and innovations during its short-lived rule. Egypt’s development was driven by modernization initiatives and reforms during Muhammad Ali Pasha’s Rule (1805–1848). Egypt’s colonial history saw a significant turning point during the British Occupation and Protectorate (1882–1952), which had a massive impact on the country’s political and

economic environments. Italy’s tiny effects on Egyptian infrastructure as well as culture are shown in the Early 20th Century. Egypt had some changes throughout the Post-World War II Period (1945–1952) as the country worked toward independence. From 1952 to the present that marked the beginning of a new era in Egypt’s history as a sovereign state negotiating its post-colonial cultural and political identity. **Table 1** provides multiple examples for every era/site.

Table 1. An index of Egypt’s colonial cultural heritage.

Site /era	Description and examples of sites
Ottoman Era Sites (1517–1798)	<p>Heritage sites from this era contain Ottoman architecture and military construction. For example, Bab Zuweila is one of the historic gates leading to the old city and had military uses during the Ottoman era. Bab Zuweila is placed in an important location for keeping an eye on Cairo’s southern neighborhoods. In addition, Saladin Citadel (Cairo Citadel): While its origins trace back to the Ayyubid dynasty, the Saladin Citadel in Cairo underwent significant renovations and fortifications during the Ottoman era. It served as a major military stronghold and administrative center, housing rulers, troops, and important state functions. Furthermore, Citadel of Aswan (Aswan Citadel) which situated on the east bank of the Nile in Aswan. This citadel dates back to ancient times but saw considerable Ottoman-era modifications. It acted as a vital defensive fortification, securing southern borders and commercial routes along the Nile.</p>
French Occupation Sites (1798–1801)	<p>The French occupation of Egypt has an impact on various aspects of Egyptian culture. It included several types of fortifications, such as Fort Julien, which worked as a strategic defensive position along the Nile Delta and secured French control over key waterways. It’s close to the ancient city of Rosetta (Rashid), built by the Mamluks and exploited by the French during their occupancy. Moreover, Fort Napoleon, located on the Mediterranean coast in Alexandria, now known as Qaitbay Citadel, was renovated and repurposed by the French to be used in the defense and control of maritime routes. Another example is the Military Camps and Barracks, which were established by the French in various locations across Egypt, including the strategic points along the Nile.</p>
Muhammad Ali Pasha’s Rule (1805–1848)	<p>Muhammad Ali Pasha undertook several reforms in Egypt. The main impact of this era was in military infrastructure. The first example of these sites is the Citadel of Cairo. It served as a military fortress. Another example is the Alexandria Fortifications. Muhammad Ali strengthened Alexandria’s coastal defenses by upgrading existing fortifications and constructing new coastal batteries and gun emplacements to protect Egypt’s vital ports and maritime. Another example is Abu Qir Fort. It was established near Alexandria in a strategic location, the fort underwent renovations and enhancements under Muhammad Ali’s rule to secure Egypt’s Mediterranean coastline.</p>
British Occupation and Protectorate (1882–1952)	<p>The British occupation of Egypt during the late 19th and early 20th centuries had a major effect on the country’s infrastructure, including railways and buildings. The first example is the Suez Canal Region Defends. Numerous military installations were established and defensive positions along the Suez Canal during their occupation such as watchtowers and barracks. Another example is during World War II. The forces established airfields, hangars, and support facilities across Egypt, especially in areas like Almaza close Cairo. Another example is Alexandria Naval Base. They developed dockyards, repair facilities, and administrative buildings.</p>
Italian Influence in the Early 20th Century	<p>Italian influence was prominent in Egypt in the beginning of 20th century. This included architecture, neighborhoods, structures, and buildings. Example of this is the World War II Italian military construction is Fort Capuzzo. Italian forces built it when they were occupying Egypt and Libya. Moreover, the Italian War Memorial in El Alamein serves as a reminder of Italy’s military actions in the area during the colonial and wartime eras, and it is located next to the El Alamein War Cemetery.</p>
Post-World War II Period (1945–1952)	<p>Following World War II and the end of British rule, Egypt, during the transitional period, has gone through several historical landmarks that reflected the country’s journey to independence. These landmarks are evidence of Egypt’s unique character during that time. The first example of this is Ras Banas Radar Station, which was relied on as an important postwar surveillance location; it contributed to coastal defense and air surveillance and acted as an early warning system. Additionally, Makari Air Base was a significant military aviation base that supported Egypt’s air defense capabilities and training programs following World War II. Furthermore, Ismailia Military Camps: Following World War II, Ismailia strategically positioned and hosted various military camps and installations, which acted as training grounds for army troops, supply centers, and coordination hubs for regional defense efforts.</p>
Post-Colonial Independence (1952 Onward)	<p>Following the 1952 Revolution, Egypt started post-colonial era. The National Military Museum is example of this. It was founded in the early 1960s, displays Egypt’s military history through artefacts, weapons, uniforms, and papers from the post-independence era. It highlights significant events such as the Suez Crisis and the Arab-Israeli conflicts. Another example is Sinai Peninsula Military Installations. With the Sinai Peninsula’s strategic importance, military installations such as air bases, radar stations, and border outposts were strengthened post-independence to monitor borders, counter security threats, and uphold territorial integrity. Additionally, various war memorials and monuments across Egypt commemorate national heroes, fallen soldiers, and pivotal military events post-independence, honoring their contributions to Egypt’s defense and sovereignty.</p>

4.2. Axes of Egyptian colonial cultural heritage sites

These Sites include a wide range of axes that shed light on many facets of the country's ironic history. Exploring these axes collectively deepens our understanding of Egypt's colonial heritage, offering a nuanced perspective on historical events, architectural evolution, power structures, and material remnants that continue to shape the country's cultural landscape. The Egyptian colonial cultural heritage sites could be divided into three main axes. These axes related to either events, historical houses and palaces or remains. The following paragraphs explains these axes.

4.2.1. Axis related to events (such as the Denshway incident)

Denshway Incident in 1906 refers to the dispute between British soldiers who mistreated peasants, took their possessions, burned their crops, and killed their children, women, and old men. It is an example of the harsh treatment of British occupation authorities against Egyptians (Luke, 2007). Such measures stirred up people, but later villagers faced different shapes of arbitrariness, and many were killed within three weeks. Harsh punishments for several villagers in the incident's wake sparked an outcry among many Egyptians and helped galvanize Egyptian nationalist sentiment against British occupation.

4.2.2. Axis related to historical houses and palaces (such as the museum of the Suez Canal authority, or the Villa of Eugenie (museum))

This site was originally constructed as the French Consulate, the building holds the distinction of being one of Port Said's oldest structures, dating back to 1866 (Elsorady, 2020). Ferdinand de Lesseps oversaw its construction during the tunneling of the Suez Canal, and it functioned as the French consulate until 1956. The closure of the consulate was a consequence of France's involvement in the tripartite aggression against Egypt. Subsequently, it was repurposed into a French library (Fouad, 2021). In 1956, the building came under the authority of the Suez Canal Authority (SCA), during this time it served as accommodation for nuns from the French Church and its associated school, recognizing their roles as nurses during the 1956 tripartite aggression. For many years, the structure was closed and used as a storage facility for the SCA, housing valuable artefacts, maps, and monuments related to the Suez Canal. In 1998, Lieutenant General Ahmad Fadil (Nour-Elsayed, 2020), Chairman and Managing Director of the Suez Canal Authority (1996–2012), decided to convert the building into the Suez Canal Historical Museum, officially opening on 6 August 2015, coinciding with Egypt's celebration of the new Suez Canal inaugural.

4.2.3. Axis related to remains (such as the battle of Al-Alamein)

Al-Alamein Battle marked a turning point, fought between Commonwealth forces and German and Italian military units led by German Field Marshal Erwin Rommel. Al-Alamein was a bottleneck for both sides. Rommel's battered armored units were rapidly running out of fuel, and he withdrew. On 2 November, he warned Hitler that his army faced destruction, but Hitler ordered him to stand fast and not retreat (Edwards, 2012). Two days later, however, Rommel was forced to order his troops to disengage, and the battle was over. The battlefield graves of those who died in the Desert Campaign were moved into the Commonwealth war cemeteries at El-Alamein.

4.3. Digital preservation contribution to colonial heritage

Digitization is described as the “conversion” of analogue information (text, images, audio, etc.) to a digital format that can be processed and conveyed using digital technologies. It is classified into various types, including temporary, general, private, and catalogue records, as well as site and museum registers (Ioannides et al., 2008). This technique safeguards the heritage of deposited objects by providing particular information and the story behind them, whether they were present, collapsed, or remain. Digitalization makes a significant contribution to the display of colonial cultural heritage sites by offering novel ways to present and interpret these historical sites, as well as designing them as interactive and engaging educational materials for public awareness (Youn and Uzzell, 2016), resulting in a new type of tourism in Egypt. Digital preservation plays a crucial role in evaluating and recontextualizing the colonial legacy, mainly in the context of cultural heritage documentation. It also includes the development of strategies and tools to warrant the long-term accessibility and usability of these materials (Fouad and Elsaid, 2022). The renovation of these resources helps in creating comprehensive account of history and colonial cultural heritage. This could contribute to:

- 1) **Accessibility and availability:** Colonial-era resources would become available to everyone, who may not be able to visit archives or museums that house these materials. This would encourage numerous perspectives and promote a better knowledge of history.
- 2) **Better engagement:** This encourages better engagement with colonial heritage documentation practices. In other words, it helps in better engagement with heritage. This engagement contributes to better interpretation such important heritage.
- 3) **Integrating viewpoints:** The management and interpretation of colonial cultural assets can more easily incorporate various viewpoints thanks to digital preservation. This helps in opposing the prevailing colonial narratives and advance a more inclusive understanding of history by giving marginalized voices and alternative narratives a space to emerge by collaborating with stakeholders.
- 4) **Technological development:** It allows to best use of new developments in data visualization, and interactive platforms to make materials from the colonial era more accessible. These tools allow users to interact with and explore the materials in novel ways and can contribute to a broader, more inclusive understanding of cultural heritage.
- 5) **Sustainable preservation:** Using digitalization to preserve colonial-era materials, safeguarding them from physical degradation, natural disasters, environmental calamities, and other risks that threaten traditional archival materials. By preserving these materials in a digital format, we can ensure their continued availability for future generations to study and learn.

4.4. Challenges in digital preservation of colonial cultural heritage

The preservation of tangible and intangible cultural heritage is a well-developed field; however, can colonial cultural heritage be preserved from being lost? As such, this will require significant cross-disciplinary collaboration among archaeologists,

historians, and archivists to prevent colonial cultural heritage from becoming lost (Kamel and Elshiwiy, 2022). According to theoretical frameworks from digital humanities, cultural theory, history of the built environment, and archaeology, digital representations and archiving can preserve colonial heritage (Bialostocka, 2021). In Egypt, the rich colonial history has left behind a wealth of cultural artefacts, documents, and architectural structures, which are vital to understanding the past of any nation (Samiei, 2020). However, the preservation of these valuable resources faces numerous challenges, particularly in this context (Sabri and Olagoke, 2021).

- 1) Limited resources challenge: One of the primary challenges in digital preservation is the lack of resources, including funding, infrastructure, and skilled personnel. Egypt, like many developing countries, struggles to allocate sufficient resources to cultural heritage preservation projects. This scarcity hampers the implementation of effective digital preservation strategies and tools.
- 2) Fragmented documentation Challenge: colonial cultural heritage in Egypt is scattered across various institutions, private collections, and even personal archives. Furthermore, the lack of unified policies and sustainable funding mechanisms hinders effective preservation strategies, exacerbating the risk of irreparable damage to the Egyptian cultural legacy.
- 3) Technological incompatibility challenge: Over time, digital formats and storage media become obsolete, leading to inaccessible data. The preservation of digital materials re-quires constant migration to newer formats and storage devices, which can be costly and time-consuming.
- 4) Metadata management challenge: Accurate and standardized metadata is crucial for effective digital preservation. However, the lack of proper metadata management in Egyptian cultural heritage institutions results in incomplete or incorrect information, hindering the process of documentation and preservation.
- 5) Technical challenge: The digital preservation of colonial cultural heritage sites necessitates advanced technology infrastructure and knowledge. However, Egypt may con-front financing and resource constraints in developing and maintaining such infrastructure. Furthermore, digital preservation technologies and procedures must be carefully chosen to ensure compatibility with the specific colonial heritage sites.
- 6) Logistical challenge: Researching colonial cultural heritage sites in Egypt involves logistical challenges related to access and site management. Some of these sites may be found in remote areas, making transportation and logistics difficult. Looting, encroachments, deliberate destruction of heritage, terrorism, vandalism, civil unrest, neglect, and even excessive urbanization and building development are destructive forces for cultural heritage around the world, and armed conflicts are the most devastating. Further, ensuring the accessibility of researchers to the heritage sites themselves can pose significant challenges, particularly in unstable regions.
- 7) Cultural challenge: Cultural legacy can often lead to conflict about who owns it. Colonial cultural heritage protection has emerged as a global humanitarian issue due to its impact on nations' social, cultural, economic, and political stability. The research on colonial cultural heritage sites in Egypt should navigate cultural sensitivities and local perspectives. The colonial era is a sensitive period in

history, and some communities may have conflicting views about the preservation and interpretation of the sites. Thus, researchers need to engage with local communities, establish trust, and incorporate their perspectives to ensure a more inclusive and cultural approach to documentation.

- 8) Ethical challenge: Local community perspective and awareness of national colonial heritage have been harmed, with colonial heritage widely regarded as a possible cause of suffering, evidence of a slavery past, or even military property that is not part of people's memory and identity. Research involving colonial cultural heritage sites raises ethical considerations, and it is essential to respect the rights and dignity of local communities and stakeholders and involve them actively in the reusing process. It is also critical to enhance the community's cultural knowledge about the significance of this type of heritage and to consider how digital information might be marketed and exploited under international standards and guidelines for the ethical treatment of cultural heritage.
- 9) Legal and policy challenge: Research on colonial cultural heritage sites in Egypt must comply with national and international legal frameworks and policies. Getting the necessary permits and permissions for research, data collection, and preservation activities can be a complex and time-consuming enactment, and it is important to be aware of the legal requirements and navigate the procedures to ensure cooperation and avoid legal challenges. Additional laws and decrees were established, modifying and enhancing existing national regulations on colonial cultural heritage conservation. Similarly, it barred the removal of any antiques owned by people or registered by the state unless the antiquities administration issued formal permission confirming their rightful disposal.
- 10) Data management and sustainability challenges: Effective digital preservation requires long-term data management and sustainability plans. Therefore, establishing robust systems for data storage, backup, and accessibility is crucial to ensuring the longevity of the preserved digital materials. In addition, developing strategies to update and adapt the preservation methods with evolving technologies is essential to prevent obsolescence and loss of data.

4.5. Strategies to mitigate the challenges and undertake colonial cultural heritage preservation

Interviewees recommended a set of recommendations to mitigate the challenges and undertake colonial cultural heritage preservation. Interviews agreed that the first step begin by understanding the significance of digital preservation in safeguarding and promoting colonial cultural heritage documentation in Egypt. This involves recognizing the potential risks of data loss, degradation, or inaccessibility that can occur due to techno-logical advancements and changes. The second step is to identify the required colonial cultural heritage documents that need to be digitally preserved. Objects that shed light on Egypt's colonial past could include maps, photos, historical documents and records, and other pertinent resources. The third step is to develop a well-structured digital preservation strategy that specifies the goals, objectives, and strategies to preserve and manage the identified documents. A clear strategic choice should be identified to create a differentiation for this cultural heritage with a set of

strategic goals and objectives. The fourth step is to develop a program and projects to undertaking digital preservation of colonial cultural heritage.

For successful implementation of the program and project in the fifth stages, involvement and collaboration between all stakeholders is vital. This includes experts of digital preservation government, heritage site team, visitors and local community. Raising the fund for the projects is another important issue that should be considered for successful implementation. Collaboration with private sector could be one of the solutions to raise fund. The integration to innovative technology is important for successful preservation, albeit it requires successful implementation to change management. Interviewees agreed that the site team should be trained on the documentation and the use of such new technology at their sites. The management of the site should ensure that technological innovation is not in heritage documentation only, but also in heritage presentation to the visitors. Hence, there should an evaluation of the whole process from all stakeholders' perspectives. This evaluation enables the site administration to identify the area for improvement and develop a corrective action for proper colonial heritage preservation.

Both UNESCO and ICOMOS; emphasized the need to protect colonial cultural heritage due to its nature, the hazards it faces, and how it is integral to historical local identity. Colonial heritage sites can contribute to peace conversations by allowing visitors and locals to interact with the sites while addressing an uncomfortable past, promoting intercultural understanding, and facilitating dialogue about identity issues.

5. Conclusion

The integration of technological innovation in heritage preservation has become crucial for successful colonial heritage preservation. This integration could include both documentation of such heritage and its presentation to visitors. This should enable visitors to explore and understand the heritage sites in detail, fostering a deeper appreciation for their historical significance. Additionally, digital documentation and preservation techniques can create accurate and comprehensive records, preventing the loss of valuable information over time. Technological innovations transform traditional services into something more appealing for heritage sites to enhance their marketing offerings. Therefore, websites can be effectively promoted through social media platforms, websites, and mobile applications, helping to strengthen the local economy and stimulate cultural diversity in society. Advanced systems, interactive guides, and real-time information displays improve the audience's experience, making their journey through these sites more informative and enjoyable. Colonial heritage sites can ensure efficient preservation, management, and promotion by embracing technological innovation in all aspects, fostering continued appreciation, and understanding of these historically significant locations. It is also important that various stakeholders (e.g., local community, government bodies and heritage institutions) should collaborate to appreciate colonial cultural heritage. This could be done through various steps including collaboration between a university, a digital technology company and local communities for reviving colonial cultural heritage. The role of government is also important by setting the policy that facilitate this process.

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