Cultural Continuity in Crisis

The Interaction of Virtual Tourism and Heritage Culture in War-torn Sudan

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Abstract: Since April 2023, Sudan has been embroiled in a devastating war, resulting in the loss of much significant cultural heritage all over the country. This study aims to explore how virtual travel and digital tools can help preserve Sudan's cultural heritage by leveraging technology. The methodology included a literature review, digitalization case studies, and qualitative methods, such as interviews with cultural heritage and tourism experts. The study discussed how Sudan could use digital tools during the conflict to preserve its cultural heritage, one of the key results of this study is the digitization process to preserve Sudanese cultural heritage through and after the conflict for future generations. The call to digitize the remaining non-destructed heritage sites is essential through VR, digital technologies, 3D scanners, photogrammetry applications, and digital platforms to share it with a global audience.

Keywords: Cultural Heritage, Virtual traveling, Sustainable tourism, VR, Preservation

1 Introduction

Preserving Sudan's cultural heritage holds paramount importance due to its reflection of the region's rich and diverse history. It boasts an abundance of archaeological sites, ancient temples, pyramids, and traditional practices that have been passed down through generations. Nowadays, in the digitalization era, it is becoming even more pertinent to use digital content reasonably.In the context of globalization, smart actions for content use should be carried out to provide sustainability of national identities [CDT15]. Simultaneously, virtual travel and digital technologies have the potential to enhance conservation efforts and promote responsible tourism. These technologies such as 3D scanning, photogrammetry software, digital platforms, etc. provide immersive and interactive reviews, allowing people to discover locations and interact with cultural history from the comfort of their own homes [Ru19]. Furthermore, virtual travel and digital technologies contribute to sustainability by utilizing and presenting accessibility, education, decreased environmental impact, cultural protection, and assisting in making plans and strategies.

By highlighting the significance of this issue, it's anticipated that other researchers will be motivated to conduct further studies in this field. This paper offers practical solutions for

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preserving cultural heritage amidst conflict, focusing on virtual travel and the digitalization process. Addressing the challenges faced by Sudan's cultural heritage during the conflict contributes timely and relevant insights to ongoing discussions and efforts to safeguard the cultural heritage in conflict-affected regions.

In terms of theoretical contributions. The methodology involved a comprehensive literature review, this review focused on identifying existing theories, models, digitalization case studies, and frameworks related to the implementation of virtual travel experiences and digital tools and reflecting on Sudan's cultural heritage in the current conflict. For applied contributions, the methodology incorporated qualitative research methods, such as interviews, which were utilized to gather insights from cultural heritage and tourism experts. These methods helped identify the current practices and challenges in virtual travel and digital technologies to preserve Sudan's cultural heritage.

2 The Status of Cultural Heritage in Sudan

Throughout the ongoing conflict, cultural heritage sites were divided into red (hot) zones, which are located in war-affected areas and inaccessible, and white (cold) zones that are reachable. Efforts are being made to preserve and document artifacts and historical sites in the white zones to protect them from the risk of loss. These areas include sites like Port Sudan, Karima, Meore, and Jebel Barkal, and also museums that are at risk and need special attention. For instance, the Sennar Museum was particularly threatened because this incident occurred in a hot zone. The National Museum of Sudan was also destroyed partly. Al-Khalifa Museum (also known as Beit Al-Khalifa) was used as barracks and was looted, resulting in the disappearance of historical weapons from the Mahdi era. The War Museum considered a historical building in itself, has been damaged from the southern side [Ta24]. To address those damages, innovative solutions like virtual tourism can play a crucial role in documenting and safeguarding Sudan's cultural heritage for future generations.

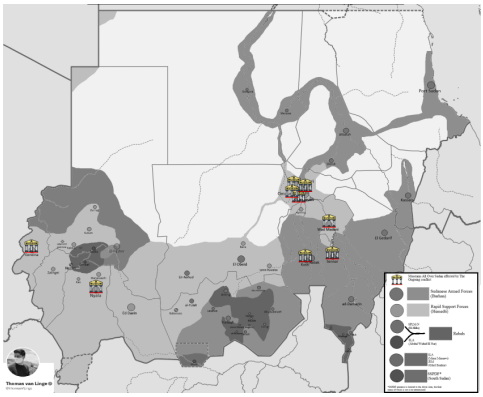

Fig. 1: The affected museums all over Sudan during the ongoing conflict. This map was reported on the first of February 2024, 10 months after the conflict—the map is approximate [SWM24]

3 Virtual Tourism as a Way to Preserve Sudanese Cultural Heritage

The global awareness of the diminishing elements of cultural heritage has grown significantly [AT22]. To highlight this concern over the past few years, digital technology has played a pivotal role in enhancing cultural communication. Users can swiftly search historical sites and capture two-dimensional and three-dimensional images and videos using their smartphones [TP23].

The practice of taking photographs and providing cultural heritage sites and artifacts in virtual and immersive contexts is becoming more and more popular as virtual photography, 3-D generation, and mobile advancements continue to adapt in unexpected ways [Sm12]. Virtual reality programs offer immersive experiences that enable users to engage with Sudan's cultural history in virtual environments, enhancing both education and entertainment, which achieves the goals of sustainability [DM13].

The implementation of digital tools in Sudan was introduced in many ways; the concept of 'Digital Sudan' holds promise for transforming Sudanese intellectual productions into safer electronic and digital platforms. Several digitization initiatives are underway in Sudan, partly driven by the destruction of libraries in Timbuktu, Mali, which resulted in the loss of significant cultural heritage elements [DM13]. There was an idea for the rehabilitation project of the Sudan National Museum, but due to the war and the need to preserve the artifacts and access Sudanese history, the concept of the 'virtual museum' was proposed and worked upon. Since 2014, the German Archaeological Institute (DAI) has collaborated closely with the National Corporation for Antiquities and Museums to create a national heritage registry. This effort involves digitizing the archive by the German architect Friedrich W. Hinkel, which contains structured information such as pictures, drawings, maps, and compiled written documentation [La17].

4 Virtual Tourism Opportunities and Challenges

Providing immersive experiences through digital 3D scanning and virtual reality technology as mentioned earlier has the potential to preserve and enhance Sudan's cultural heritage. These tools enable visitors to take virtual tours, especially in difficult situations like the ongoing conflict. Furthermore, by simulating traditional practices, virtual reality can improve knowledge and appreciation of cultural practices. However, virtual reality technology can be used to provide safer and more enjoyable travel experiences, address issues of congestion, and enhance tourism in times of emergency.

The integration of virtual experiences into sustainable tourism practices presents both challenges and opportunities. Challenges include the need for the tourism sector to adapt to emerging technologies like VR, especially in the face of current conflict. However, leveraging VR technology can provide travelers with immersive virtual environments, offering safe and interactive travel experiences. Virtual tourism serves as a sustainable alternative to real-life tourism, addressing mobility constraints and increasing tourism during crises, including ongoing conflict. Furthermore, virtual tourism can combat issues like over-tourism and provide a credible solution for travelers seeking continuous and uninterrupted experiences. , One of the primary challenges and limitations related to implementing technology-driven approaches for safeguarding cultural heritage in conflict zones is funding. Insufficient funding often serves as a significant obstacle to executing digitalization projects effectively. Despite collaborations with organizations such as UNESCO and various technology companies, there is still a need for financial support to preserve the cultural heritage.

5 Digitalization of Cultural Heritage Cases

5.1 Railways Building Digitalization Case – Atabara

This project aimed to preserve the cultural heritage in Sudan during the time of conflict and provide an accessible and digital version of the building, especially the railway buildings in Atbara, which are considered one of the heritage buildings in cold zones that need to be digitalized. The tools used in this process were only the phone camera to collect the database through the Yamera app, which helped in controlling the exposure, light, focus, etc. in both videos and photos. The data were imported to Agisoft Metashape, which photogrammetrically processes digital images and generates 3D spatial data through the generation of the matched point from the database and builds a mesh, then builds texture that can be used in geographic information system (GIS) applications, cultural heritage documentation, and visual effects production.

The experience was evaluated as follows: Agisoft Metashape is highly recommended for creating 3D models; the photos and videos were taken by phone, but the quality and size of the photos and videos were very high (6 MB per photo), which initially caused memory

problems in Metashape. The database was converted to JPEG format by Meatshape for a better alignment experience and, most importantly, to scan the site multiple times for better understanding when comparing the final 3D model to the actual building.

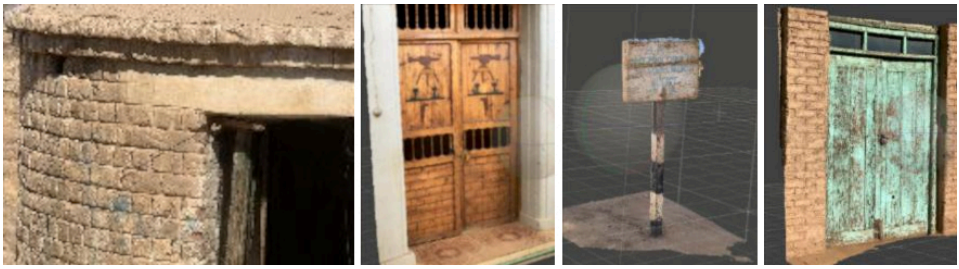

Fig. 2: The digitized building and the three construction elements using Methashape

5.2 The Old Paiwan Aboriginal Settlement Case Study

Taking an old Paiwan aboriginal settlement as an example of the digitization of heritage cultural buildings, a detailed examination of a stone slab house with three different 3D techniques is put into practice. Developed by the Italian software company 3Dflow, 3DF Zephyr software is used to generate 3D models of masonry structures using multi-view image measurements. The software uses a single-lens fixed focal length camera (35mm full-frame camera) SONY A7 uses and has a multi-angle ambient view shooting process. It consists of conjugate points, high-density feature point clouds, polygonal models, and textured materials. The 3D virtual reality model can be viewed from multiple angles and can be used for spatial planning, area measurement, and earthwork calculations. It can also be coupled with Gexcel Reconstructor 3D analysis software for orthophoto, terrain, section, contour line, and transformation contrast analysis [LYL23].

Fig. 3: Immediate scan and immediate overlay, onsite viewing of 3D point cloud - Kaarta Contour mid-range 3D scanner - Virtual reconstruction of the stone slab house and the surrounding topography after scanning with Kaarta Contour [LYL23]

5.3 Digitalization Process

From the two case studies, the digitization of cultural heritage sites involves seven steps, starting with the first step planning to define and select the site in general as well as the

consideration of the availability of resources, the historical significance of the site, etc. The data capture process is the second step, through which the use of 3D scanning tools to take high-quality images and videos. This may involve drones, cameras, laser scanners, and other specialized equipment. The third step is the creation of the 3D model from the accurately captured data to create accurate 3D models, maps, and digital reconstructions of the historical cultural site through photogrammetry software like Agisoft Metashape, 3DF Zephyr, Autodesk Recape, etc. The fourth step is the process of preservation of the data, through which to ensure the saving of the digitized data for long-term usage, and the fifth step is evaluation and elaboration of the collected data to add more information about historical context, multimedia content, and interactive elements. Sharing the final digital model; sharing and making it accessible for people through websites, virtual tours, apps, and other platforms; after that comes the sixth step the collaboration with cultural institutions, researchers, and educators to share the digital content widely. The final step is the evaluation by the users to improve the experience and usability of the digitized cultural heritage sites and enhance public engagement. Through all this, the cultural heritage of Sudan can be saved and shared with global audiences through virtual technologies.

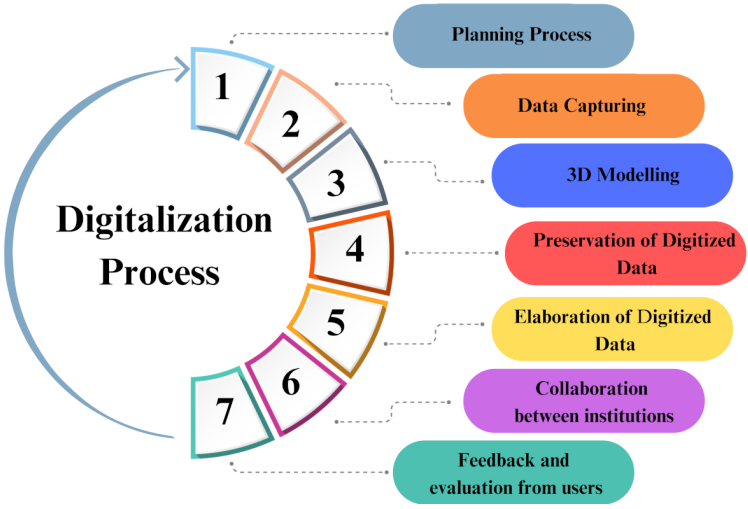

Fig. 4: The Digitalization Process

It's important to mention that 3D scanning provides opportunities to create a preventive database of phantom models of objects for their creation after the end of hostilities and a promising direction for the development of new technologies for performing repair and restoration work. While considering database capture as the most important aspect for accurate 3D modeling Laser scanners, such as those from Faro or Leica, offer excellent range and precision for capturing complex geometries and large-scale objects [TP23].

Drones with virtual reality technology such as 360° cameras can greatly improve the interaction of tourists with cultural ansites, stimulate cultural dialogue, and enhance cultural

appreciation. While the cost-effectiveness of some software programs and the accessibility improvements made possible by virtual single-lens reflex cameras and 360° cameras reap the benefits of historical past practitioners and enable future programs, the use of cameras and virtual tools proves beneficial [Ma19]. By taking noteworthy photogrammetric fashions, 360-degree cameras and digital lens reflex cameras can accurately digitize historical past lifestyles by capturing high-quality photogrammetric models and providing accurate 3D models of cultural heritage buildings. This virtual tool enhances the conservation process by incorporating geo-referenced virtual models for preventive conservation plans, which enable fast and detailed documentation of heritage sites, enhancing their preservation and dissemination for future generations [He22].

6 Outcomes and Lessons Learned

The outcomes of the digitalization process involve mainly the creation of an accurate 3D model, a digital version of cultural heritage sites, through photogrammetry software to have long-term preserved data of the digitalized sites. While enhancing public engagement through virtual reality tools like virtual tours and platforms, as well as collaboration with other institutions and researchers and sharing content globally to reach out to global audiences. The evaluation from users can enhance the overall experience of the digitalized cultural heritage sites and allow the international audience to appreciate the Sudanese cultural heritage which can be used to optimize the digital experience. Also highlights the importance of careful planning and resource disruption, as well as the need for specialized software and tools to ensure the long-term preservation and full access to the Sudanese cultural heritage sites.

The lessons learned revolved around how the preservation of cultural heritage sites has become critically important in today's digital age. The use of digital methods, including photogrammetry and the creation of 3D models, can promote and enhance the preservation and success of cultural heritage sites, which are considered essential. The creation of 3D models and digital reconstructions of Sudanese heritage can be useful when sites can't be reached physically due to their location in hot zones during the ongoing conflict. Also, it allows the creation of interactive experiences through virtual tours, to engage with a wider audience and increase the appreciation of the Sudanese heritage. Additionally, digital perseveration allows the creation of multiple copies to ensure that the data can't be lost, damaged, or destroyed.

However, there are several limitations to keep in mind when persevering the Sudan's cultural heritage. the primary concerns as mentioned earlier, are that sites can't be reached due to their location in war risky areas. Additionally, the funding and the need for high-quality equipment and up-to-date software because are critical. If these requirements are not met, the final product will not be detailed enough or accurate to capture the full complexity of the cultural site which ultimately may lead to limited understanding. Moreover, the digital presentation needs regular updates and maintenance, which is considered a challenge,

particularly in areas with poor infrastructure like Sudan. Finally, the sensitivity and respect of the cultural heritage site take into account throughout the digital process, the cultural significance and context of the site that requires a deep understanding of the site's history.

7 The Way Forward

During times of conflict, Sudan can utilize virtual and digital tools to preserve and promote its cultural heritage. 3D scanning devices, digital preservation technologies, and online platforms are essential tools for heritage preservation. Cameras with digital backs provide high-quality digital files for preservation and wider diffusion. Image processing software protects digital reproductions of artworks and offers virtual restoration tools to improve the appearance and highlight features of interest. VR entails creating appealing destination images and enhancing customer expectations, which are crucial for post-conflict tourism recovery. With advancements in multimedia technologies, VR also provides simulated visits and interactive experiences, enriching travelers' pre-trip experiences. These tools not only promote destinations effectively but also enhance user engagement and satisfaction in the virtual tourism realm. By leveraging these technologies, Sudan can safeguard its intangible and tangible cultural heritage for future generations.

Through the usage of virtual reality to create interactive and engaging experiences, Sudan's cultural heritage can be preserved, accessed, and promoted globally, reducing the risks of war-like conflicts that have persisted since April 2023 on the screen, while virtual reality (VR) technologies such as drones with 360° cameras can dramatically increase visitor engagement with cultural sites. These technologies, such as immersion, animation, presence, and animation, stimulate user engagement, stimulate cultural segmentation behaviors, and ultimately foster cultural appreciation. By allowing visitors to create personalized content and immerse themselves in virtual heritage sites, VR applications facilitate higher levels of engagement and rich interpretation.

8 Conclusion

As the conflict has not come to an end yet, the call for the digitalization of the remaining non-destructed heritage sites is essential through VR and digital technologies, through 3D scanners and photogrammetry applications and to share it with a global audience. This study highlighted the importance of a balance between the adoption and enhancement of technical tools to protect the authenticity and integrity of heritage components for cultural heritage conservation. It highlighted the need for cultural network organizations to work together with local communities to use technology to preserve and promote Sudan's rich cultural heritage in the face of ongoing conflict and to solve the main issues such as funding. By encouraging collaboration, innovation, and inclusion, Sudan can overcome the complexity of technological integration in a way that remains resilient and vibrant despite the challenges facing its heritage culture.

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